Appendix A
Wenatchee Subbasin Plan

Draft
Columbia Cascade Ecoprovince

Wildlife Assessment

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1.0 Wildlife Assessment Framework

This section briefly describes the framework used to develop subbasin wildlife assessments for subbasin plans in Washington State. Appropriate federal, state, tribal, and local wildlife/land management entities were consulted and/or have partnered with the Washington Department of Fish and Wildlife (WDFW) to complete ecoprovince/subbasin plans. As lead wildlife agency in Washington State, WDFW is responsible for compiling wildlife assessment, inventory, and management information for the Columbia Cascade Ecoprovince, which includes the Entiat, Lake Chelan, Wenatchee, Methow, Okanogan, and the Upper Middle Mainstem of the Columbia River subbasins. Ecoprovince level planners chose to include the Crab subbasin in the assessment and inventory of wildlife resources due to the ecological similarities with the subbasins in the Columbia Cascade Ecoprovince. To avoid confusion, the term *"Ecoprovince*" refers collectively, therefore, to the Entiat, Lake Chelan, Wenatchee, Methow, Okanogan, Upper Middle Mainstem Columbia River, and Crab subbasins. These contiguous subbasins occupy the north central portion of Washington State east of the Cascade Mountains (Figure_1).

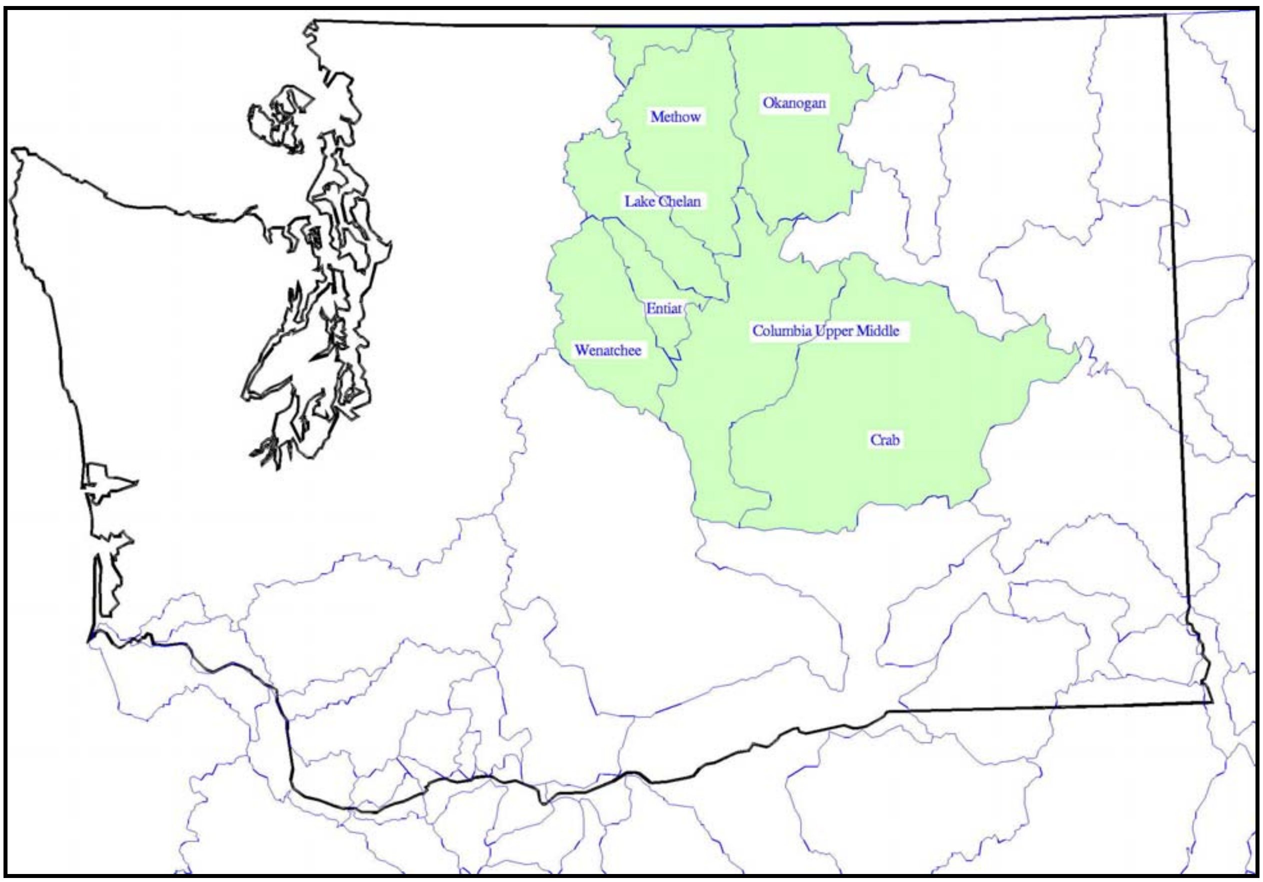

Figure 1. Location of the Columbia Cascade Ecoprovince, Washington.

Ecoprovince subbasins share similar habitats, soils, wildlife populations, limiting factors, land uses, and physiographic/hydrologic features. Furthermore, water from streams and rivers within the Ecoprovince eventually converge with the Columbia River, further tying the subbasins together at the landscape level.

Wildlife conservation activities are usually conducted in a partial, fragmented way that emphasizes only a single species or a habitat type in a small geographic area. Advances in conservation biology reveal a need for a holistic approach - protecting the full range of biological diversity at a landscape scale with attention to size and condition of core areas (or refugia), physical connections between core areas, and buffer zones surrounding core areas to ameliorate impacts from incompatible land uses. As most wildlife populations extend beyond subbasin or other political boundaries, this "conservation network" must contain habitat of sufficient quantity and quality to ensure long-term viability of wildlife species. Subbasin planners recognized the need for large-scale planning that would lead to effective and efficient conservation of wildlife resources.

In response to this need, Ecoprovince level planners created an approach to subbasin planning at two scales. The Ecoprovince scale emphasizes focal macro habitats and related strategies, goals, and objectives. The subbasin scale highlights species guilds, individual focal species, important micro habitats, and habitat linkages, as well as subbasin specific strategies, goals, and objectives that are not addressed at the Ecoprovince level. To facilitate this multi-faceted approach, Ecoprovince planners organized two interactive planning teams consisting of Ecoprovince level planners and subbasin level planners (Figure 2). Washington Department of Fish and Wildlife is the lead planning entity for the wildlife assessment at the Ecoprovince level. Subbasin lead entities are shown in Table 1. Subbasin level planners provide information to the Ecoprovince level planners on both the subbasin and landscape scale.

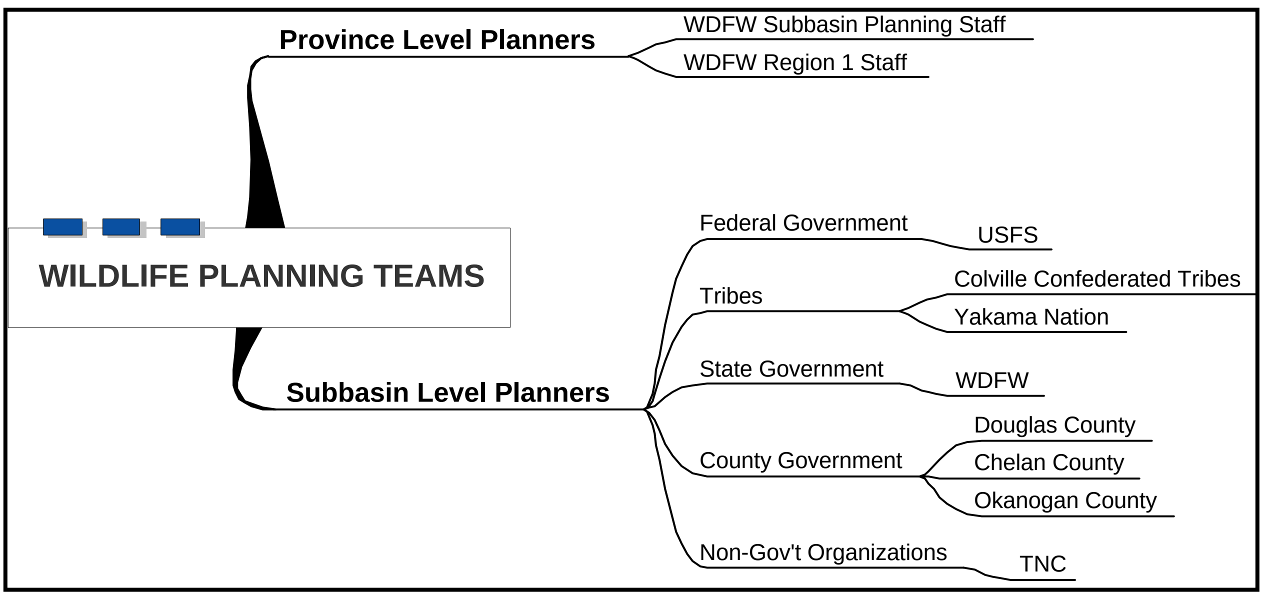

Figure 2. Columbia Cascade Ecoprovince and subbasin wildlife planning organization.

Table 1. Subbasin lead entities for the Columbia Cascade Ecoprovince, Washington.

Subbasin	Lead Entity
Entiat	Yakama Nation, Chelan County
Lake Chelan	WDFW, Chelan County
Wenatchee	Yakama Nation, Chelan County
Methow	Yakama Nation, Okanogan County
Okanogan	Colville Tribes, Okanogan County
Upper Middle Mainstem Columbia River	WDFW, Douglas County
Crab	WDFW

1.1 Assessment Tools

The wildlife assessment was developed from a variety of "tools" including subbasin summaries, the Northwest Habitat Institute's (NHI's) Interactive Biodiversity Information System (IBIS), WDFW Priority Habitats and Species (PHS) database, Washington GAP Analysis database, Partners in Flight (PIF) information, National Wetland Inventory maps, Ecoregion Conservation Assessment (ECA) analyses, and input from local state, federal, and tribal wildlife managers. Specific information about these data sources is located in Appendix_A.

Although IBIS is a useful assessment tool, it should be noted that the historic habitat maps have a minimum polygon size of 1 km^2 while current NHI wildlife habitat maps have a minimum polygon size of 250 acres (T. O'Neil, NHI, personal communication, 2003). In either case, linear aquatic, riparian, wetland, subalpine, and alpine habitats are under represented as are small patchy habitats that occur at or near the canopy edge of forested habitats. It is also likely that micro habitats located in small patches or narrow corridors were not mapped at all. Another limitation of NHI data is that they do not reflect habitat quality nor do they associate habitat elements (key environmental correlates [KECs]) with specific areas. As a result, a given habitat type may be accurately depicted on NHI map products, but may be lacking quality and functionality. For example, NHI data do not distinguish between shrubsteppe habitat dominated by introduced weed species and pristine shrubsteppe habitat.

Washington State GAP data were also used extensively throughout the wildlife assessment. The GAP-generated acreage figures may differ from NHI figures as an artifact of using two different data sources. The differences, however, are relatively small (less than five percent) and will not impact planning and/or management decisions.

The ECA spatial analysis is a relatively new terrestrial habitat assessment tool developed by The Nature Conservancy (TNC). The ECA has not been completed in all areas within the greater Columbia River Basin. Where possible, however, WDFW integrated ECA outputs into Ecoprovince/ subbasin plans. The major contribution of ECA is the spatial identification of priority areas where conservation strategies should be implemented. Ecoregion Conservation Assessment products were reviewed and modified as needed by local wildlife area managers and subbasin planners.

2.0 Physical Features

2.1 Land Area

The Ecoprovince covers approximately 21.6 percent of Washington State (66,582 mi^2) and, at an estimated 14,338 mi^2 (9,174,848 acres), is 62 percent larger than the state of Maryland. Of the seven subbasins in the Ecoprovince, the Crab subbasin is the largest, consisting of 3,159,052 acres (4,936 mi^2) and comprising 34.4 percent of the entire Ecoprovince (Table_2). The Entiat subbasin is the smallest, making up only 3.2 percent of the Ecoprovince.

2.2 Physiography

The Ecoprovince is within the Columbia Plateau, a vast area of arid and semi-arid landscape that begins in the rainshadow of the Cascade Mountains and extends east to cover most of the non-forested portions of eastern Oregon and Washington. The Columbia Plateau is characterized by a relatively uniform underlying geology dominated by thick flows of basalt lava that are punctuated in localized areas by volcanic ashflows and deposits of volcanic tuffs and rhyolite. The uniform bedrock of the Columbia Plateau has been faulted and uplifted, cut by rivers and eroded by wind, water, and glaciers to produce a diverse landscape that contains considerable topographic relief. Present within the landscape are desert mountain ranges, low rolling hills, riverine valleys, broad basins containing permanent lakes and seasonal playas,

Table 2. Subbasin size relative to the Columbia Cascade Ecoprovince and Washington State (NHI 2003).

Subbasin	Size		Percent of Ecoprovince	Percent of State
	Acres	Mi^2		
Enitat	298,363	466	3.2	.7
Lake Chelan	599,925	937	6.5	1.4
Wenatchee	851,894	1,333	9.3	2.0
Methow	1,167,795	1,825	12.7	2.8
Okanogan	1,490,079	2,328	16.2	3.5
Upper Middle Mainstem Columbia River	1,607,740	2,512	17.5	3.8
Crab	3,159,052	4,936	34.4	7.4
Total (Ecoprovince)	**9,174,848**	**14,337**	**100**	**21.6**

sand dunes, plateaus, and expansive plains. Many of the current features present in the region date only from the Pleistocene epoch or one million years before present. This is a relatively new landscape that is continuing to change and be altered by natural processes.

The Palouse bioregion (Bailey 1995) covers 3,953,600 mi^2 in west central Idaho, southeastern Washington, and northeastern Oregon between the western edge of the Rocky Mountains and the Columbia River Basin. The region is characterized by a moderate climate and loess soils deposited on plateaus dissected by rivers deeply incised through layers of bedded basalt. The Palouse Prairie, composed primarily of interior grasslands, lies at the eastern edge of the Palouse bioregion, north of the Clearwater River. Here, where the loess hills are most developed, soils are often more than 39 inches deep. The depth and fertility of the soils make the region one of the world's most productive grain-growing areas (Williams 1991).

The highly productive loess dunes which characterize the region are Pleistocene in origin (Alt and Hyndman 1989). Having been deposited by southwest winds, the steepest slopes (up to 50 percent slope) face the northeast. The dune-like topography and northeastern orientation are important ecological features; the lee slopes are moist and cool, and level areas tend to be in the bottom lands. Due to their ontogeny, low-lying areas are often disconnected from stream systems and are thus seasonally saturated.

Geology on the west side of the Ecoprovince is a result of massive meltwater flooding during the last ice age which radically altered the geology and vegetation patterns over the entire Columbia Basin. The most spectacular meltwater floods were the Spokane Floods, also known Missoula floods for the glacial lake of their origin, or as Bretz floods, after J. Harlan Bretz, their discoverer. Bretz (1959) first discerned that the geology of Washington’s aptly named channeled scablands must have been due to flooding, the origin of which was due to periodic failures of ice dams holding back 2,000 km^2 of water in glacial Lake Missoula (Waitt 1985).

The effect of the Spokane floods was profound. A network of meltwater channels was cut through bedrock hundreds of feet deep and as many miles long, reaching from the Idaho panhandle to the mouth of the Columbia and even into Oregon. The floods moved huge walls of rock and mud across the state, leaving behind a landscape of scoured bedrock, dry waterfalls, alluvial gravels the size of trucks, anomalous rock deposits left by rafted ice blocks, and ripple bars with 30-meter crests. Over the last 10,000 years, these flooded landscapes developed into unique plant communities, possibly even producing new species, such as *Hackelia hispida* var. *disjuncta* (Hitchcock *et al.* 1969; Gentry and Carr 1976), which only occurs in large meltwater coulees.

In some areas the flood sediments have been locally reworked by wind to form dune sands or loess deposits (Reidel *et al.* 1992). Another prominent soil feature which covers hundreds of square miles of central Washington and occurs in the northwest corner of the Ecoprovince is the regularly spaced low mounds of fine soil atop a matrix of scoured basalt, known as biscuit-swale topography. This type of patterned ground has many competing hypotheses to explain its origin, such as intensive frost action associated with a periglacial climate (Kaatz 1959).

Soils are a conspicuous component of shrubsteppe ecosystems and influence the composition of the vegetation community. The composition, texture, and depth of soils affect drainage, nutrient availability, and rooting depth and result in a variety of edaphic climax communities (Daubenmire 1970). Much of the interior Columbia Basin in eastern Washington is underlain by basaltic flows, and the soils vary from deep accumulations of loess-derived loams to shallow lithosols in areas where glacial floods scoured the loess from underlying basalt. Sandy soils cover extensive areas in the west central and southern parts of the basin, the result of glacial outwash and alluvial and wind-blown deposition (Daubenmire 1970; Wildung and Garland 1988). Results of a previous census of shrubsteppe birds in eastern Washington suggested that the abundance of some species might vary with soil type of the vegetation community (Dobler *et al.* 1996). If it exists, this relationship might prove a valuable asset to management, because soils are a mapable component of the landscape and could be incorporated into spatially explicit models of resource use and availability.

In this landscape, riparian and wetland habitats have special importance and provide significant distinction to the region. The Ecoprovince contains two very different types of river systems: one which has direct connections to the Pacific Ocean and in many instances still supports anadromous fish populations, and one that contains only internally drained streams and is one of the defining characteristics of the hydrographic Great Basin.

The natural history of the Columbia Basin led to the development of many, diverse communities typically dominated by shrubs or grasses that are specialized for living in harsh, dry climates on a variety of soils. Many other species have adapted to these conditions, including invasive species, which have fundamentally altered the function of the ecosystem. Arno and Hammerly (1984) identified a number of factors that help maintain the treeless character of these areas: wind speed and duration; soils and geology; temperature; snow; precipitation; soil moisture; frozen ground; light intensity and biotic factors such as the lack of thermal protection from tree cover, and the lack of a seed bank for new tree establishment. Of these, the authors postulated the strongest determinants of tree exclusion to be precipitation, insolation (excessive heating) and cold.

3.0 Socio-Political Features

3.1 Land Ownership

Ecoprovince land ownership is illustrated in Figure_3. Approximately 48 percent of the Ecoprovince is in federal, state, tribal and local government ownership, while the remaining 52 percent is privately owned (Table_3). The Colville Indian Reservation is approximately 341,333 acres and encompasses 21 percent and 1.8 percent of the total land base in the Okanogan and Upper Middle Mainstem Columbia River subbasins, respectively, or 4 percent of the Ecoprovince overall. The Lake Chelan subbasin is comprised of the highest percentage (86 percent) of federally owned lands in the Ecoprovince, while federal ownership in the Upper Middle Mainstem Columbia River subbasin makes up only 8 percent of subbasin.

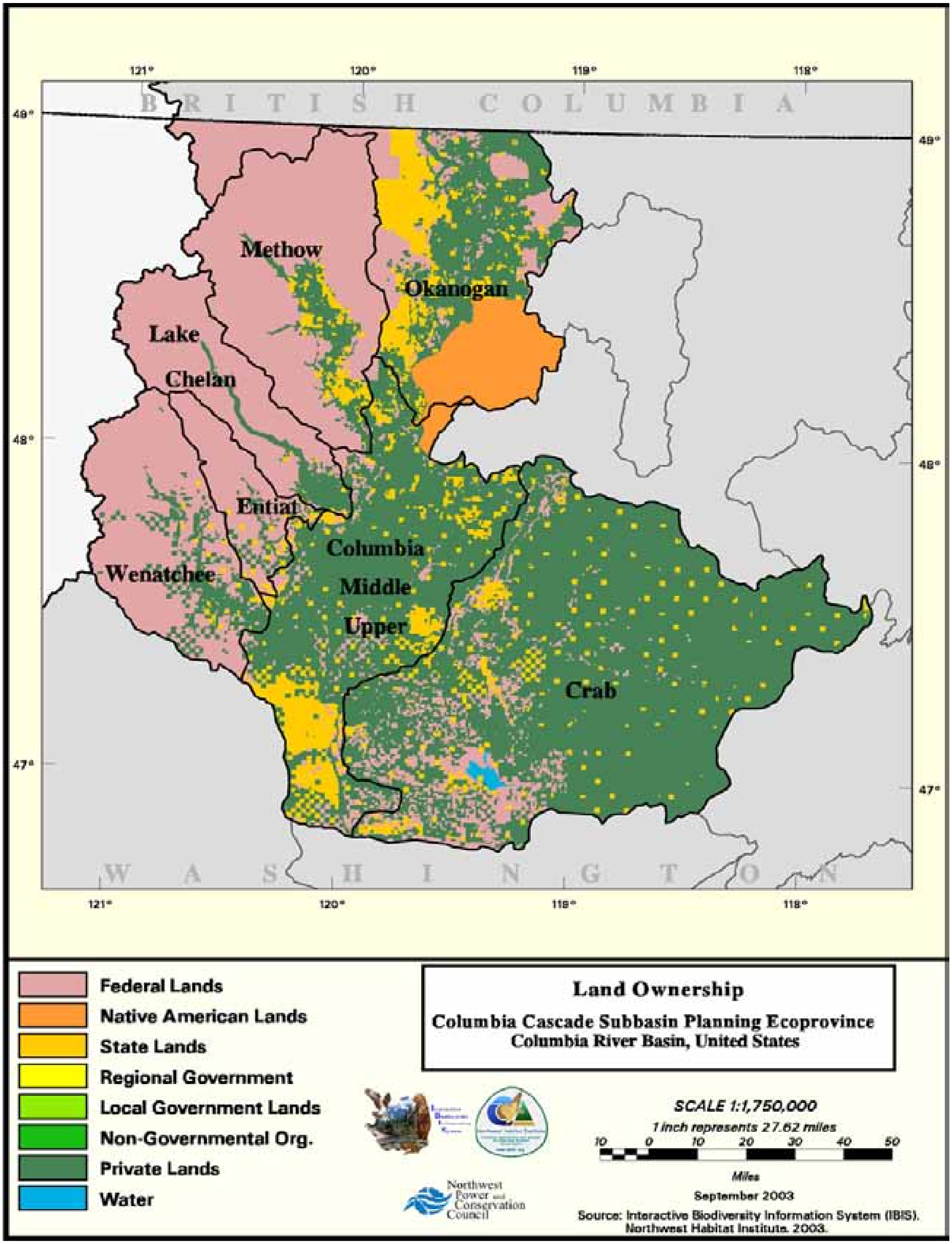

Figure 3. Land ownership of the Columbia Cascade Ecoprovince, Washington (NHI 2003).

Table 3. Land ownership of the Columbia Cascade Ecoprovince, Washington (NHI 2003).

Subbasin	Federal Lands[1] (acres)	Tribal Lands (acres)	State Lands[2] (acres)	Local Gov't Lands (acres	Private Lands (acres)	Water (acres)	Total (Subbasin) (acres)
Entiat	247,064	0	13,629	0	37,670	0	298,363
Lake Chelan	517,883	0	3,549	0	78,493	0	599,925
Wenatchee	682,295	0	11,836	0	159,182	0	853,313
Methow	985,234	0	55,836	0	126,724	0	1,167,794
Okanogan	400,496	311,826	261,598	0	516,159	0	1,490,079
Upper Middle Mainstem Columbia River	124,492	29,507	284,996	0	1,168,744	0	1,607,739
Crab	303,136	0	13,629	25	2,681,363	16,100	3,014,253
Total (Ecoprovince)	3,260,600	341,333	645,073	25	4,768,335	16,100	9,031,466

[1] Includes lands owned by U.S. Forest Service, U.S. Fish and Wildlife Service, Bureau of Reclamation, and U.S. Army Corps of Engineers.

[2] Includes lands owned by WDFW, Washington State Parks, University, and Washington Department of Natural Resources.

3.2 Land Use

This section is meant to describe broad changes in land use throughout the Ecoprovince from circa 1850 to today. A more detailed discussion of changes in vegetation, wildlife habitats and factors limiting wildlife population and abundance (resulting from changes in land use) can be found in section 4.

It is well known that the Ecoprovince has undergone extensive change over the past 125 years. The European-American settlement and land-use patterns differed dramatically from Native American practices. Native Americans lived in the river valleys, while European-Americans lived on the prairies. Native Americans were hunter-gatherers or low-impact agriculturists of native species; the European-Americans were high-impact agriculturists of introduced species.

Both biophysical and human changes have been closely associated with advances in agricultural technology. The conversion from perennial native grass, shrub, and forest vegetation to agriculture and the interactions between human cultures and environment influenced the extent and spatial pattern of landscape change, and therefore influenced wildlife population dynamics and viability.

Major changes in land use between 1901 and 1930 resulted from the intensification of agriculture. Farming became commercialized. Farming remained labor-intensive and still relied heavily on human and horse power. An organized harvesting/threshing team in the 1920s required 120 men and 320 mules and horses (Williams 1991). The quest for a less labor-intensive bushel of wheat continued, but combine use lagged behind other farming areas in the United States (Williams 1991). It was only when the Idaho Harvester Company in Moscow began to manufacture a smaller machine that widespread combine harvesting became feasible (Sisk 1998). Such improvements enabled farmers to use lands previously left for grazing and as "waste," but the steepest hills and hilltops were still left as pasture for cattle and horses.

The era between 1931 and 1970 was one of continued mechanization, and especially industrialization. With the development of each new technology, farming became less labor intensive, allowing fewer people to farm larger areas. Petroleum-based technology replaced horse and most human labor early in the era. By 1970, most farm workers used motorized equipment, which removed the need for pasture lands and provided equipment that could till even the steepest slopes. Fertilizers, introduced after World War II, increased crop production by 200 – 400 percent (Sisk 1998). Federal agricultural programs encouraged farmers to drain seasonally wet areas, allowing farming in flood plains and seasonally saturated soils. With the advent of industrial agriculture, the last significant refugia for native communities were plowed.

Since 1970, major changes have occurred in the composition of the rural population and land use. Rural populations began to rise as more town and city residents sought rural suburban homesites. Some lands with highly erodible soils have been temporarily removed from crop production under the Federal Conservation Reserve Program (CRP). In Douglas County alone, this program removed about 187,711 acres from agricultural production (R. Fox, WDFW, personal communication, 2003)

Instead of living in the river canyons and foraging on the prairies, people now live on the prairies, cultivate the former wild meadows, and recreate in the river canyons. Local economies are based on extraction rather than subsistence. With each advance in agricultural technology, crop production has increased and more native vegetation has been converted to field or pasture. First the draining of wetlands, then equipment that enabled farming of steep slopes, then the introduction of chemicals; each effectively shrank remaining refugia for native flora and fauna. Grazing and farming introduced new species and imposed a different set of disturbance regimes on the landscape.

A broad-scale analysis lacks the spatial resolution necessary to detect changes in the number and composition of small patches, connectivity, and other fine-grained landscape patterns. Ecoprovince planners believe that the past abundance of riparian areas and the small patches of wetlands and shrubs once common in the Ecoprovince are vastly underestimated. The fine-scale topography of the Ecoprovince would have harbored wetlands of a size too small to be captured at the current scale. In addition, such changes were captured only over the last 90 years, 40 years after European-Americans began to settle the area.

Planners also believe small patches of brush, grass, and riparian vegetation was converted to agriculture, mostly from open shrublands and riparian areas. Most forest lands were logged, creating open forests with shrubs. Significant conversions of riparian areas to fields and pastures probably occurred between 1880 and 1940. Stringers of riparian vegetation shrunk to thin, broken tendrils, and shrub vegetation virtually disappeared. The cumulative effects of such changes are enormous. Alteration in the size, quality, and connectivity of habitats may have important consequences for wildlife species (Forman and Godron 1986; Soule 1986).

Many once-intermittent streams are now farmed; many perennial streams with large wet meadows adjacent to them are now intermittent or deeply incised, and the adjacent meadows are seeded to annual crops. Clean farming practices (field burning, herbicide use, and roadbed-to-roadbed farming) leave few fences and fewer fencerows, negatively impacting even those edge species which can flourish in agricultural areas (Ratti and Scott 1991).

With the virtual elimination of native habitats, species dependent on these habitats have declined or disappeared as well. Formerly abundant sharp-tailed grouse (*Tympanchus phasianellus*) occur only in highly fragmented, marginal, and disjunct populations (Kaiser 1961; Burleigh 1972; Ratti and Scott 1991). The white-tailed jack rabbit (*Lepus townsendii*) and ferruginous hawk (*Buteo regalis*) have been nearly extirpated as breeding populations.

At the same time, new land uses offer habitats for a different suite of species (Table_4). Humans have intentionally introduced the gray partridge (*Perdix perdix*), ring-necked pheasant (*Phasianus colchicus*), turkey (*Meleagris gallopavo*), and chukar (*Alectoris chukar*), species which generally fare well in agricultural landscapes. Grazing, agriculture, and accidents have introduced a variety of exotic plants, many of which are vigorous enough to earn the title "noxious weed" (Table_5).

Table 4. Examples of changes in species composition: increasing and decreasing species since European-American settlement.

Decreasing		Increasing	
Common Name	**Scientific Name**	**Common Name**	**Scientific Name**
Sharp-tailed grouse	*Pedioecetes phasianellus*	Ring-necked pheasant	*Phasianus colchicus*
Black-tailed jack rabbit	*Lepus californicus*	White-tailed jack rabbit	*L. townsendii*
Mule deer	*Odocoileus hemionus*	White-tailed deer	*O. virginianus*
Ferruginous hawk	*Buteo regalis*	European starling	*Sturnus vulgaris*
Spotted frog	*Rana pretiosa*	Bullfrog	*R. catesbeiana*

Table 5. Noxious weeds in the Columbia Cascade Ecoprovince, Washington (Callihan and Miller 1994).

Common Name	Scientific Name	Origin
Field bindweed	*Convolvulus arvensis*	Eurasia
Scotchbroom	*Cytisus scoparius*	Europe
Buffalobur nightshade	*Solanum rostratum*	Native to the Great Plains of the U.S
Pepperweed whitetop	*Cardaria draba*	Europe
Common crupina	*Crupina vulgaris*	Eastern Mediterranean region
Jointed goatgrass	*Aegilops cylindrica*	Southern Europe and western Asia
Meadow hawkweed	*Hieracium caespitosum*	Europe
Orange hawkweed	*Hieracium aurantiacum*	Europe
Poison hemlock	*Conium maculatum*	Europe
Johnsongrass	*Sorghum halepense*	Mediterranean
White knapweed	*Centaurea diffusa*	Eurasia
Russian knapweed	*Acroptilon repens*	Southern Russia and Asia
Spotted knapweed	*Centaurea bibersteinii*	Europe
Purple loosestrife	*Lythrum salicaria*	Europe
Mat nardusgrass	*Nardus stricta*	Eastern Europe
Silverleaf nightshade	*Solanum elaeagnifolium*	Central United States
Puncturevine	*Tribulus terrestris*	Europe
Tansy ragwort	*Senecio jacobaea*	Eurasia
Rush skeletonweed	*Chondrilla juncea*	Eurasia
Wolf's milk	*Euphorbia esula*	Eurasia
Yellow star thistle	*Centaurea solstitialis*	Mediterranean and Asia
Canadian thistle	*Cirsium arvense*	Eurasia
Musk thistle	*Carduus nutans*	Eurasia
Scotch cottonthistle	*Onopordum acanthium*	Europe
Dalmatian toadflax	*Linaria dalmatica*	Mediterranean
Yellow toadflax	*Linaria vulgaris*	Europe

Conversion of agricultural lands to suburban homesites invites a second new suite of biodiversity onto the Ecoprovince. Suburbanization of agricultural lands does not necessarily favor native species. Rapid colonization by an exotic bullfrog (*Rana catesbeiana*) may compete with and/or eat native amphibians, including the sensitive spotted frog (*Rana pretiosa*). The brown-headed cowbird (*Molothrus ater*) and European starling (*Sturnus vulgaris*) have taken advantage of the new habitats and moved into the area. The black-tailed jack rabbit (*Lepus californicus*) has largely displaced the white-tailed jack rabbit (Tisdale 1961; Johnson and Cassidy 1997).

Changes in biodiversity in the canyonlands follow a parallel track, though from slightly different causes. Due to steep slopes and infertile soils, the canyonlands have been used for grazing instead of farming (Tisdale 1986). Intense grazing and other disturbances have resulted in irreversible changes, with the native grasses being largely replaced by nonnative annual brome grasses and noxious weeds.

Breaking of the original perennial grass cover left the soil vulnerable to erosion by wind and water. Commercial farming practices exacerbated these problems. Summer fallow leaves the soils with poor surface protection during the winter; burning crop residues leave the soil with less organic binding material; and heavier, more powerful farming equipment pulverizes the soil, leaving it more vulnerable to wind and water erosion (Kaiser 1961).

Erosion measurements and control efforts began in the early 1930s. Soil loss by water erosion in the Upper Middle Mainstem Columbia River subbasin was most severe in portions of farmed areas of Douglas County, where soil losses of 20 tons/acre/year from wind erosion and 10 tons/acre/year from water erosion occurred (M. Bareither, NRCS, personal communication, 2003).

Intensification of agriculture has affected both water quantity and quality as well. Replacing perennial grasses with annual crops resulted in more overland flow and less infiltration, which translates at a watershed level to higher peak flows that subside more quickly than in the past. The result is more intense erosion and loss of perennial prairie streams.

Changes in vegetation and settlement pattern have changed the frequency, size, and pattern of the Ecoprovince's two major disturbances: fires and floods. European-American settlers used fire to clear land for settlement and grazing. Since then, forest fires have become less common because of fire suppression, human settlement, the presence of roads which act as fire breaks, and the conversion of grass and forests to cropland (Morgan *et al.* 1996). One result of the lower fire frequency has been increasing tree density on forested lands and encroachment of shrubs and trees into previously open areas. Consequently, when fires occur in forests they are more likely to result in mixed severity or stand-replacing events instead of the low severity fires of the past. Fires are still frequent in canyons, though today, fires give exotic annual grasses an edge over native species in burned areas.

Flooding on the major rivers has been curtailed in the region by large hydroelectric projects on the Columbia River. Changes in hydrology, such as drainage tiles placed under seasonally wet areas to allow agricultural production, removal of riparian vegetation, channeling of streams, and building in flood plains, contribute to more severe localized flood events during winter and spring.

3.3 Protection Status

The Northwest Habitat Institute relied on Washington State GAP data to determine how concentrations of species overlap with the occurrence of protected areas. Locations where species concentrations lie outside protected areas constitute a "gap" in the conservation protection scheme of the area. One limitation of the GAP Analysis approach is the need for accurate information on the geographic distribution of each component species. The GAP "protection status" is the classification scheme or category that describes the relative degree of management or protection of specific geographic areas for the purpose of maintaining biodiversity. The goal is to assign each mapped land unit with categories of management or protection status, ranging from 1 (highest protection for maintenance of biodiversity) to 4 (no or unknown amount of protection. Protection status categories (Scott *et al.* 1993; Crist *et al.* 1995; Edwards *et al.* 1995) are further defined below.

Status 1 (High Protection): An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a natural state within which disturbance events of natural type are allowed to proceed without interference or are mimicked through management. Wilderness areas garner this status. Approximately 12 percent of the Ecoprovince is within this category.

Status 2 (Medium Protection): An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a primarily natural state, but which may receive use or management practices that degrade the quality of the existing natural state. An estimated 3 percent of the lands within the Ecoprovince are in this category.

Status 3 (Low Protection): An area having permanent protection from conversion of natural land cover for the majority of the area, but subjective to uses of either a broad, low intensity type or localized intense type. It also confers protection to federally listed endangered and threatened species throughout the area. Lands owned by WDFW within the Ecoprovince fall within medium and low protection status. Twenty-seven percent of the lands within the Ecoprovince are in this category.

Status 4 (No or Unknown Protection): Lack of irrevocable easement or mandate to prevent conversion of natural habitat types to anthropogenic habitat types and allow for intensive use throughout the tract, or existence of such activity is unknown. This category includes the majority (58 percent) of the land base within the Ecoprovince.

The protection status and amount of land within each subbasin are described in Table 6 and illustrated in Figure 4. Protection status by ownership at the 6th level hydrologic unit code (HUC) is shown in Figure 5.

Table 6. Protection status of lands in the Columbia Cascade Ecoprovince, Washington (NHI 2003).

Subbasin	Status 1: High Protection (acres)	Status 2: Medium Protection (acres)	Status 3: Low Protection (acres)	Status 4: No Protection (acres)	Total (Subbasin)
Entiat	25,130	3,926	221,978	47,329	**298,363**
Lake Chelan	277,480	63,069	195,607	63,769	**599,925**
Wenatchee	312,265	1,611	360,451	177,567	**851,894**
Methow	317,865	14,078	706,058	129,794	**1,167,795**
Okanogan	199,143	12,798	438,793	839,345	**1,490,079**
Upper Middle Mainstem Columbia River	0	109,523	312,766	1,185,451	**1,607,740**
Crab	0	70,861	215,072	2,873,119	**3,159,052**
Total (Ecoprovince)	**1,131,883**	**275,866**	**2,450,725**	**5,316,374**	**9,176,265**

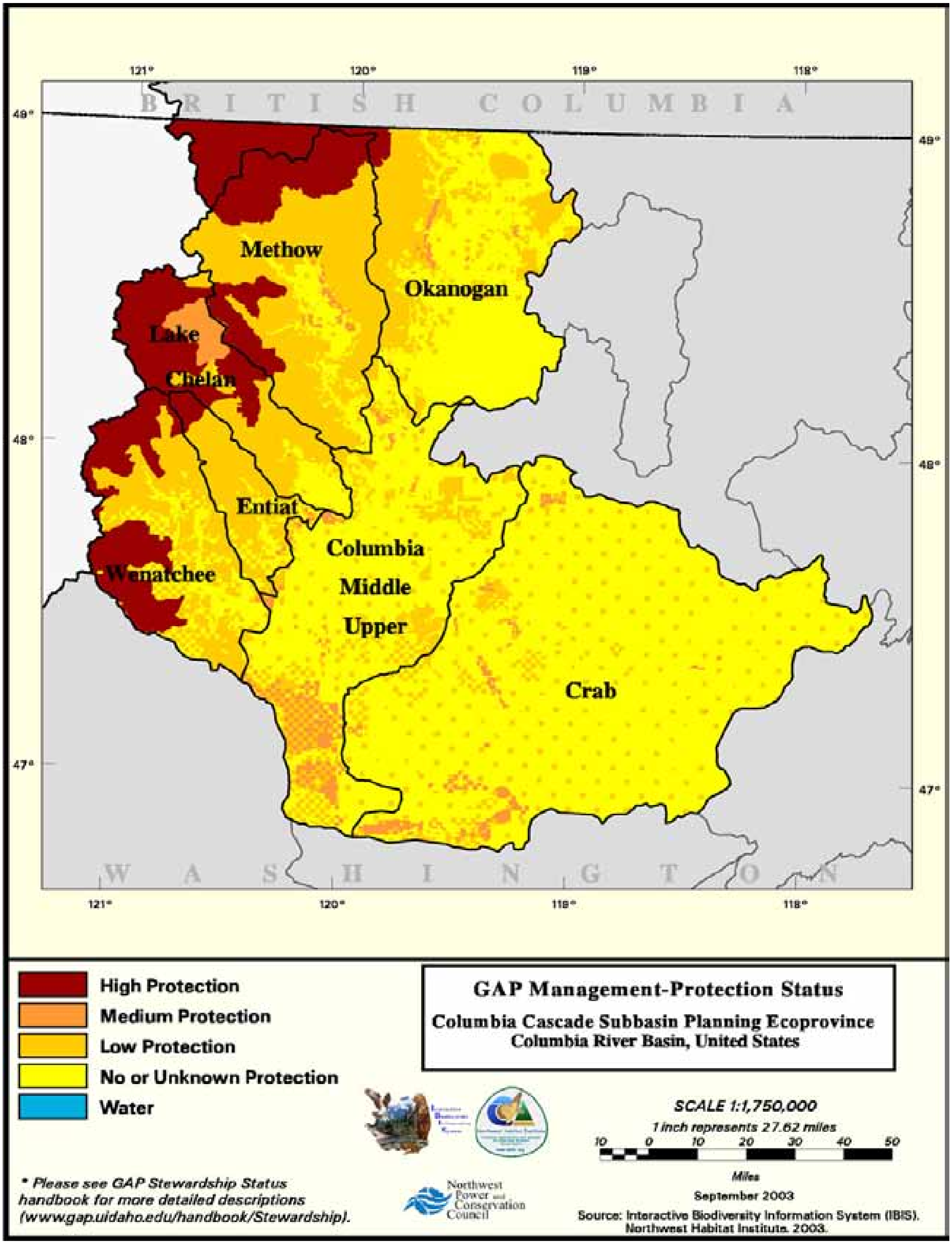

Figure 4. GAP management-protection status of lands within the Columbia Cascade Ecoprovince, Washington (NHI 2003).

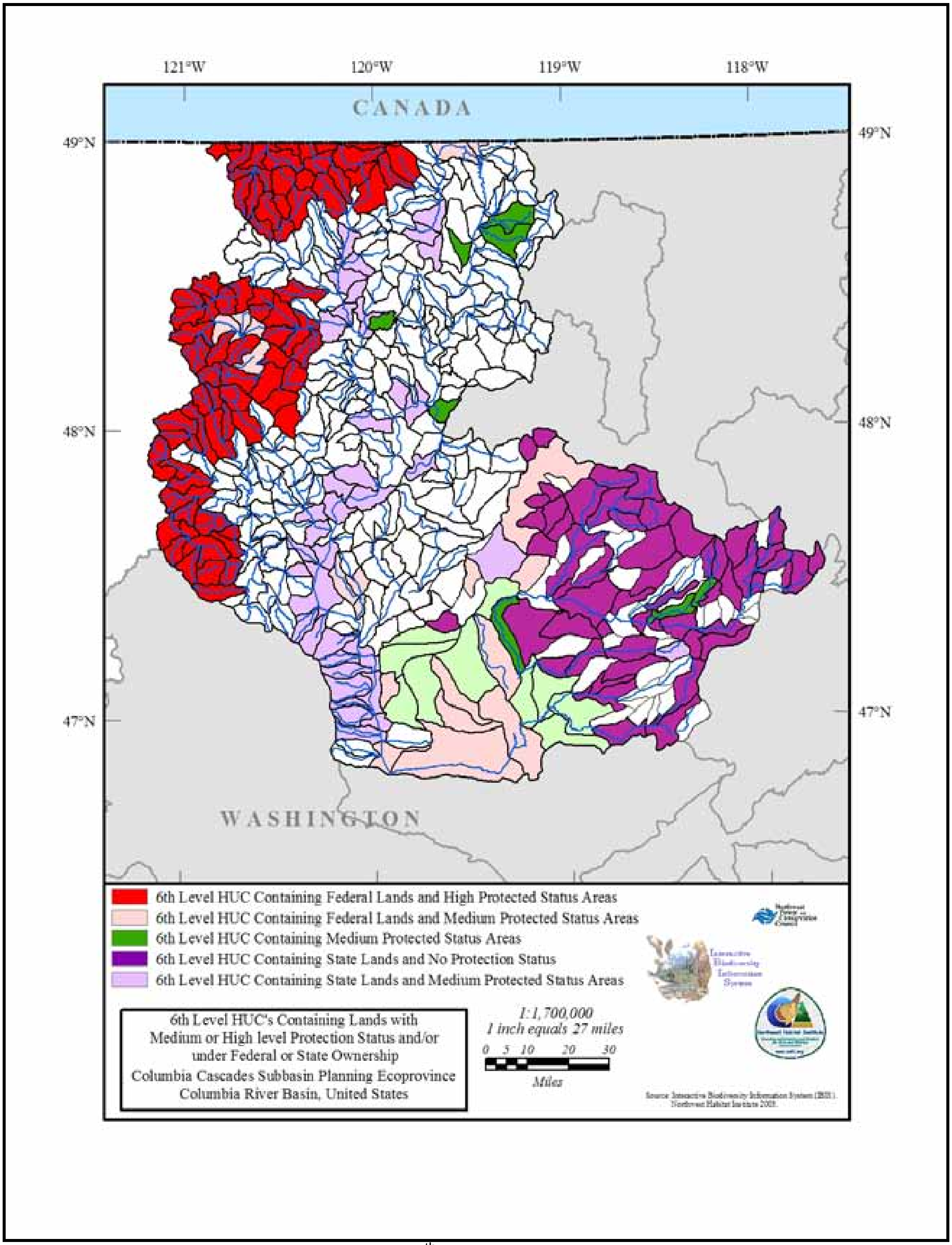

Figure 5. Protection status of lands at the 6th - level HUC within the Columbia Cascade Ecoprovince, Washington (NHI 2003).

3.4 Ecoregion Conservation Assessment Priorities and Public Land Ownership

Together with TNC, WDFW identified and prioritized critical wildlife habitats throughout eastern Washington using the ECA process. The primary distinction between ECA classes in the wildlife assessment is the amount of risk potential associated with those habitats. Ecoprovince ans subbasin planners used this relatively new "tool" in conjunction with EDT and NHI information to identify critical wildlife/fish habitats and needs throughout the entire Ecoprovince and to develop strategies to address Ecoprovince/subbasin limiting factors and management goals (for further discussion on ECA, see Appendix_A). Ecoregion Conservation Assessment classifications include:

- Class 1: Key habitats mostly under private ownership (high risk potential)
- Class 2: Key habitats on public lands (low to medium risk depending on ownership)
- Class 3: Unclassified/unspecified land elements (mainly agricultural lands)

An integral part of any land protection or prioritization process is to identify those lands already under public ownership and, thus, likely afforded some protection. The ECA analysis has been completed for the Upper Middle Mainstem Columbia River and Crab subbasins, but is not yet complete for the Columbia Cascade Ecoprovince.

4.0 Ecological Features

4.1 Vegetation

Ecoprovince rare plant information, wildlife habitat descriptions, and changes in habitat distribution, abundance and condition are summarized in the following sections. Landscape level vegetation information is derived from the Washington GAP Analysis Project (Cassidy 1997) and NHI data (2003).

The eastern Cascade forests are bioregionally outstanding and are endangered (Ricketts *et al.* 1999:231). Vegetation is highly variable throughout the Ecoprovince and is influenced primarily by edaphic processes and disturbance regimes (Franklin and Dyrness 1973). Several ecotones exist, particularly along the Cascade crest where western Cascade forest types overlap with eastern Cascade forests (e.g., the Wenatchee National Forest in Washington has conifer species present on both sides of the Cascade) and along the lower timberline where forest species mix with shrub and shrubsteppe communities (Franklin and Dyrness 1973).

The natural vegetation of the region is a complex mosaic of shrublands, grasslands, and coniferous forests (Küchler 1966; Franklin and Dyrness 1973; Bailey 1995). The dominant forest type along the eastern slopes of the Cascade is ponderosa pine (*Pinus ponderosa*) (Franklin and Dyrness 1973). Within forested landscapes, species composition (forest type) varies along environmental gradients defined by physical factors such as temperature and moisture (DellaSala *et al.* 1996). Topographic-moisture gradients (e.g., from sheltered valleys to exposed ridges) and soil conditions further determine the distribution of vegetation types. Fire resistance among different communities varies considerably (Habeck and Mutch 1973).

4.1.1 Rare Plant Communities

The Ecoprovince contains several rare plant occurrences and high-quality plant communities, the approximate locations of which are illustrated in Figure_6. An estimated 44 percent of the rare plant communities in the Ecoprovince are associated with upland forested habitats, 19 percent with shrubsteppe habitat, 15 percent with grassland habitat, 8 percent with riparian habitat, and 14 percent with wetland habitat. For a detailed list of known rare plant occurrences and high quality/rare plant communities in the Ecoprovince, see Appendix_D.

Table_7. Detailed descriptions of these habitat types can be found in Appendix_B. Historic and current wildlife habitat distribution is illustrated in Figure_7 and Figure_8.

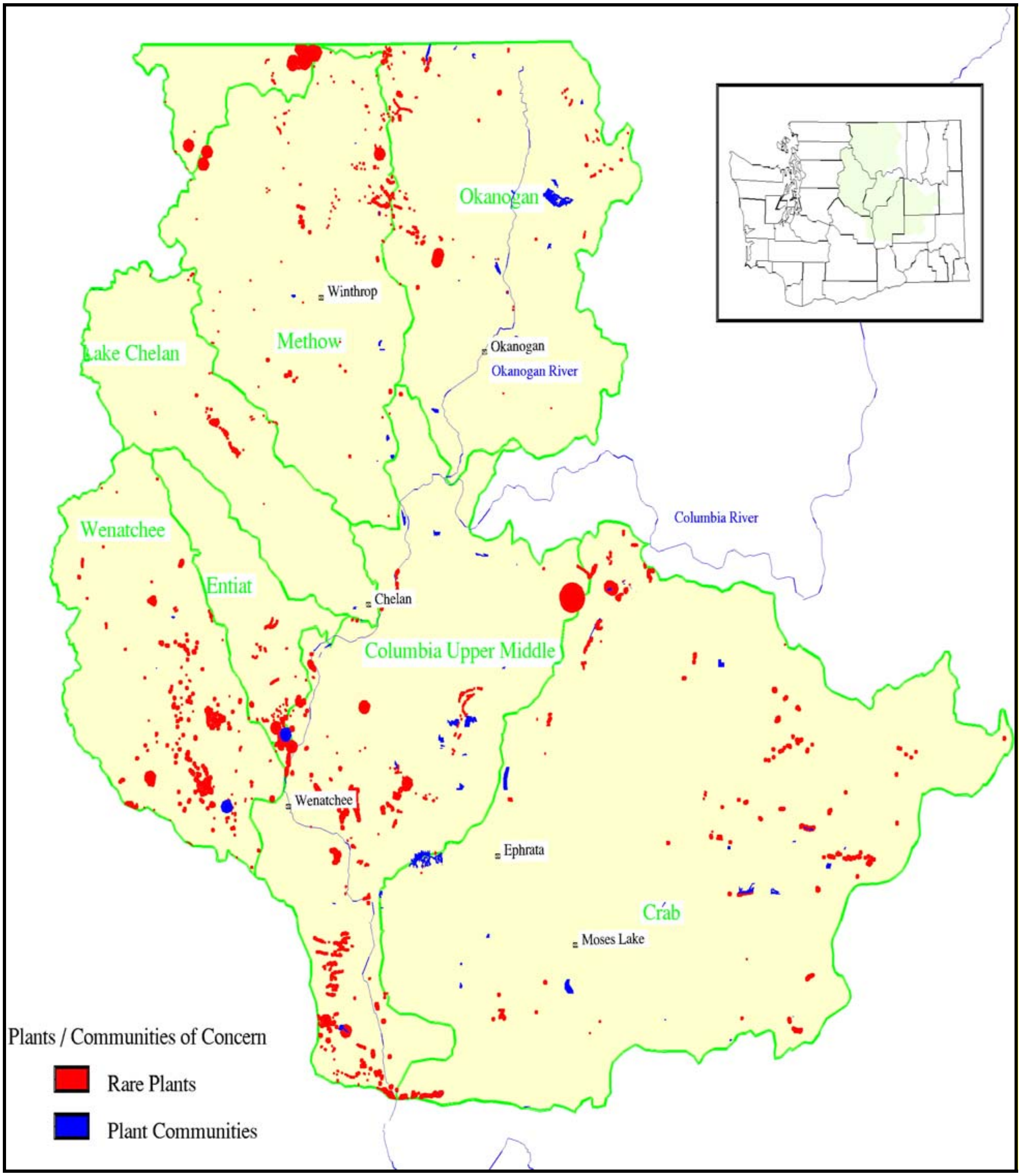

Figure 6. Rare plant/community occurrence in the Columbia Cascade Ecoprovince, Washington (WNHP 2003).

4.1.2 Wildlife Habitats

The Ecoprovince consists of seventeen wildlife habitat types, which are briefly described in Table_7. Detailed descriptions of these habitat types can be found in Appendix_B. Historic and current wildlife habitat distribution is illustrated in Figure_7 and Figure_8.

Table 7. Wildlife habitat types within the Columbia Cascade Ecoprovince, Washington (NHI 2003).

Habitat Type	Brief Description
Westside Lowlands Conifer-Hardwood Forest	One or more of the following are dominant: Douglas-fir, western hemlock, western redcedar (*Thuja plicata*), Sitka spruce (*Picea sitchensis*), red alder (*Alnus rubra*).
Montane Mixed Conifer Forest	Coniferous forest of mid-to upper montane sites with persistent snow pack; several species of conifer; understory typically shrub-dominated.
Eastside (Interior) Mixed Conifer Forest	Coniferous forests and woodlands; Douglas-fir commonly present, up to eight other conifer species present; understory shrub and grass/forb layers typical; mid-montane.
Lodgepole Pine Forest and Woodlands	Lodgepole pine dominated woodlands and forests; understory various; mid- to high elevations.
Ponderosa Pine and Interior White Oak Forest and Woodland	Ponderosa pine dominated woodland, often with Douglas-fir; shrub, forb, or grass understory; lower elevation above shrubsteppe.
Upland Aspen Forest	Quaking aspen (*Populus tremuloides*) is the characteristic and dominant tree in this habitat.
Subalpine Parkland	Whitebark pine (*P. albicaulis*) is found primarily in the eastern Cascade Mountains, Okanogan Highlands, and Blue Mountains.
Alpine Grasslands and Shrublands	Grassland, dwarf-shrubland, or forb dominated, occasionally with patches of dwarfed trees.
Eastside (Interior) Grasslands	Dominated by short to medium height native bunchgrass with forbs, cryptogam crust.
Shrubsteppe	Sagebrush and/or bitterbrush dominated; bunchgrass understory with forbs, cryptogam crust.
Agriculture, Pasture, and Mixed Environs	Cropland, orchards, vineyards, nurseries, pastures, and grasslands modified by heavy grazing; associated structures.
Urban and Mixed Environs	High, medium, and low (10-29 percent impervious ground) density development.
Lakes, Rivers, Ponds, Reservoirs	Natural and human-made open water habitats.
Herbaceous Wetlands	Grasses, sedges, bulrushes, aquatic beds, other aquatic plant species; sea level to upper montane.
Montane Coniferous Wetlands	Forest dominated by evergreen and deciduous trees; understory dominated by shrubs, forbs, or graminoids; mid- to upper montane.
Eastside (Interior) Riparian Wetlands	Shrublands, woodlands and forest, less commonly grasslands; often multi-layered canopy with shrubs, graminoids, forbs below.

4.1.2.1 Changes in Wildlife Habitats

Dramatic changes in wildlife habitat have occurred throughout the Ecoprovince since pre-European settlement (circa 1850). The most significant habitat change throughout the Ecoprovince is the loss of once abundant shrubsteppe and ponderosa pine habitat (Figure_7 and Figure_8). Quantitative and distribution changes in all Ecoprovince wildlife habitat types are further described in Table_8 and the maps illustrating these changes are included in Appendix_C. The protection status of all Ecoprovince wildlife habitat types is shown in Table_9.

4.1.3 Focal Wildlife Habitat Selection and Rationale

To ensure that species dependent on given habitats remain viable, Haufler (2002) advocated comparing the current availability of the habitat against its historic availability. For more information on historic and current focal wildlife habitat availability, see Table_14 and section 4.1.6. According to Haufler, this "coarse filter" habitat assessment can be used to quickly evaluate the relative status of a given habitat and its suite of obligate species. To ensure that "nothing drops through the cracks," Haufler also advocated combining the coarse filter habitat analysis with a single species or "fine filter" analysis of one or more obligate species to further ensure that species viability for the suite of species is maintained. For a more detailed discussion of focal wildlife species selection and rationale, see section 5.1.

The following four key principles/assumptions were used to guide selection of focal habitats. See Figure_9 for an illustration of the focal habitat/species selection process.

- Focal habitats were identified by WDFW at the Ecoprovince level and reviewed/modified at the subbasin level.
- Focal habitats can be used to evaluate ecosystem health and establish management priorities at the Ecoprovince level (course filter).
- Focal species/guilds can be used to represent focal habitats and to infer and/or measure response to changing habitat conditions at the subbasin level (fine filter).
- Focal species/guilds were selected at the subbasin level.

To identify focal macro habitat types within the Ecoprovince, Ecoprovince planners used the assessment tools to develop a habitat selection matrix based on various criteria, including ecological, spatial, and cultural factors. As a result, subbasin planners selected four focal wildlife habitat types of the seventeen that occur within the Ecoprovince (Table_10). Ecoprovince focal habitats include ponderosa pine, shrubsteppe, and eastside (interior) riparian wetlands. For an illustration of where the focal wildlife habitat types occur in the Ecoprovince, see Figure_10.

4.1.3.1 Focal Habitat Selection Justification

4.1.3.1.1 Ponderosa Pine

The justification for ponderosa pine (*Pinus ponderosa*) as a focal habitat is the extensive loss and degradation of forests characteristic of this type, and the fact that several highly associated bird species have declining populations and are species of concern. Declines of ponderosa pine forest are among the most widespread and strongest declines among habitat types in an analysis of source habitats for terrestrial vertebrates in the Interior Columbia Basin (Wisdom *et al.* in press). In addition to the overall loss of this forest type, two features, snags and old-forest conditions, have been diminished appreciably and resulted in declines of bird species highly associated with these conditions or features (Hillis *et al.* 2001).

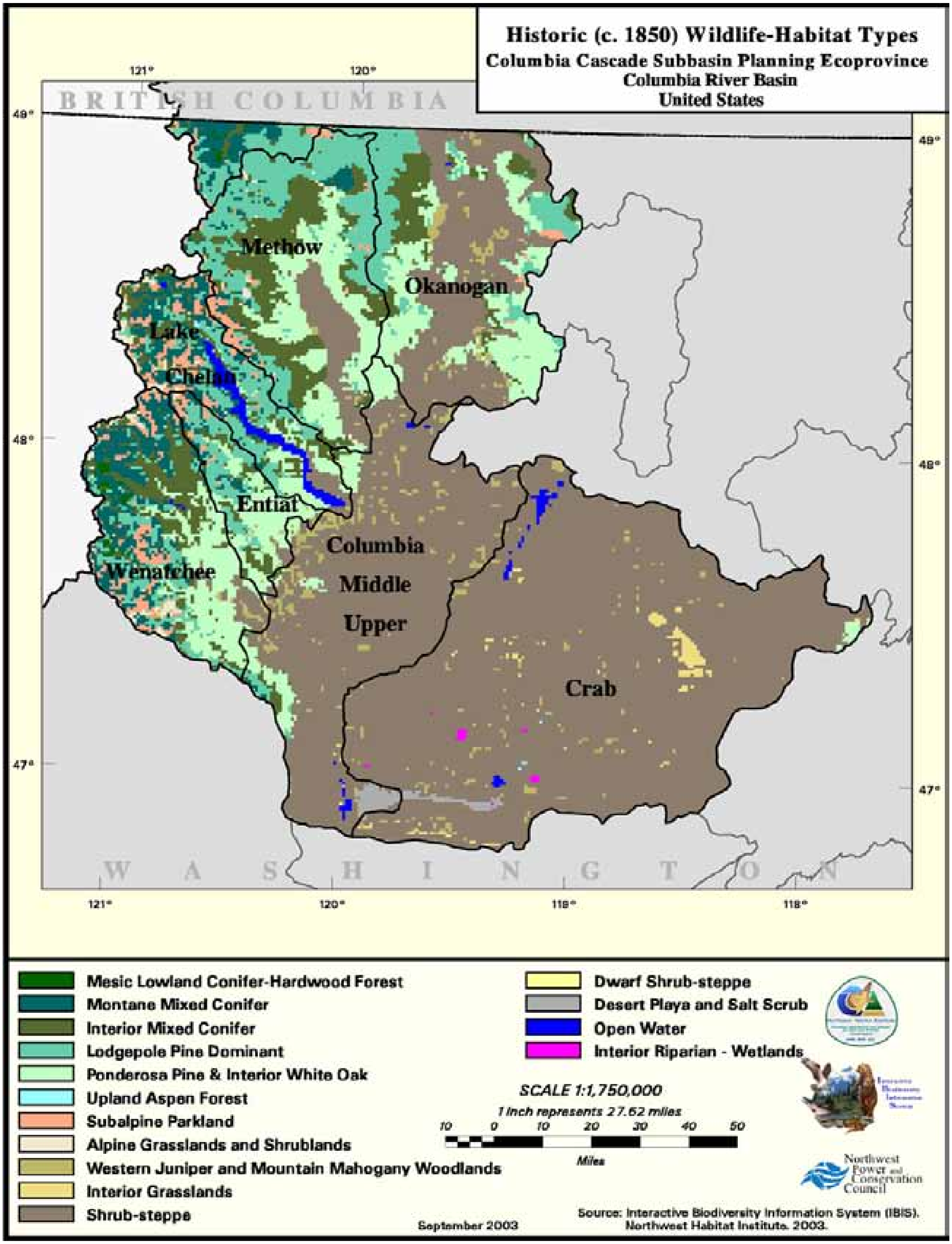

Figure 7. Historic wildlife habitat types of the Columbia Cascade Ecoprovince, Washington (NHI 2003).

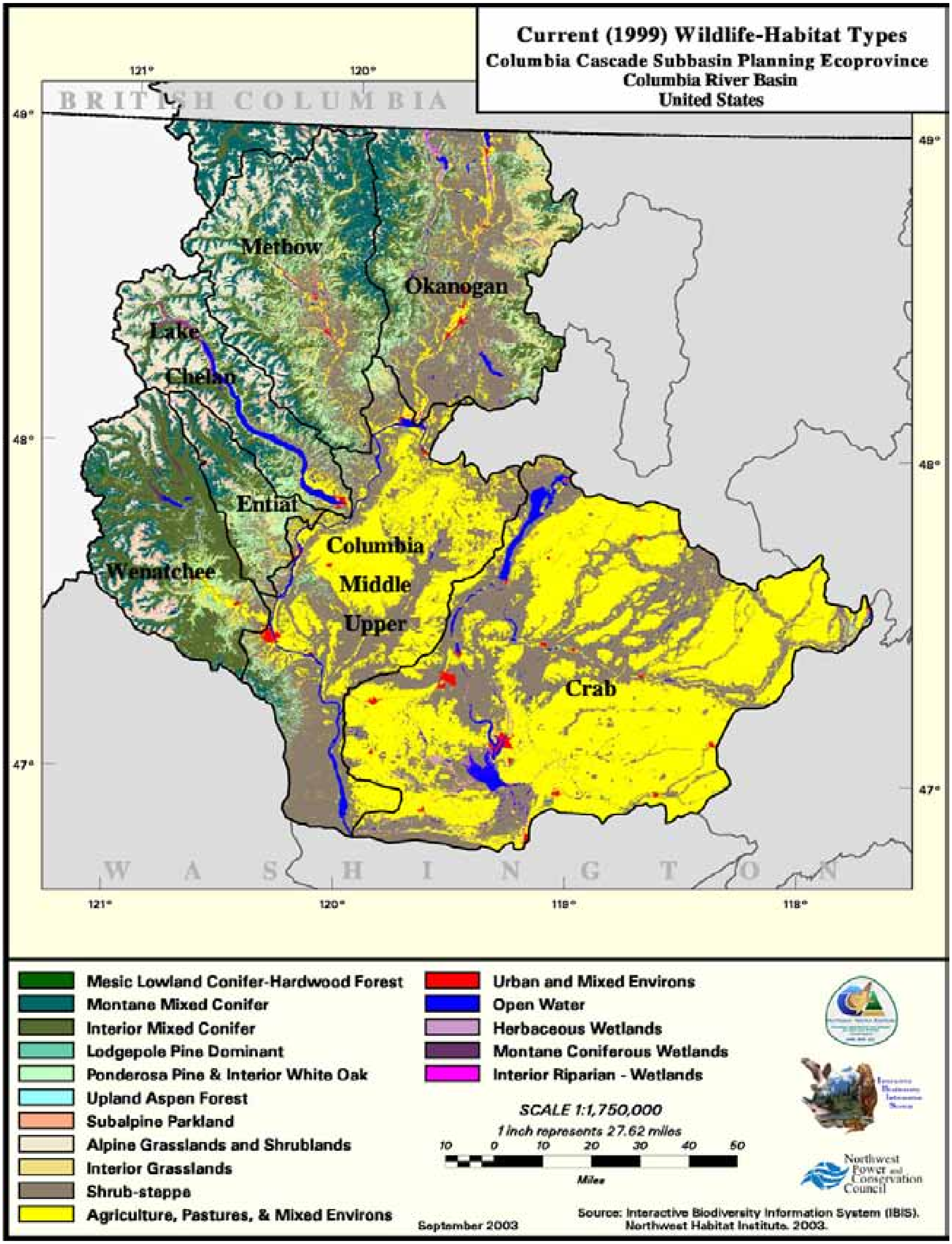

Figure 8. Current wildlife habitat types of the Columbia Cascade Ecoprovince, Washington (NHI 2003).

Table 8. Changes in wildlife habitat types in the Columbia Cascade Ecoprovince, Washington, from circa 1850 (historic) to 1999 (current) (NHI 2003).

Subbasin	Status	Westside Lowlands Conifer-Hardwood Forest	Montane Mixed Conifer Forest	Eastside (Interior) Mixed Conifer Forest	Lodgepole Pine Forest and Woodlands	Ponderosa Pine Forest and Woodlands	Upland Aspen Forest	Subalpine Parkland	Alpine Grasslands and Shrublands	Eastside (Interior) Grasslands	Shrubsteppe	Agriculture, Pastures, and Mixed Environs	Urban and Mixed Environs	Open Water - Lakes, Rivers, and Streams	Herbaceous Wetlands	Montane Coniferous Wetlands	Eastside (Interior) Riparian-Wetlands
Entiat	Historic	0	19,394	37,793	82,050	**123,821**	0	12,183	995	8,951	**5,967**	0	0	0	0	0	**0**
	Current	0	51,556	62,445	6,449	**55,807**	0	15,708	22,363	40,699	**32,986**	7,830	172	948	27	1,278	**94**
	Change (acres)	0	31,162	24,653	-75,601	**-68,013**	0	3,525	21,368	31,748	**27,019**	7,830	172	948	0	1,278	**94**
	Change (percent)	0	161	65	-92	**-55**	0	28	2,148	355	**453**	100	100	100	100	100	**100**
Lake Chelan	Historic	0	125,508	95,426	140,303	**61,398**	2,712	60,412	21,452	19,726	**9,123**	0	0	57,946	0	0	**0**
	Current	0	103,751	107,771	7,699	**45,480**	669	20,935	174,418	30,516	**45,018**	18,569	1,967	36,370	92	1,590	**5,079**
	Change (acres)	0	-21,757	12,345	-132,604	**-15,918**	-2,043	-39,476	152,966	10,790	**35,895**	18,569	1,967	-21,575	92	1,590	**5,079**
	Change (percent)	0	-17	13	-95	**-26**	-75	-65	713	55	**393**	100	100	-38	100	100	**100**
Wenatchee	Historic	11,618	201,957	175,260	117,417	**208,137**	742	65,754	21,506	28,180	**9,146**	0	0	1,236	0	0	**0**
	Current	1,411	149,209	389,213	4,287	**51,912**	0	36,044	108,886	38,377	**24,248**	30,700	1,752	8,154	41	8,937	**141**
	Change (acres)	-10,207	-52,748	213,953	-113,130	**-156,225**	-742	-29,709	87,380	10,197	**15,101**	30,700	1,752	6,918	41	8,937	**141**
	Change (percent)	-88	-25	56	-97	**-74**	-100	-44	81	11	**64**	100	100	82	100	100	**100**
Methow	Historic	0	37,830	316,489	339,978	**284,593**	495	27,446	6,429	108,546	**40,056**	0	0	0	0	0	**0**
	Current	0	290,023	228,450	8,851	**139,853**	11,652	24,988	189,331	76,760	**107,655**	31,997	1,212	4,474	737	7,523	**4,232**
	Change (acres)	0	252,193	-88,039	-331,127	**-144,740**	11,158	-2,457	182,903	-31,786	**112,603**	31,997	1,212	4,474	737	7,523	**4,232**
	Change (percent)	0	667	-28	-97	**-51**	2,256	-9	2,845	-29	**268**	100	100	100	100	100	**100**
Okanogan	Historic	4,36	66,138	141,407	272,696	**328,962**	0	19,989	2,221	464,940	**139,186**	0	0	740	0	0	**0**
	Current	0	183,384	219,316	5,559	**140,738**	19,731	10,574	60,968	151,271	**562,763**	81,912	4,201	19,683	12,965	7,093	**9,920**
	Change (acres)	-4,936	117,246	77,909	-267,137	**-188,224**	19,731	-9,416	58,747	-313,669	**423,577**	81,912	4,201	18,943	12,965	7,093	**9,920**
	Change (percent)	-100	177	55	-98	**-57**	100	-47	2,645	-67	**304**	100	100	2,558	100	100	**100**
Upper Middle Mainstem Columbia River	Historic	0	2,718	16,804	9,638	**100,329**	0	247	0	117,133	**1,237,065**	0	0	7,166	0	0	**0**
	Current	0	10,500	24,401	1,045	**50,843**	292	1,179	421	14,396	**753,073**	693,861	8,026	41,882	3,514	407	**3,898**
	Change (acres)	0	7,782	7,597	-8,592	**-49,487**	292	932	421	-102,737	**-483,992**	693,861	8,026	34,716	3,514	407	**3,898**
	Change (percent)	0	286	45	-89	**-49**	999	377	999	-88	**-39**	100	100	484	100	100	**100**
Crab	Historic	0	0	0	0	**11,362**	988	0	0	47,917	**3,002,953**	0	0	18,772	0	0	**5,928**
	Current	0	0	15	0	**4,660**	0	0	0	3,212	**991,397**	2,010,208	22,030	83,193	28,613	3,499	**12,227**
	Change (acres)	0	0	15	0	**-6,702**	-988	0	0	-44,705	**-2,011,556**	2,010,208	22,030	64,421	28,613	3,499	**6,299**
	Change (percent)	0	0	100	0	**-59**	-100	0	0	-93	**-67**	100	100	343	100	100	**106**
Total	Historic	16,554	453,546	783,178	962,081	**1,118,602**	4,936	52,602	795,393	962,081	**4,443,496**	0	0	85,860	0	0	**5,928**
	Current	1,411	453,546	1,031,611	33,890	**489,293**	32,345	109,429	556,387	355,232	**2,557,196**	2,875,078	39,361	194,704	45,989	30,327	**35,590**
	Change (acres)	-15,143	334,877	248,433	-928,191	**-629,309**	27,409	-76,602	503,785	-440,161	**-1,886,299**	2,875,078	39,361	108,844	45,989	30,327	**29,662**
	Change (percent)	-92	44	26	-98	**-55**	69	-50	91	-59	**-41**	100	100	55	100	100	**500**

Table 9. Gap protection status of wildlife habitat types in the Columbia Cascade Ecoprovince, Washington (NHI 2003).

Subbasin	GAP Status	Montane Mixed Conifer Forest	Interior Mixed Conifer Forest	Lodgepole Pine Forest	Ponderosa Pine Forest	Upland Aspen Forest	Subalpine Parkland	Alpine Grasslands and Shrublands	Interior Grasslands	Shrubsteppe	Agriculture, Pasture, and Mixed Environs	Urban and Mixed Environs	Lakes, Rivers, Ponds, and Reservoirs	Herbaceous Wetlands	Montane Coniferous Wetlands	Interior Riparian Wetlands	Total Acres
Entiat	High Protection	7,801	2,706	0	11	0	4,022	10,370	0	0	0	0	82	0	137	0	25,130
	Medium Protection	0	208	0	545	0	0	0	151	2,331	692	0	0	0	0	0	3,926
	Low Protection	43,746	53,279	5,867	43,248	0	11,672	11,947	32,161	17,066	2,098	0	185	3	688	17	221,978
	No Protection	7	6,251	582	12,008	0	12	42	8,386	13,586	5,044	172	683	23	455	77	47,329
Lake Chelan	High Protection	53,114	49,5859	4,449	7,556	504	12,241	131,315	9,845	2,451	0	0	3,809	0	1,113	1,488	277,480
	Medium Protection	11,385	15,991	1,373	4,175	125	1,101	18,927	3,099	1,034	94	0	2,774	0	206	2,785	63,069
	Low Protection	39,253	40,021	1,875	28,030	40	7,645	24,112	16,174	22,013	705	0	15,152	1	250	337	195,607
	No Protection	0	2,152	0	5,715	0	0	0	1,394	19,540	17,767	1,967	14,650	91	21	473	63,769
Wenatchee	High Protection	97,858	78,215	1,337	674	0	29,235	92,843	8,518	0	13	0	2,078	0	1,483	11	312,265
	Medium Protection	15	240	6	225	0	46	3	32	990	32	0	22	0	0	0	1,611
	Low Protection	44,326	235,805	1,945	24,616	0	5,678	13,605	18,444	6,525	4,321	0	835	10	4,336	4	360,451
	No Protection	7,105	74,948	1,010	26,387	0	1,053	2,386	11,407	16,702	26,335	1,738	5,225	30	3,115	125	177,567
Methow	High Protection	131,725	29,546	2,334	5,151	1,529	15,371	120,525	8,498	42	412	0	888	0	1,844	0	317,865
	Medium Protection	65	973	0	1,381	52	7	1,258	877	8,274	710	0	158	75	79	168	14,078
	Low Protection	158,265	193,942	6,520	119,451	9,712	9,595	67,595	62,988	65,670	8,004	5	551	29	3,296	434	706,058
	No Protection	28	3,987	3	13,851	358	20	6	4,363	73,647	22,873	1,208	2,877	631	2,309	3,632	129,794
Okanogan	High Protection	118,081	12,212	538	107	694	8,026	54,668	443	671	90	0	520	17	3,060	17	199,143
	Medium Protection	0	756	0	1,799	95	0	0	245	7,863	756	29	272	72	623	288	12,798
	Low Protection	63,652	131,675	4,398	66,880	8,887	2,519	6,372	40,079	98,912	11,960	16	921	372	1,093	1,058	438,793
	No Protection	1,196	74,623	625	72,034	10,059	3	60	110,521	455,538	69,154	4,156	17,975	12,519	2,320	8,563	839,345
Upper Middle Mainstem Columbia River	High Protection	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Medium Protection	4,000	3,529	647	5,127	0	448	73	1,230	84,291	7,415	0	2,408	66	17	274	109,523
	Low Protection	5,462	10,139	350	21,540	222	680	331	4,399	168,508	98,313	210	1,436	411	118	647	312,766
	No Protection	1,031	10,743	50	24,127	70	53	22	8,765	500,284	588,137	7,804	38,080	3,038	272	2,974	1,185,451
Crab	High Protection	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Medium Protection	0	6	0	22	0	0	0	0	52,231	8,275	177	5,580	3,266	0	1,304	70,861
	Low Protection	0	0	0	457	0	0	0	321	102,388	102,760	972	4,679	2,316	172	1,008	215,072
	No Protection	0	9	0	4,179	0	0	0	2,887	836,880	1,899,170	20,847	72,897	23,018	3,325	9,908	2,873,119
Total	High Protection	408,578	172,275	8,657	13,498	2,726	68,897	409,721	27,304	3,163	516	0	7,378	17	7,636	1,516	1,131,882
	Medium Protection	15,465	21,703	2,026	13,275	273	1,601	20,261	5,633	157,014	17,974	206	11,212	3,479	924	4,819	275,866
	Low Protection	354,704	664,862	20,956	304,222	18,861	37,790	123,961	174,556	481,082	228,161	1,203	23,760	3,142	9,951	3,505	2,450,725
	No Protection	9,368	172,713	2,269	158,300	10,487	1,141	2,516	147,720	1,916,178	2,628,482	37,892	152,387	39,351	11,817	25,752	5,316,373

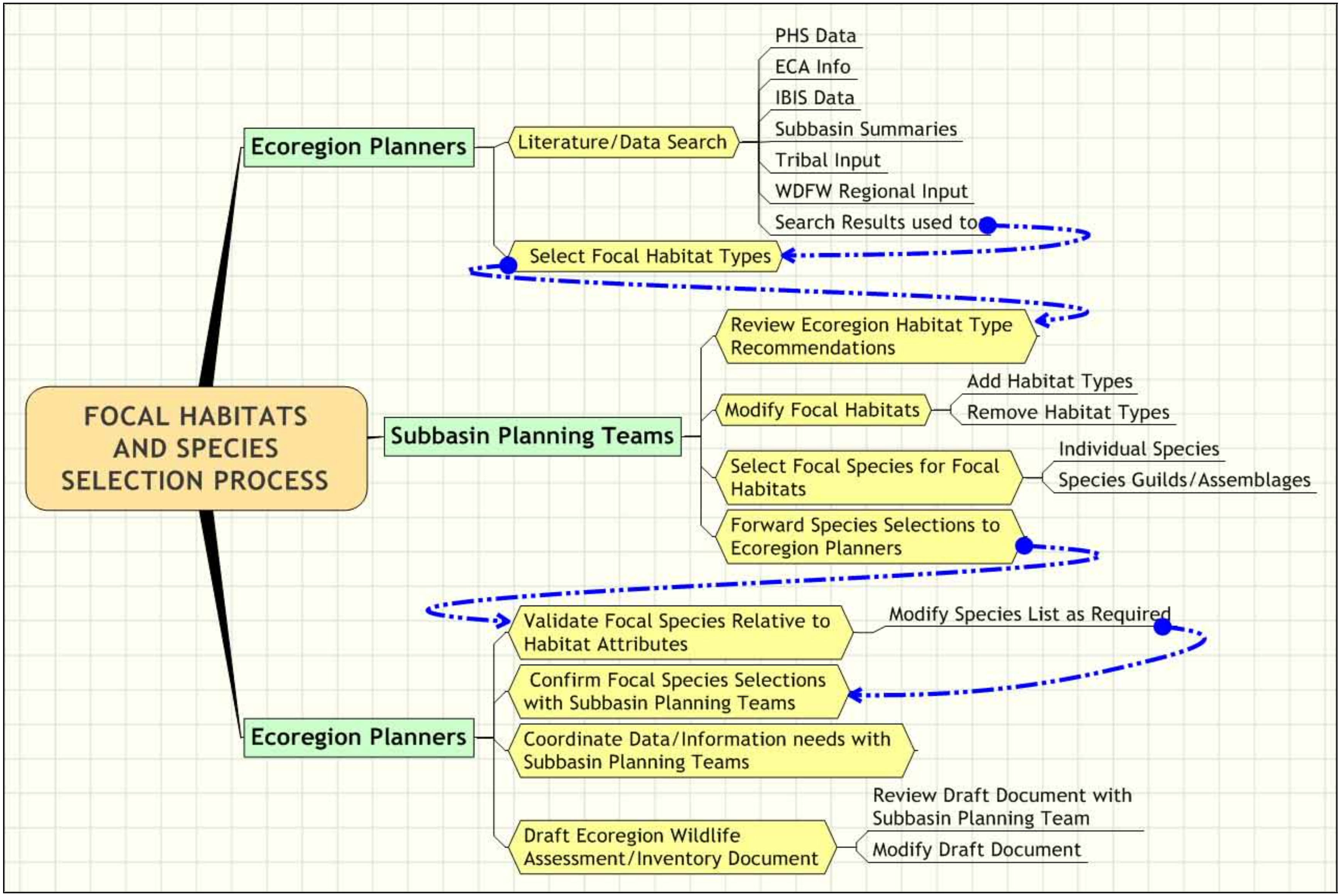

Figure 9. Focal habitat and species selection process summary.

Table 10. Focal habitat selection matrix for the Columbia Cascade Ecoprovince, Washington.

Habitat Type	Criteria						
	PHS Data	ECA Data	NHI Data	Culturally Significant	Present in all Subbasins	Listed in Subbasin Summaries	Present in macro quantities[1]
Ponderosa Pine	No	No	Yes	Yes	Yes	Yes	No
Shrubsteppe	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Eastside (Interior) Riparian Wetlands	Yes	Yes	Yes	Yes	Yes	Yes	No
Agriculture[2]	No	No	Yes	No	Yes	Yes	No

[1] Habitat types historically comprising more than five percent of the Province land base. This does not diminish the importance of various micro habitats.

[2] Agriculture is not a focal habitat; it is a habitat of concern. Because agricultural habitat is a result of the conversion of other native wildlife habitat types, planners chose to discuss agricultural land use within the text rather than prioritizing it as a focal wildlife habitat type. Therefore, specific focal species were not selected to represent this habitat type.

4.1.3.1.2 Shrubsteppe

Shrubsteppe was selected as a focal habitat because changes in land use over the past century have resulted in the loss of over half of Washington's shrubsteppe habitat (Dobler *et al.* 1996). Shrubsteppe communities support a wide diversity of wildlife. The loss of once extensive shrubsteppe communities has reduced substantially the habitat available to a wide range of shrubsteppe-associated wildlife, including several birds found only in this community type (Quigley and Arbelbide 1997; Saab and Rich 1997). More than 100 bird species forage and nest in sagebrush communities, and at least four of them (sage grouse, sage thrasher, sage sparrow, and Brewer's sparrow) are obligates, or almost entirely dependent upon sagebrush (Braun *et al.* 1976). In a recent analysis of birds at risk within the interior Columbia Basin, the majority of species identified as of high management concern were shrubsteppe species (Vander Haegen *et al.* 1999). Moreover, over half these species have experienced long-term population declines according to the Breeding Bird Survey (BBS) (Saab and Rich 1997).

4.1.3.1.3 Eastside (Interior) Riparian Wetlands

Riparian wetlands was selected as a focal habitat because its protection, compared to other habitat types, may yield the greatest gains for fish and wildlife while involving the least amount of area (Knutson and Naef 1997). Riparian habitat:

- covers a relatively small area yet it supports a higher diversity and abundance of fish and wildlife than any other habitat;
- provides important fish and wildlife breeding habitat, seasonal ranges, and movement corridors;
- is highly vulnerable to alteration; and
- has important social values, including water purification, flood control, recreation, and aesthetics.

4.1.4 Habitats of Concern

4.1.4.1 Agriculture

Agriculture is the dominant land use throughout the Ecoprovince and is a result of the conversion of other native wildlife habitat types. Therefore, this assessment treats agriculture in that context rather than as a focal wildlife habitat.

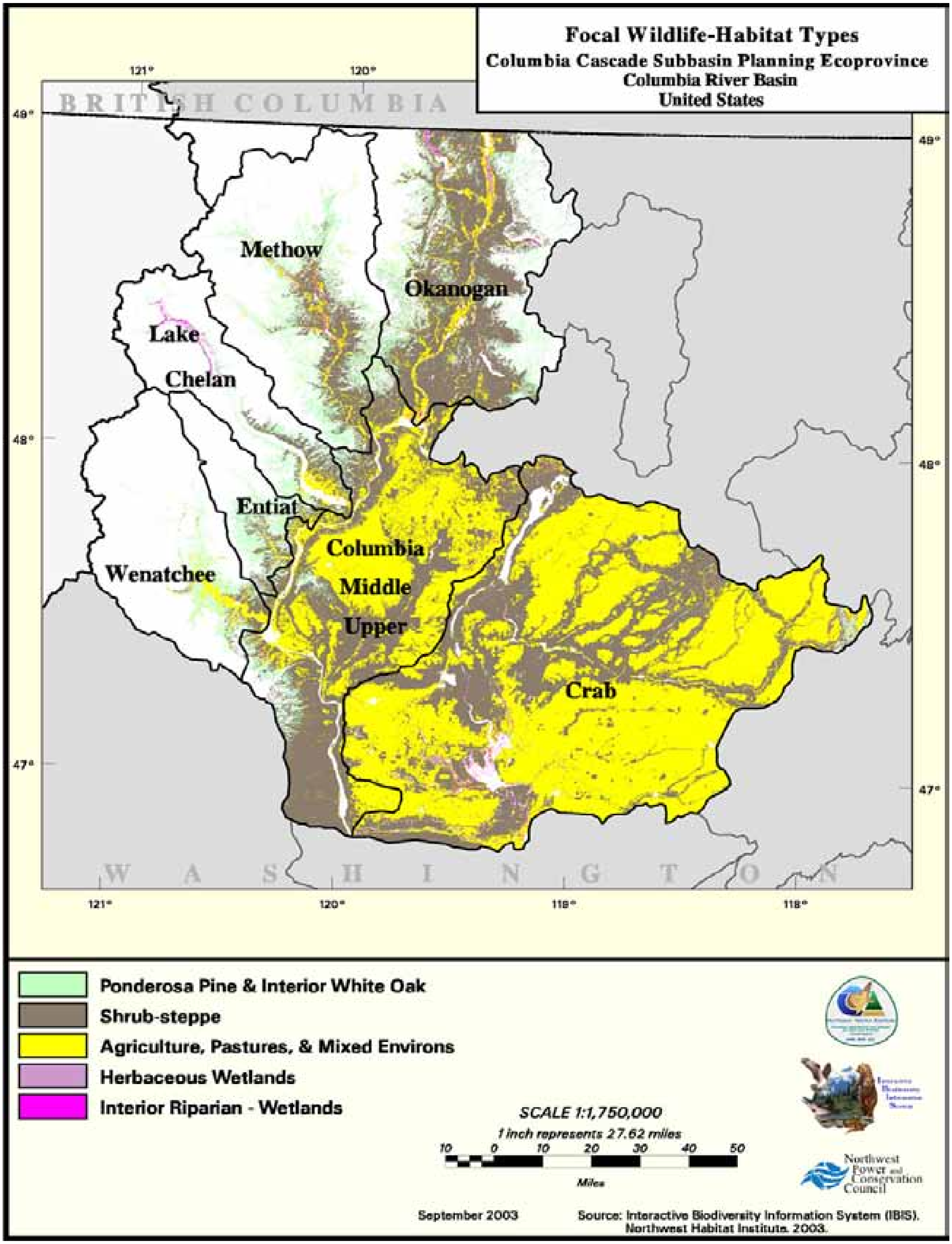

Figure 10. Focal wildlife habitat types of the Columbia Cascade Ecoprovince, Washington (NHI 2003).

4.1.5 Protection Status of Focal Wildlife Habitats

The protection status of focal wildlife habitats is depicted in Table_11 through Table_13. With the exception of CRP lands, which could be classified as having low protection status in some cases, agricultural lands have no protection. Therefore, the table for the agriculture habitat type was omitted.

Approximately 5 percent of the remaining ponderosa pine habitat is in the high/medium protection category. Similarly, approximately 6.2 percent of the remaining shrubsteppe is in the high/medium protection class. An estimated 17.8 percent of riparian wetland habitat in the Columbia Cascade Ecoprovince is in the high/medium protection class. Clearly, the vast majority of these focal wildlife habitats has either low protection or no protection and is therefore subject to further degradation and/or conversion to other uses. Further habitat loss and/or degradation will negatively impact habitat dependant obligate wildlife species.

Table 11. Ponderosa pine protection status in the Columbia Cascade Ecoprovince, Washington (NHI 2003).

Subbasin	Status 1: High Protection (acres)	Status 2: Medium Protection (acres)	Status 3: Low Protection (acres)	Status 4: No Protection (acres)	Total (Subbasin) (acres)
Entiat	11	545	43,248	12,008	**55,812**
Lake Chelan	7,556	4,175	28,030	5,715	**45,476**
Wenatchee	674	225	24,616	26,387	**51,902**
Methow	5,151	1,381	119,451	13,851	**139,834**
Okanogan	107	1,799	66,880	72,034	**140,820**
Upper Middle Mainstem Columbia River	0	5,127	21,540	24,127	**50,794**
Crab	0	22	457	4,179	**4,658**
Total (Ecoprovince)	**13,499**	**13,274**	**304,222**	**158,301**	**489,296**

Table 12. Shrubsteppe protection status in the Columbia Cascade Ecoprovince, Washington (NHI 2003).

Subbasin	Status 1: High Protection (acres)	Status 2: Medium Protection (acres)	Status 3: Low Protection (acres)	Status 4: No Protection (acres)	Total (Subbasin) (acres)
Entiat	0	2,331	17,066	13,586	**32,983**
Lake Chelan	2,451	1,034	22,013	19,540	**45,038**
Wenatchee	0	990	6,525	16,702	**24,217**
Methow	42	8,274	65,670	73,647	**147,633**
Okanogan	671	7,863	98,912	455,538	**562,984**
Upper Middle Mainstem Columbia River	0	84,291	168,508	500,284	**753,083**
Crab	0	52,231	102,388	836,880	**991,499**
Total (Ecoprovince)	**3,164**	**157,014**	**481,082**	**1,916,177**	**2,557,437**

Table 13. Eastside (interior) riparian wetland protection status in the Columbia Cascade Ecoprovince, Washington (NHI 2003).

Subbasin	Status 1: High Protection (acres)	Status 2: Medium Protection (acres)	Status 3: Low Protection (acres)	Status 4: No Protection (acres)	Total (Subbasin) (acres)
Entiat	0	0	17	77	**94**
Lake Chelan	1,488	2,785	337	473	**5,083**
Wenatchee	11	0	4	125	**140**
Methow	0	168	434	3,632	**4,234**
Okanogan	17	288	1,058	8,563	**9,926**
Upper Middle Mainstem Columbia River	0	274	647	2,974	**3,895**
Crab	0	1,304	1,008	9,908	**12,220**
Total (Ecoprovince)	**1,516**	**4,819**	**3,505**	**25,752**	**35,592**

4.1.6 Changes in Focal Wildlife Habitat Quantity and Distribution

Changes in focal habitat distribution at the Ecoprovince level are depicted in Table 14. Forest succession, logging, and development account for 55 percent of the total change (loss) in ponderosa pine habitat (NHI 2003). Similarly, agricultural conversion accounts for most of the 41 percent decline in shrubsteppe habitat (NHI 2003). Focal wildlife habitats at the subbasin level have experienced similar changes and are included in ‹**bold**› in Table 8. Maps comparing changes for all historic habitats are located in Appendix C.

Table 14. Changes in focal wildlife habitat types in the Columbia Cascade Ecoprovince from circa 1850 (historic) to 1999 (current) (NHI 2003).

Focal Habitat Type	Historic Acres	Current Acres	Percent Change
Ponderosa pine	1,118,602	489,293	-55
Shrubsteppe	4,443,496	2,557,196	-41
Eastside (Interior) Riparian Wetlands	5,928	35,590	+66
Total	**5,568,026**	**3,082,079**	**-30**

The NHI riparian habitat data are incomplete. Therefore, riparian wetlands are not well represented on NHI maps. Accurate habitat type maps, especially those detailing wetland habitats, are needed to improve assessment quality and support management strategies and actions. Ecoprovince planners, however, believe that significant physical and functional losses have occurred to these important riparian habitats from dam construction and inundation, agricultural development, and livestock grazing.

4.1.7 Conditions of Focal Wildlife Habitats

This section contains historic information, current conditions, and desired future conditions for each focal habitat. Historic descriptions are derived primarily from Washington GAP data and, to a lesser extent, Daubenmire (1970), Daubenmire and Daubenmire (1968), NHI (2003), and other contributors. The ponderosa pine, shrubsteppe, and interior grassland focal wildlife habitat types have been subdivided into vegetation zones where possible. Riparian habitats were not subdivided due to minimal information pertaining to those habitats within this Ecoprovince.

The purpose of delineating vegetation zones within broader course filter habitat types is to use vegetation zones as a *fine filter* assessment tool in order to:

- aid subbasin planners in identifying and prioritizing critical habitat protection and restoration needs, and
- develop strategies to protect and enhance wildlife populations within the Ecoprovince.

For example, general Ecoprovince/subbasin strategies, goals, and objectives could be developed, in part, based on focal habitats. These strategies, goals, and objectives could be further refined, and/or areas needing protection and enhancement could be identified and prioritized by comparing the overlap between vegetation zones, ECA, EDT, and NHI data, and local level input.

4.1.7.1 Ponderosa pine

4.1.7.1.1 Historic

Prior to 1850, ponderosa pine habitat was mostly open and park-like with relatively few undergrowth trees. The ponderosa pine ecosystem has been heavily altered by past forest management. Specifically, the removal of overstory ponderosa pine since the early 1900s and nearly a century of fire suppression have led to the replacement of most old-growth ponderosa pine forests by younger forests with a greater proportion of Douglas-fir (*Pseudotsuga menziesii*) than ponderosa pine (Habeck 1990). Fire scar evidence in the northern Rocky Mountains indicates that ponderosa pine forests burned approximately every 1-30 years prior to fire suppression, preventing contiguous understory development and, thus, maintaining relatively open ponderosa pine stands (Arno 1988; Habeck 1990).

The 1930s-era timber inventory data (Losensky 1993) suggests large diameter ponderosa pine-dominated stands occurred in very large stands, encompassing large landscapes. Such large stands were fairly homogeneous at the landscape scale, but were relatively heterogeneous at the acre scale, with "patchy" tree spacing, and multi-age trees (Hillis *et al.* 2001).

Clear cut logging and subsequent reforestation have converted many older stands of ponderosa pine/Douglas-fir forest to young, structurally simple ponderosa pine stands (Wright and Bailey 1982). Changes in the distribution of ponderosa pine habitat from circa 1850 (historic) to 1999 (current) are illustrated in Figure_11 and Figure_12.

4.1.7.1.2 Current

General:

The ponderosa pine zone covers 3.7 million acres in Washington and is one of the most widespread zones of the western states. This dry forest zone between unforested steppe and higher-elevation, closed forests corresponds to Merriam's Arid Transition zone.

Ponderosa pine forms climax stands that border grasslands and is also a common member in many other forested communities (Steele *et al.* 1981). Ponderosa pine is a drought tolerant tree that usually occupies the transition zone between grassland and forest. Climax stands are characteristically warm and dry, and occupy lower elevations throughout their range. Key understory associates in climax stands typically include grasses such as bluebunch wheatgrass *(Pseudoroegneria spicata)* and Idaho fescue *(Festuca idahoensis),* and shrubs such as bitterbrush *(Purshia tridentata)* and common snowberry *(Symphoricarpus albus)*. Ponderosa pine associations can be separated into three shrub-dominated and three gras-dominated habitat types. Four community types are associated with ponderosa pine (Cooper *et al.* 1991):

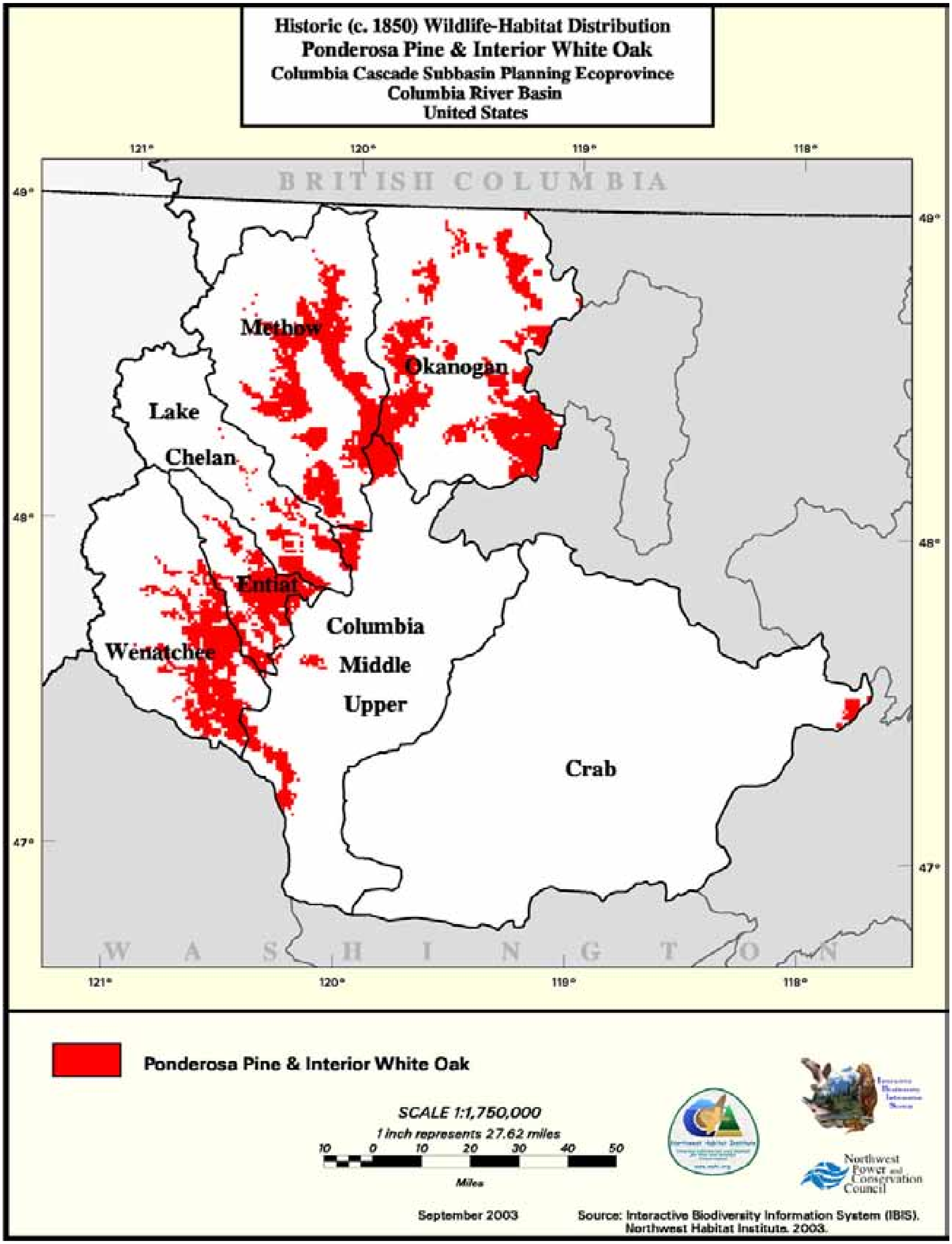

Figure 11. Historic ponderosa pine distribution in the Columbia Cascade Ecoprovince, Washington (NHI 2003).

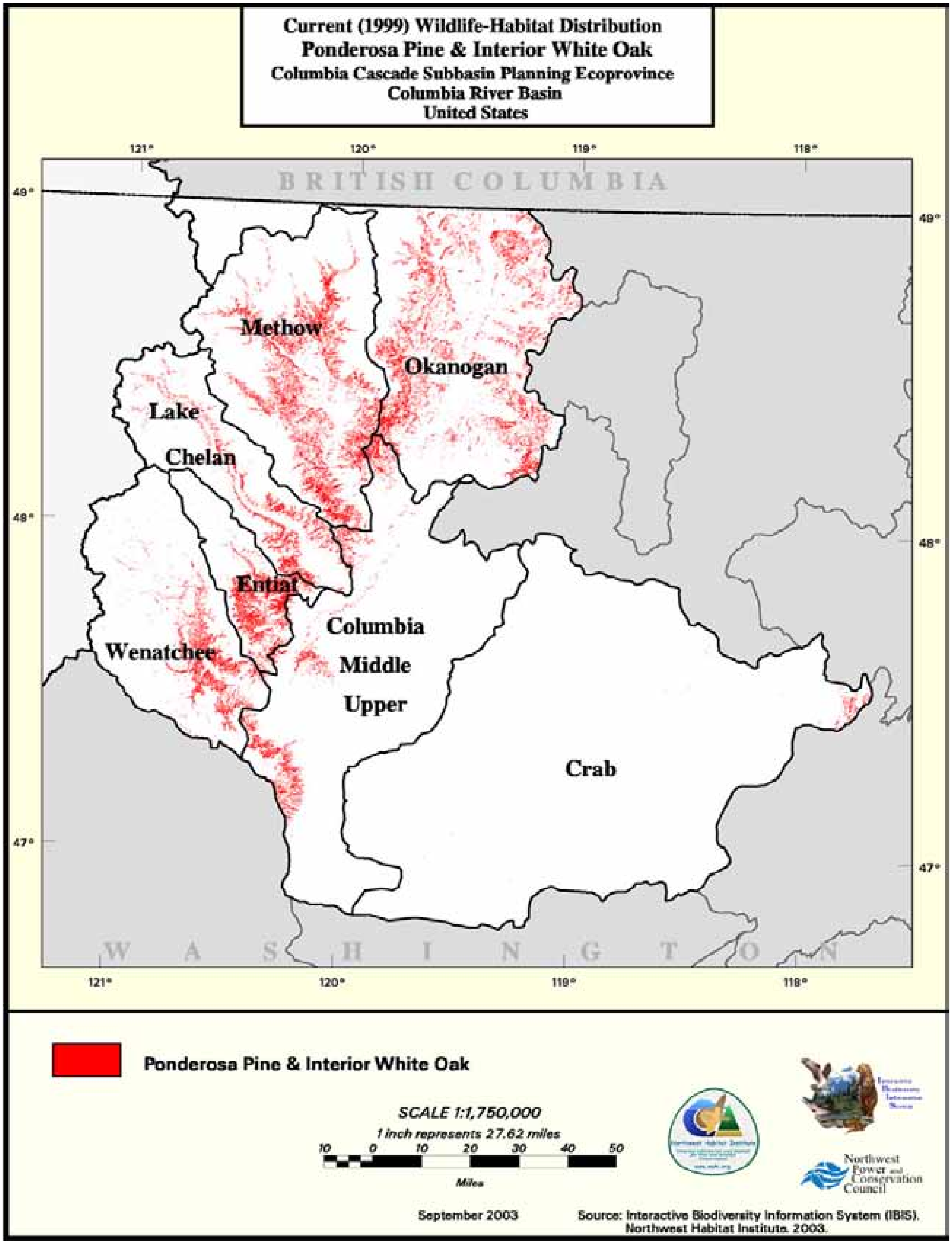

Figure 12. Current ponderosa pine distribution in the Columbia Cascade Ecoprovince, Washington (NHI 2003).

1. *Physocarpus malvaceus* (ninebark; limited; northeast to northwest aspects)
2. *Symphoricarpos albus* (common snowberry; sporadic from Coeur d'Alene south along western forest edge in northern Idaho
3. *Festuca ovina ingrata* (Idaho fescue; most prevalent along Clearwater, Snake, and Salmon River drainages)
4. *Pseudoroegneria spicatum* (bluebunch wheatgrass; steep south-facing slopes overlooking the Snake and Salmon Rivers)

Daubenmire and Daubenmire (1984) recognize two more habitat types within the *P. ponderosa* series:

1. *Stipa comata* (needlegrass)
2. *Purshia tridentata* (bitterbrush)

Ponderosa pine has many fire resistant characteristics. Seedlings and saplings are often able to withstand fire. Pole-sized and larger trees are protected from the high temperatures of fire by thick, insulative bark, and meristems are protected by the surrounding needles and bud scales. Other aspects of the pine's growth patterns help in temperature resistance. Lower branches fall off the trunk of the tree, and fire caused by the fuels in the understory will usually not reach the upper branches. Ponderosa pine is more vulnerable to fire at more mesic sites where other conifers such as Douglas-fir, and grand fir (*Abies grandis*) form dense understories that can carry fire upward to the overstory. Ponderosa pine seedlings germinate more rapidly when a fire has cleared the grass and the forest floor of litter, leaving only mineral rich soil. (Fischer and Bradley 1987).

Fire suppression has lead to a buildup of fuels that, in turn, increase the likelihood of stand-replacing fires. Heavy grazing, in contrast to fire, removes the grass cover and tends to favor shrub and conifer species. Fire suppression combined with grazing creates conditions that support cloning of oak and invasion by conifers.

Ponderoas pine is shade intolerant and grows most rapidly in near full sunlight (Franklin and Dyrness 1973; Atzet and Wheeler 1984). Logging is usually done by a selection-cut method. Older trees are taken first, leaving younger, more vigorous trees as growing stock. This effectively regresses succession to earlier seral stages and eliminates climax, or old growth, conditions. Logging also impacts understory species by machine trampling or burial by slash. Clearcutting generally results in dominance by understory species present before logging, with invading species playing only a minor role in post logging succession (Atzet and Wheeler 1984).

Currently, much of this habitat has a younger tree cohort of more shade-tolerant species that gives the habitat a more closed, multi-layered canopy. For example, this habitat includes previously natural fire-maintained stands in which grand fir can eventually become the canopy dominant. Large late-seral ponderosa pine, Douglas-fir, and Oregon white oak are harvested in much of this habitat. Under most management regimes, typical tree size decreases and tree density increases in this habitat. Ponderosa pine-Oregon white oak habitat is now denser than in the past and may contain more shrubs than in pre-settlement habitats. In some areas, new woodlands have been created by patchy tree establishment at the forest-steppe boundary.

Annual precipitation in this vegetation zone is between 14 and 30 inches. Wide seasonal and diurnal temperature fluctuations are the rule. In Washington, the ponderosa pine zone generally lies between 2,000 and 5,000 feet, but its occurrence at any particular location is strongly influenced by aspect and soil type (Cassidy 1997).

It is possible to find ponderosa pine woodlands at nearly 5,000 feet on southern aspects and subalpine fir (*Abies lasiocarpa*) communities at the same elevation on opposite northern aspects (Hall 1973). In some places, the change from steppe to closed forest occurs without the transitional ponderosa pine zone, for example, at locations along the east slopes of the north and central Cascades. More commonly, the aspect dependence of this zone creates a complex inter-digitization between the steppe and ponderosa pine stands, so that disjunct steep zone fragments occur on south-facing slopes deep within forest while ponderosa pine woodlands reach well into the steppe along drainages and north slopes.

A similar process occurs between the ponderosa pine zone and the higher-elevation closed forest zones. At higher elevations, Pacific ponderosa pine is seral to trees more shade tolerant and moisture demanding. In the Pacific Northwest, this generally includes Douglas-fir, grand fir, and white fir (Howard 2001). Also common are mosaics created by soil type in which ponderosa pine stands on coarse-textured soil are interspersed with steppe communities on finer soil. Because of variations in complexity of soil types and topography, the ponderosa pine belt in Washington varies from a discontinuous zone, especially in the northeast Cascades, east central Cascades, and Blue Mountains, to a broad, relatively unbroken transition zone above steppe and along the southeast Cascade slopes (Figure_13).

Climax Vegetation:
The successional status of ponderosa pine can be best expressed by its successional role, which ranges from seral to climax depending on specific site conditions. It plays a climax role on sites toward the extreme limits of its environmental range and becomes increasingly seral with more favorable conditions. On more mezic sites, ponderosa pine encounters greater competition and must establish itself opportunistically, and is usually seral to Douglas-fir and true firs (grand fir and white fir). On severe sites it is climax by default because other species cannot establish. On such sites, establishment is likely to be highly dependent upon the cyclical nature of large seed crops and favorable weather conditions (Steele 1988).

Successional and climax tree communities are inseparable in this zone because frequent disturbance by fire is necessary for the maintenance of open woodlands and savanna. Natural fire frequency is very high, with cool ground fires believed to normally occur at 8 to 20 year intervals by one estimate and 5 to 30-year intervals by another. Ponderosa pine trees are killed by fire when young, but older trees survive cool ground fires. Fire suppression favors the replacement of the fire-resistant ponderosa pine by the less tolerant Douglas-fir and grand fir.

The high fire frequency maintains an arrested seral stage in which the major seral tree, ponderosa pine, is the “climax” dominant because other trees are unable to reach maturity. The ponderosa pine zone is most narrowly defined as the zone in which ponderosa pine is virtually the only tree. As defined in this document, the ponderosa pine zone encompasses most warm, open-canopy forests between steppe and closed forest, thus it includes stands where other trees, particularly Douglas-fir, may be co-dominant with ponderosa pine (Daubenmire and Daubenmire 1968).

Throughout most of the zone, ponderosa pine is the sole dominant in all successional stages. At the upper elevation limits of the zone, on north-facing slopes in locally mesic sites, or after long-term fire suppression, other tree species Douglas-fir, grand fir, western larch (*Larix occidentalis*), lodgepole pine (*Pinus contorta latifolia*), western juniper (*Juniperus occidentalis*), or Garry oak (*Quercus garryanna*) may occur. At the upper-elevation limits of the zone, in areas where the ponderosa pine belt is highly discontinuous, and in cooler parts of the zone, Douglas-

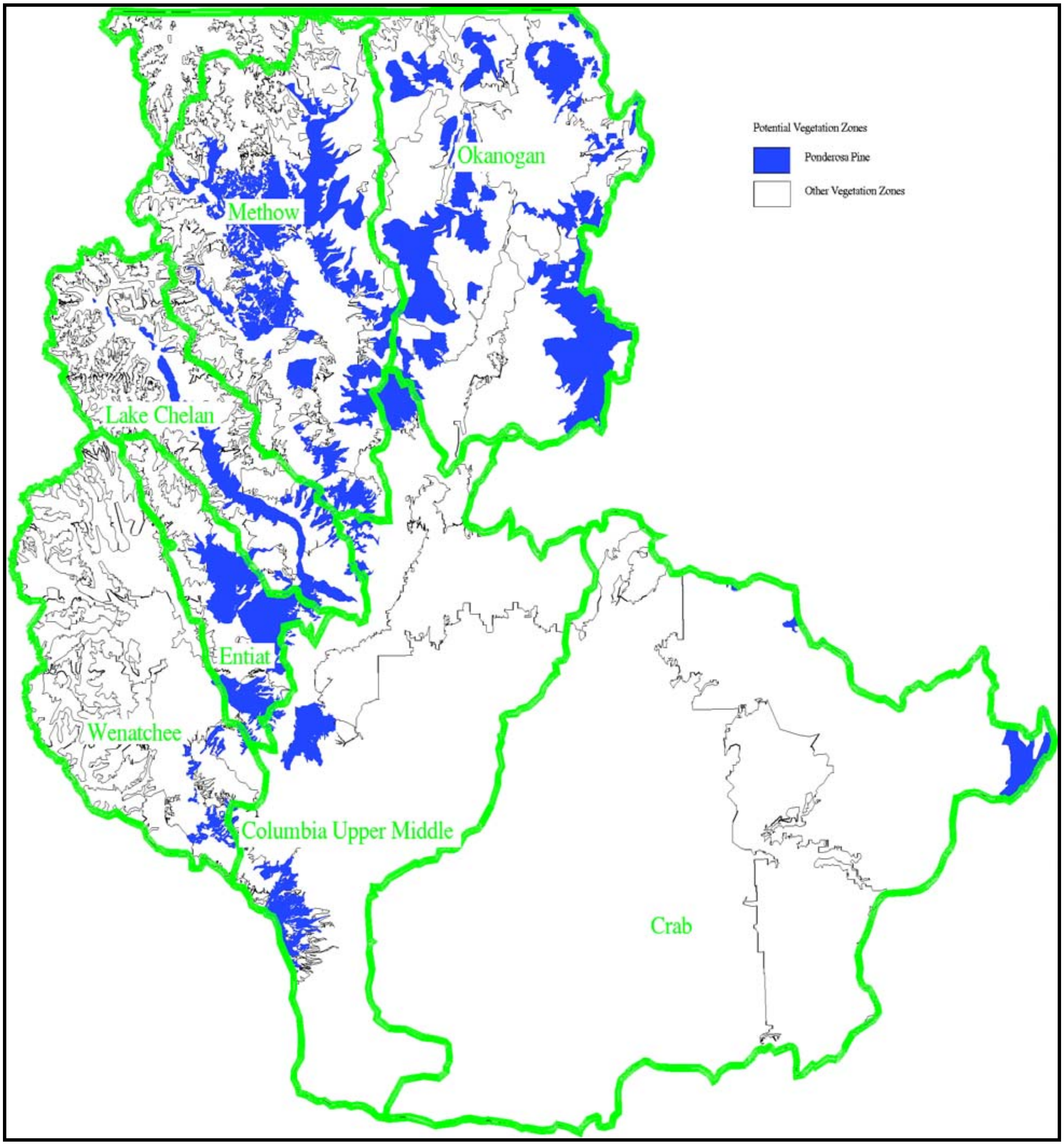

Figure 13. Historic (potential) ponderosa pine vegetation zone in the Columbia Cascade Ecoprovince, Washington (Cassidy 1997).

fir, and occasionally western larch, lodgepole pine, and grand fir become increasingly significant. In Yakima and Klickitat Counties, Garry Oak may be present, especially in drainages (extensive Garry oak stands are assigned to the Oak zone).

The major defining structural feature of this zone is open-canopy forest or a patchy mix of open forest, closed forest, and meadows. On flat terrain, trees may be evenly spaced. On hilly terrain, the more common pattern is a mix of dry meadows and hillsides, tree clumps, closed forest in sheltered canyons and north-facing slopes, shrub patches, open forest with an understory of grass and open forest with an understory of shrubs. Without fire suppression, the common belief is that the forest would be less heterogeneous and more savanna-like with larger, more widely spaced trees and fewer shrubs (see Daubenmire and Daubenmire 1968 for a dissenting opinion).

Understory associations in Washington are broadly differentiated into a mesic shrub group and a xeric grass/shrub group. Soil type appears to be the major determining factor separating these groups. The mesic shrub group usually occurs on deeper heavier-textured, more fertile soils than the xeric grass/shrub group. Understories of the mesic shrub associations are usually dominated by snowberry or ninebark (*Physocarpus malvaceus*). The snowberry association is widespread. The ninebark association, the most mesic of the ponderosa pine associations, is rare outside of northeastern Washington. Where it occurs outside of northeast Washington (and perhaps in the northwest as well), it appears to be a seral association of the Douglas-fir zone (Daubenmire and Daubenmire 1968).

The xeric grass/shrub associations usually occur on stony, coarse-textured or rocky soils. They have an understory dominated by bluebunch wheatgrass, Idaho fescue, needle and thread grass (*Stipa comata*), bitterbrush (*Purshia tridentate*), or combinations of these species. Bluebunch wheatgrass and Idaho fescue associations are common throughout Washington. Needle and thread associations occur on sandy soils. The bitterbrush association, which has a shrub layer dominated by bitterbrush over a xeric grass layer, is most common along the east slope of the Cascades (Daubenmire and Daubenmire 1968).

Disturbance:
Heavy grazing of ponderosa pine stands in the mesic shrub habitat type tends to lead to swards of Canada bluegrass (*Poa pratensis*) and Kentucky bluegrass (*Poa compressa*). Heavy grazing of the xeric grass/shrub habitat types tends to lead to replacement of native understory species by introduced annuals, especially cheatgrass (*Bromus tectorum*). Four exotic *Centaurea* species are spreading rapidly through the ponderosa pine zone and threatening to replace cheatgrass as the dominant increaser after grazing. Dense cheatgrass stands eventually change the fire regime of these stands resulting often in stand replacing, catastrophic fires.

Along with anthropogenic disturbances and weed infestations, diseases and insects impact and define ponderosa pine sites. Parasites, root diseases, rusts, trunk decays, and needle and twig blights cause significant damage. Dwarf mistletoe causes the most damage. A major root disease of pine is caused by white stringy root rot *(Fomes annosus*) and is often found in concert with bark beetle infestations. Western gall rust *(Endocronartium harknessii*), limb rust *(Peridermium filamentosum*), and comandra blister rust *(Cronartium comandrae*) cause damage only in localized areas. Various silvicultural treatments can minimize damage caused by dwarf mistletoe. Clearcutting is used only if regeneration is not a problem. The pruning of branches and witches brooms, fertilization, watering, and the planting of nonsusceptible species also aid in combating dwarf mistletoe (Hawksworth *et al.* 1988 in Howard 2001).

Similarly, approximately 200 insect species may impact ponderosa pine from its cone stage to maturity (Schmid 1988 in Howard 2001). The effects of insect damage are decreased seed and seedling production, reforestation failures or delays, and reduction of potential timber productivity (Schmid 1988 in Howard 2001). Several insect species destroy seeds before they germinate, the most damaging being the ponderosa pine cone beetle *(Conophthorus ponderosae)* and the pine seed chalcid *(Megastigmus albifrons)*. Seedlings and saplings are deformed by tip moths *(Rhyacionia bushnelli)*, shoot borers *(Eucosma sonomana)*, and budworms *(Choristoneura lambertiana)*. Two major lepidopteran pests, the pine butterfly (*Neophasia menapia)* and Pandora moth *(Coloradia pandora)*, severely defoliate their hosts causing growth reductions. Extensive mortality in defoliated stands usually results from simultaneous infestations by bark beetles. Bark beetles, primarily of the genus *Dendroctonus* and *Ips*, kill thousands of pines annually and are the major mortality factor in commercial saw timber stands (Schmid 1988 in Howard 2001).

Edaphic and other special communities:
<u>Wetlands</u>: Quaking aspen stands occur on moist sites, riparian areas, and deep rich soils. Black cottonwood occurs along rivers and on gravel terraces. <u>Topographic and topoedaphic</u>: In cooler sites on northern slopes or on other favorable microsites, closed-canopy Douglas-fir-dominated communities may form. Steppe communities similar to those in adjacent steppe zones often occur in patches among ponderosa pine woodlands. An apparently unique steppe-like Idaho fescue/Wyeth buckwheat (*Festuca idahoensis/Eriogonum heracleoides*) association occurs in a matrix with ponderosa pine woodlands in the Okanogan Highlands.

Land Use and Land Cover:
Development - 2.24 percent (High-density - 0.71 percent; Mid-density -1.05 percent; Low-density - 0.35 percent; Mixed/unknown density - 0.13 percent).

Agriculture - 9.70 percent (Irrigated - 1.92 percent; Non-irrigated - 0.89 percent; Mixed unknown irrigation status - 6.88 percent). Pastures, grain fields and orchards along the larger rivers are probably the major crop types. Most fields are relatively small compared to the agricultural fields in the Columbia Basin.

Open water wetlands - 3.76 percent (Open water - 3.23 percent; Marsh - 0.03 percent; Riparian - 0.50 percent). The disproportionately high open water cover is due to the presence of several large rivers that flow through the zone, notably sections of the Columbia River. Numerous small lakes and marshes occur scattered through the zone.

Non-forested - 20.84 percent (Grassland - 5.08 percent; Shrub savanna - 4.99 percent; Shrubland- 5.07 percent; Tree savanna - 1.47 percent; Unknown mixed type - 4.22 percent. Alternately: Created by fire or logging disturbance - 7.19 percent; Apparently natural meadows and steppe vegetation - 0.75 percent; Unknown disturbance status - 12.90 percent).

Hardwood forest - 0.15 percent. These are primarily Garry oak stands near the oak zone. Other hardwoods may also form small stands, usually along drainages.

Mixed hardwood/conifer forest - 0.95 percent. These are usually conifers and hardwoods along drainages. Conifer species include ponderosa pine, Douglas-fir, and lodgepole pine. Typical hardwoods are quaking aspen, black cottonwood, and willows. Garry oak is common along the southeast Cascade.

Conifer forest – 62.31 percent (Open-canopy – 52.40 percent; Closed-canopy – 9.30 percent; Mixed/unknown canopy closure - 0.62 percent). Open-canopy conifer forest, the defining feature of this zone, covers slightly more than half the area of the zone. Open-canopy forests are dominated by ponderosa pine over most of the zone. At the higher-elevations and in northern parts of the zone, Douglas-fir may be codominant or dominant. Closed-canopy forests are usually a mix of Douglas-fir and ponderosa pine, with lesser amounts of western larch and lodgepole pine.

Conservation Status of the Ponderosa Pine Vegetation Zone (Cassidy 1997):

Conservation Status 1 - The largest blocks of land in this category within the Ecoprovince are the Lake Chelan-Sawtooth Wilderness, and Pasayten Wilderness. Small fragments lie in the Glacier Peak Wilderness and William O. Douglas Wilderness.

Conservation Status 2 - Lands in this category within the Ecoprovince include the Lake Chelan National Recreation Area (Chelan County), L .T. Murray Wildlife Area (Kittitas County), Quilomene Wildlife Area (Kittitas County), Colockum Wildlife Area (Kittitas County), and Sinlahekin Wildlife Area (Okanogan County). Small pieces of the zone occur in the Methow Wildlife Area (Okanogan County), and Entiat and Swakane Wildlife Areas (Chelan County).

Conservation Status 3 - The largest blocks of land in this category are in the Wenatchee, Okanogan, and Colville National Forests. The WDNR owns lands which form moderately large contiguous areas in Okanogan County in addition to regularly spaced section blocks throughout the zone. Several of the Status 2 WDFW lands (especially the Oak Creek, Quilomene, and Colockum Wildlife Areas) are composed of section blocks in a checkerboard pattern with WDNR and National Forest sections.

Conservation Status 4 - About two-thirds of Status 4 lands are privately owned and about one-third is on Indian Reservations.

Land Management Considerations (Cassidy 1997):
Ponderosa pine and oak zones, the major transition zones between steppe and closed forest in Washington, are the east-side forest zones with the poorest protection status. Both zones have similarly low percentages of their area (3 to 4 percent) on status 1 and 2 lands, but the ponderosa pine zone is better represented on status 3 lands, which allows more flexibility for future land management options. Both zones present some similar problems in biodiversity management. Both tend to be intermingled in a complex pattern with steppe and higher-elevation closed forest and support species that depend on the interface between steppe and forest, so management policies in neighboring higher- and lower-elevation zones have a greater effect on these zones than on most zones. Because frequent fire is important in maintaining the pine woodlands and savanna that characterize this zone, biodiversity management of the zone must also consider the problem of fire management where houses and farms are scattered within dry woodlands.

The pattern of land ownership of the ponderosa pine zone varies considerably across the State. In the northeast Cascade and east central Cascade regions, where the ponderosa pine zone is a broken string of large patches, conservation status 3 lands are the rule. These status 3 lands are mostly formed from blocks of the Okanogan or Wenatchee National Forests or blocks of WDNR land. Status 2 lands are either Wildlife Areas or the lowest elevations of Wilderness and National Recreation Areas. Uphill, in the Douglas-fir zone, status 3 lands, mostly National Forest, are even more predominant. Downhill, in the three-tip sage or central arid steppe zone, most land is privately owned except for a few places where Wildlife Areas form a narrow buffer between ponderosa pine forests and private lands.

In the northeast and Okanogan Highlands regions, the ponderosa pine zone is broader and more continuous than elsewhere in the State. Status 4 lands are the rule. The Colville Tribe owns much of the zone in southern Okanogan County. Private lands, occupying most of the remainder, are interspersed with regularly-spaced WDNR section blocks. The lower elevations of the Colville and Okanogan National Forests lie on this zone in northern Okanogan County. Status 2 lands in these regions are scattered.

Management strategies for the ponderosa pine zone in these regions must consider the needs of private and tribal landowners and the management of higher-elevation forest zones. Potential improvement of biodiversity protection on public lands in this zone depends primarily on management policies of the National Forests and the WDNR, but the relative influence of those owners varies across the zone. National Forests are most prominent in the northeast Cascade and east central Cascade. This zone is also a large component of the major east-side Tribal lands (the Yakama and Colville Indian Reservations), and the management policies of these tribes will greatly influence biodiversity protection of the zone.

Status and Trends:
Quigley and Arbelbide (1997) concluded that the interior ponderosa pine habitat type is significantly less in extent than pre-1900 and that the Oregon white oak habitat type is greater in extent than pre-1900. They included much of this habitat in their dry forest potential vegetation group, which they concluded has departed from natural succession and disturbance conditions. The greatest structural change in this habitat is the reduced extent of the late-seral, single-layer condition. This habitat is generally degraded because of increased exotic plants and decreased native bunchgrasses. One third of Pacific Northwest Oregon white oak, ponderosa pine, and dry Douglas-fir or grand fir community types listed in the National Vegetation Classification are considered imperiled or critically imperiled.

4.1.7.1.3 Recommended Future Condition

Recognizing that extant ponderosa pine habitat within the Ecoprovince currently covers a wide range of seral conditions, Ecoprovince planners identified three general ecological/management conditions that, if met, will provide suitable habitat for multiple wildlife species at the Ecoprovince scale within the ponderosa pine habitat type. These ecological conditions correspond to life requisites represented by a species' assemblage that includes white-headed woodpecker (*Picoides albolarvatus*), flammulated owl (*Otus flammeolus*), pygmy nuthatch (*Sitta pygmaea*), and gray flycatcher (*Empidonax wrightii*) (Table_20). Specific species information is included in Appendix_F. These species may also serve as a performance measure to monitor and evaluate the results of implementing future management strategies and actions.

Subbasin wildlife managers will review the conditions described below to plan and, where appropriate, guide future enhancement/protection actions on ponderosa pine habitats. Specific desired future conditions, however, are identified and developed within the context of subbasin-level management plans.

Condition 1a – mature ponderosa pine forest: The white-headed woodpecker represents species that require/prefer large patches (greater than 350 acres) of open mature/old growth ponderosa pine stands with canopy closures between 10 - 50 percent and snags (a partially collapsed, dead tree) and stumps for nesting (nesting stumps and snags grater than 31 inches DBH). Abundant white-headed woodpecker populations can be present on burned or cut forest with residual large diameter live and dead trees and understory vegetation that is usually very sparse. Openness however, is not as important as the presence of mature or veteran cone producing pines within a stand (Milne and Hejl 1989).

Condition 1b – mature ponderosa pine forest: The pygmy nuthatch represents species that require heterogeneous stands of ponderosa pine with a mixture of well-spaced, old pines and vigorous trees of intermediate age and those species that depend on snags for nesting and roosting, high canopy density, and large diameter (greater than 18 inches DBH) trees characteristic of mature undisturbed forests. Connectivity between suitable habitats is important for species, such as pygmy nuthatch, whose movement and dispersal patterns are limited to their natal territories.

Condition 2 – multiple-canopy ponderosa pine mosaic: Flammulated owls represent wildlife species that occupy ponderosa pine sites that are comprised of multiple-canopy, mature ponderosa pine stands or mixed ponderosa pine/Douglas-fir forest interspersed with grassy openings and dense thickets. Flammulated owls nest in habitat types with low to intermediate canopy closure (Zeiner *et al.* 1990), two layered canopies, tree density of 508 trees/acre (9-foot spacing), basal area of 250 $ft.^2$/acre (McCallum 1994), and snags greater than 20 inches DBH 3-39 feet tall (Zeiner *et al.* 1990). Food requirements are met by the presence of at least one snag greater than 12 inches DBH/10 acres and 8 trees/acre greater than 21 inches DBH.

Condition 3 – pine/shrubsteppe interface: Gray flycatchers represent wildlife species that occupy the pine/shrubsteppe interface (pine savannah) with a shrub/bunchgrass understory. Gray flycatchers require nest trees 18 inches DBH and a tree height of 52 feet for their reproductive life requisites.

Change in the extent of ponderosa pine from circa 1850 to 1999 is illustrated at the 6^{th}-level HUC in Figure_14 (NHI 2003). Red color tones indicate negative change while blue color tones indicate positive change. Although the data are displayed at the 6^{th}-level HUC, it does not necessarily mean that the entire HUC was historically, or is currently comprised entirely of the ponderosa pine habitat type. The data simply indicate that the ponderosa pine habitat type occurred somewhere within a particular HUC.

The data displayed in Figure_14 can be used by subbasin planners to identify and prioritize conservation and restoration areas and strategies. For example, planners may develop a hierarchical approach to protecting ponderosa pine habitat where HUCs that have exhibited positive change receive a higher initial prioritization than those that have experienced a negative change. Ecoprovince planners could then cross-link this information with other data such as ECA and GAP protection status to develop comprehensive strategies to identify and prioritize critical areas and potential protection actions.

4.1.7.2 Shrubsteppe

4.1.7.2.1 Historic

Shrubsteppe occurred primarily in the eastern areas of the Ecoprovince and included three shrub-dominated steppe vegetation zones: three-tipped sage, central arid, and big sage/fescue (Cassidy 1997) (Figure_15). Similarly, Daubenmire (1970) identified three primary habitat types within the ecosystem, including:

1. *Artemesia tripartita – Festuca idahoensis* (three-tip sage – Idaho fescue)
2. *Artemesia tridentata – Agropyron spicatum* (big sagebrush – bluebunch wheatgrass)
3. *Artemesia tridentata – Festuca idahoensis* (big sagebrush – Idaho fescue)

The sage dominated shrublands occurred primarily in the eastern half of the Ecoprovince, and to the largest extent in the Okanogan, Upper Middle Mainstem Columbia River, and Crab subbasins. Shrublands were historically co-dominated by shrubs and perennial bunchgrasses with a microbiotic crust of lichens and mosses on the surface of the soil. Dominant shrubs were sagebrush of several species and subspecies: basin, Wyoming, and mountain big sagebrush; low sagebrush; and early, rigid, and three-tip. Bitterbrush also was important in many

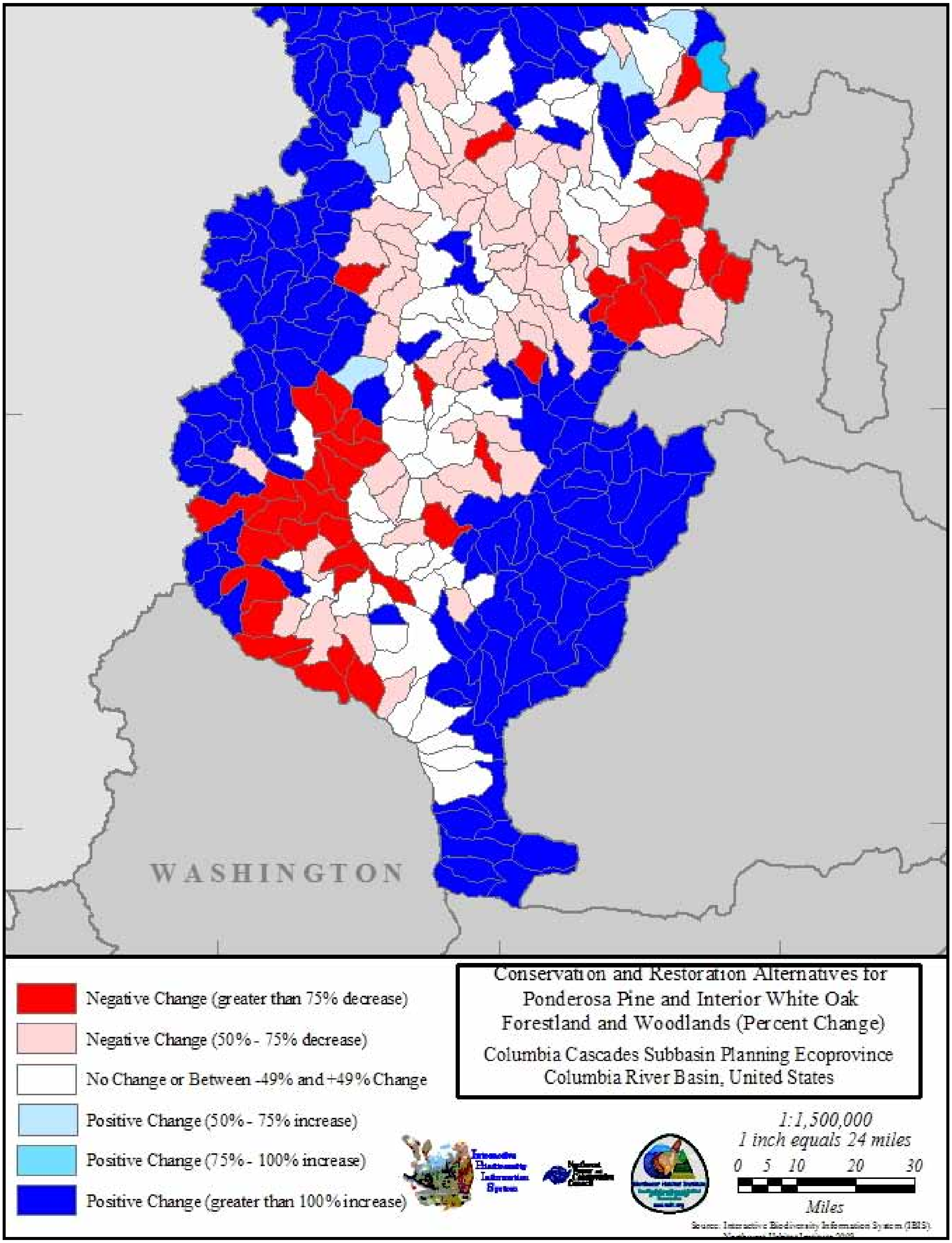

Figure 14. Ponderosa pine conservation and restoration alternatives (NHI 2003).

shrubsteppe communities. Bunchgrasses were largely dominated by four species: bluebunch wheatgrass, Idaho fescue, needle and thread grass, and Sandberg bluegrass. Soils, climate and topography acted to separate out distinct plant communities that paired sagebrush species with specific bunchgrasses across the landscape. Within the shrubsteppe landscape there also were alkaline basins, many of which contained large lakes during wetter pluvial times, where extensive salt desert scrub communities occur. This characteristic Great Basin vegetation contained numerous shrubs in the shadscale group including greasewood which has wide ecological amplitude, being equally at home in seasonally flooded playas and on dunes or dry hillsides.

Shrublands that were located in areas of deep soil have largely been converted to agriculture leaving shrublands intact on shallow lithosols soil. Floristic quality, however, has generally been impacted by decades of heavy grazing, introduced vegetation, wild fires, and other anthropogenic disturbances. Changes in the distribution of shrubsteppe habitat from circa 1850 (historic) to 1999 (current) are illustrated in Figure_16 and Figure_17.

4.1.7.2.2 Current

The greatest changes in shrubsteppe habitat from historic conditions are the reduction of bunchgrass cover in the understory and an increase in sagebrush cover. Soil compaction is also a significant factor in heavily grazed lands affecting water percolation, runoff and soil nutrient content. A long history of grazing, fire, and invasion by exotic vegetation has altered the composition of the plant community within much of the extant shrubsteppe in this region

(Quigley and Arbelbide 1997; Knick 1999), and it is difficult to find stands which are still in relatively natural condition. Shrubsteppe communities are important wildlife habitats as they provide structural diversity and varying plant communities amidst, what is today a largely agricultural landscape (Figure_18).

The loss of once extensive shrubsteppe communities has reduced substantially the habitat available to a wide range of shrubsteppe-associated wildlife, including several birds found only in this community type (Quigley and Arbelbide 1997; Saab and Rich 1997). Sage sparrows, Brewer's sparrows, sage thrashers, and sage grouse are considered shrubsteppe obligates, and numerous other species are associated primarily with shrubsteppe at a regional scale (Appendix E, Table_49). In a recent analysis of birds at risk within the interior Columbia Basin, the majority of species identified as of high management concern were shrubsteppe species. Moreover, according to the BBS, over half these species have experienced long-term population declines (Saab and Rich 1997).

Today, shrubsteppe habitat is common across the Columbia Plateau of Washington, and it extends up into the cold, dry environments of surrounding mountains. Characteristic and dominant mid-tall shrubs in the shrubsteppe habitat include all 3 subspecies of big sagebrush, basin (*Artemisia tridentata* ssp. *tridentata*), Wyoming (*A. t.* ssp. *wyomingensis*) or mountain (*A t.* ssp. *vaseyana*), antelope bitterbrush (*Purshia tridentata*), and two shorter sagebrushes, silver (*A. cana*) and three-tip (*A. tripartita*) (Daubenmire 1970). Each of these species can be the only. shrub or appear in complex seral conditions with other shrubs. Common shrub complexes are bitterbrush and Wyoming big sagebrush, bitterbrush and three-tip sagebrush, Wyoming big sagebrush and three-tip sagebrush, and mountain big sagebrush and silver sagebrush.

Wyoming and mountain big sagebrush can codominate areas with tobacco brush (*Ceanothus velutinus)*. Rabbitbrush (*Chrysothamnus viscidiflorus*) and short-spine horsebrush (*Tetradymia spinosa*) are common associates and often dominate sites after disturbance. Big sagebrush

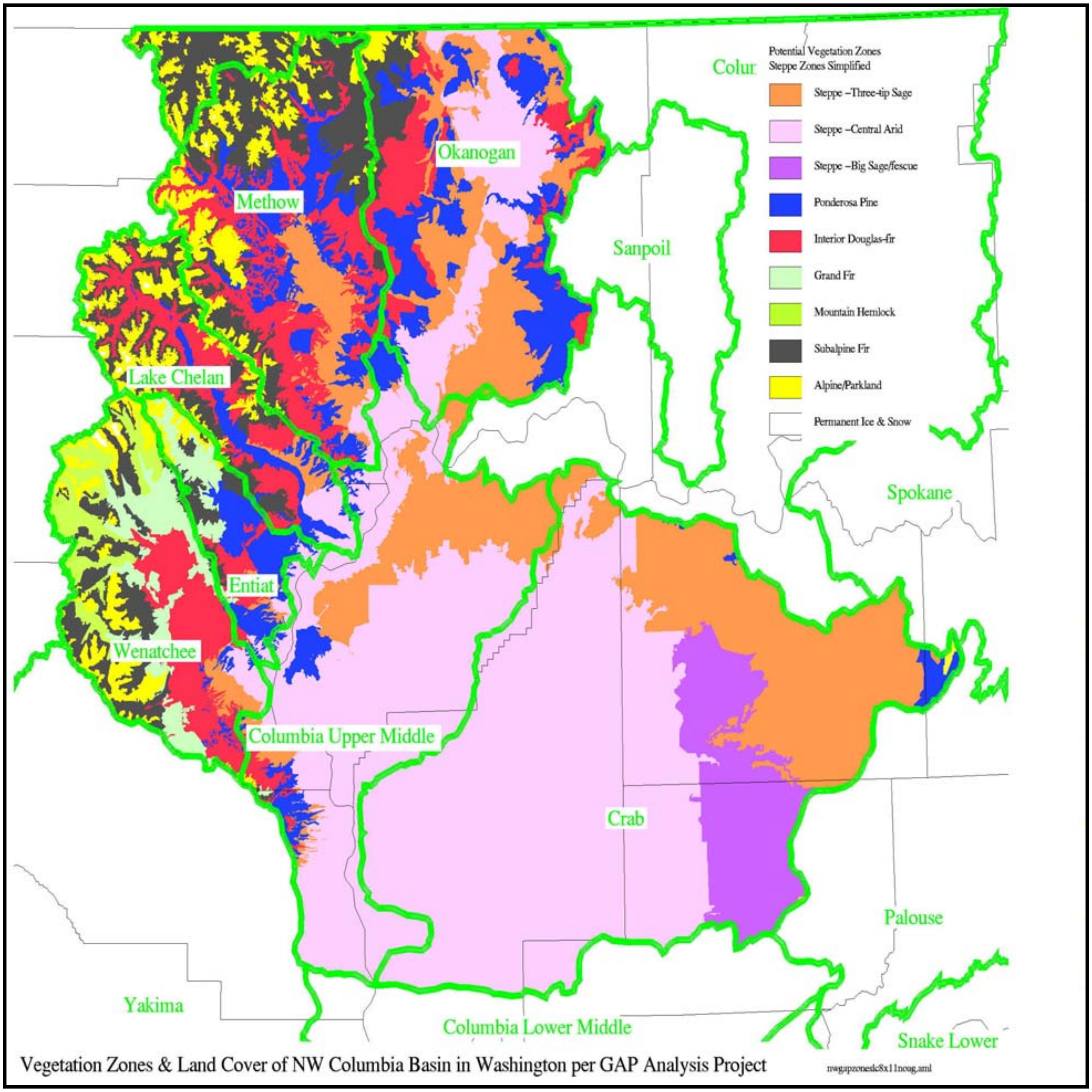

Figure 15. Historic (potential) vegetation zones of the Columbia Cascade Ecoprovince, Washington (Cassidy 1997).

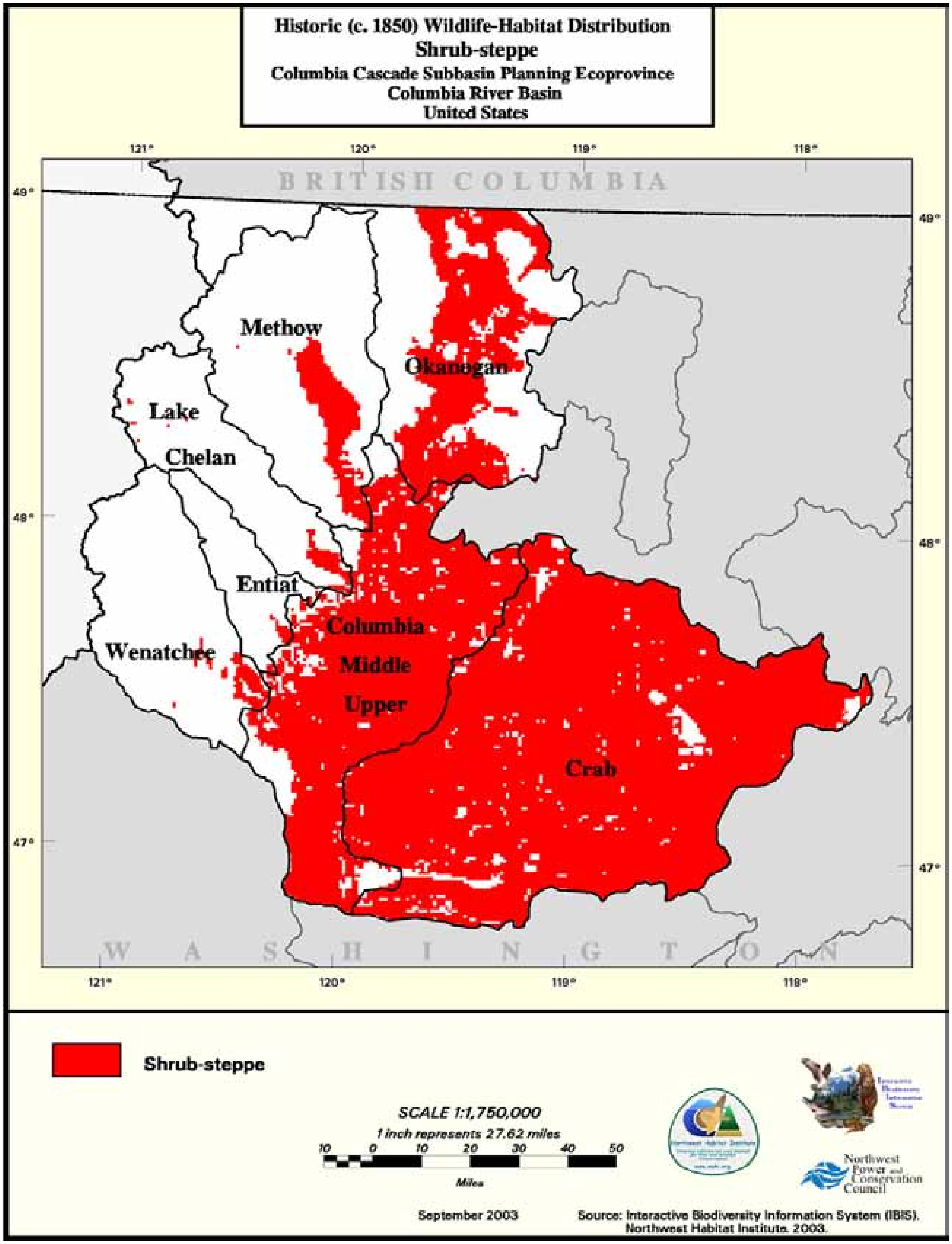

Figure 16. Historic shrubsteppe distribution in the Columbia Cascade Ecoprovince, Washington (NHI 2003).

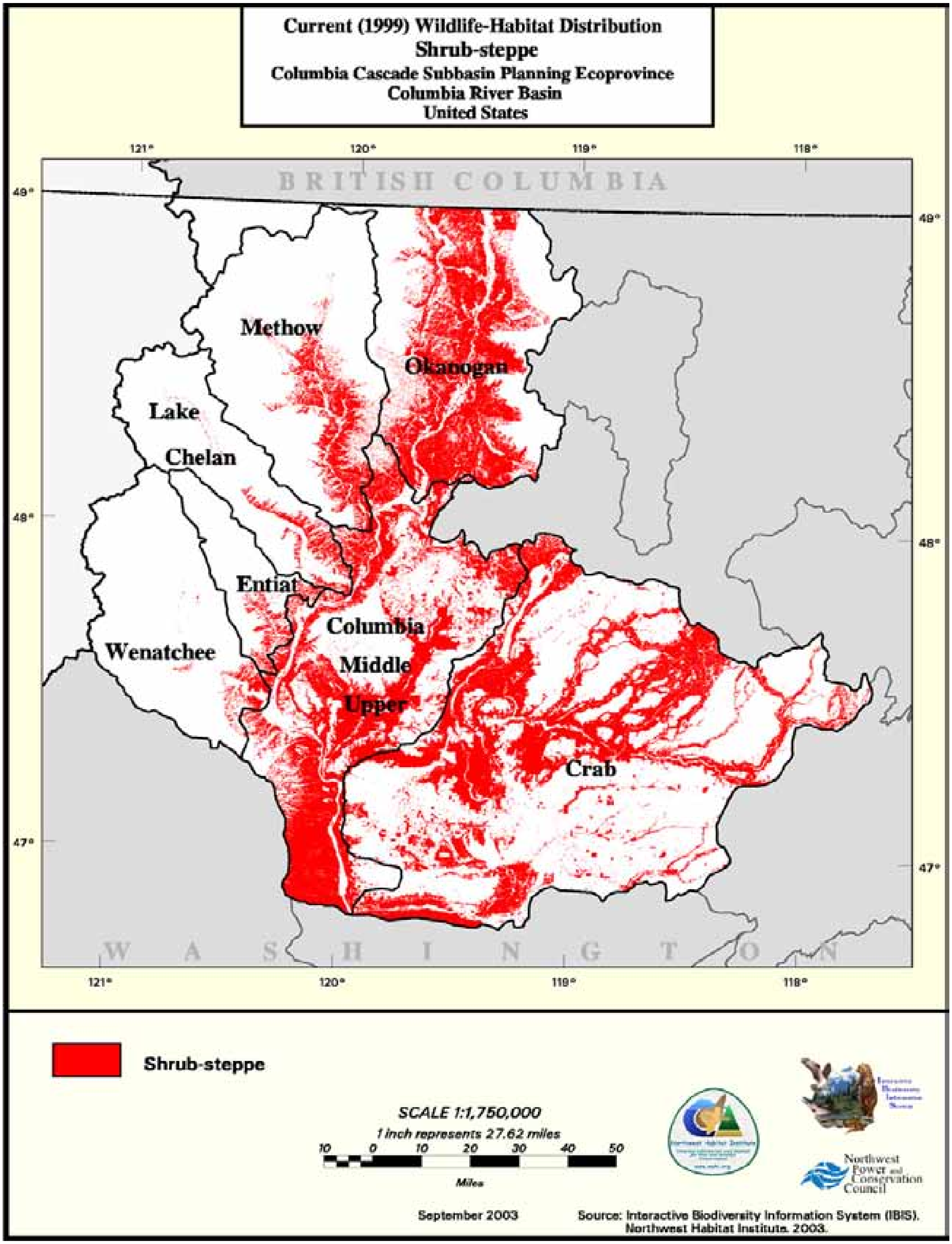

Figure 17. Current shrubsteppe distribution in the Columbia Cascade Ecoprovince, Washington (NHI 2003).

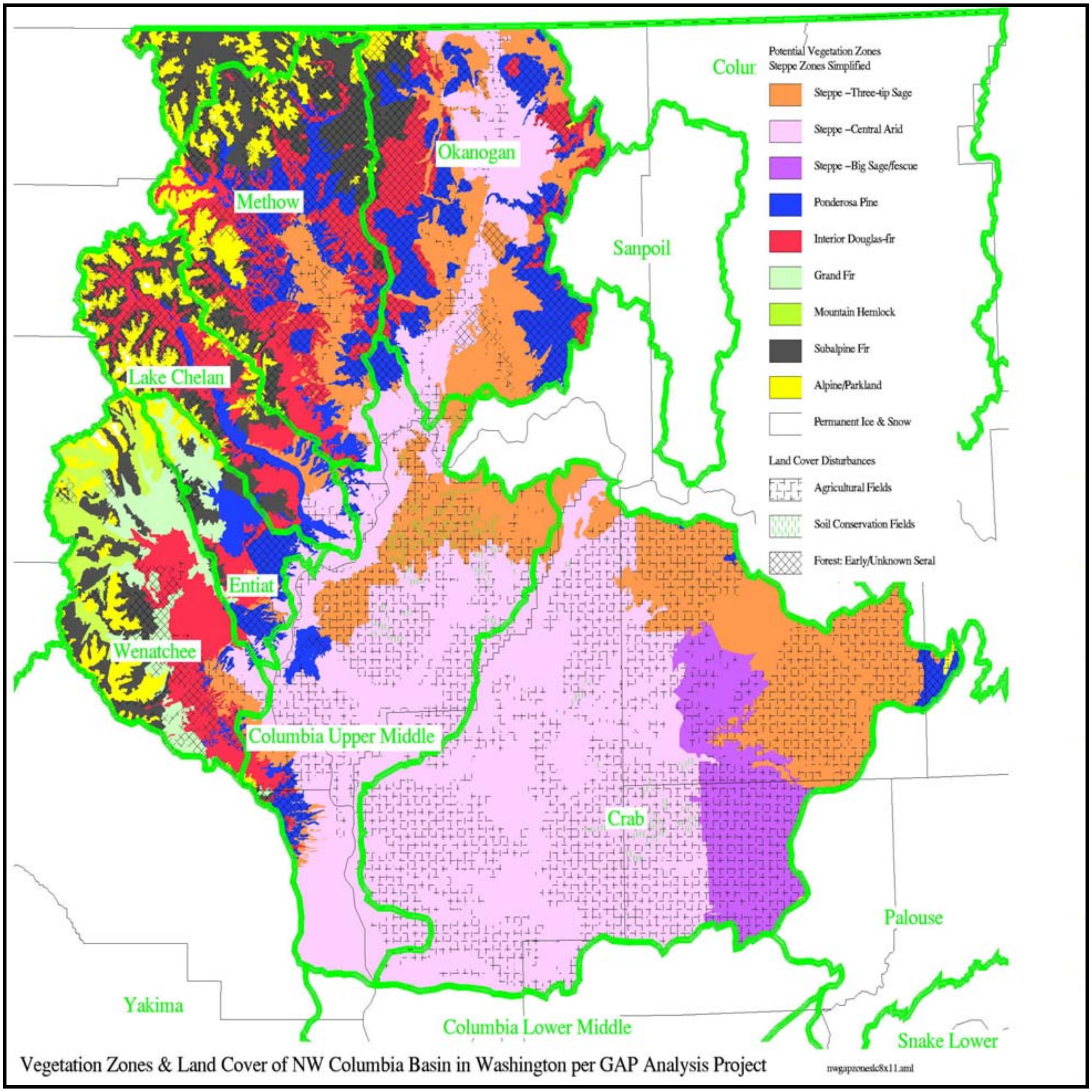

Figure 18. Current shrubsteppe vegetation zones and agricultural land use in the Columbia Cascade Ecoprovince, Washington (Cassidy 1997).

occurs with the shorter stiff sagebrush (*A. rigida*) or low sagebrush (*A. arbuscula*) on shallow soils or high elevation sites. Many sandy areas are shrub-free or are open to patchy shrublands of bitterbrush and/or rabbitbrush. Silver sagebrush is the dominant and characteristic shrub along the edges of stream courses, moist meadows, and ponds. Silver sagebrush and rabbitbrush are associates in disturbed areas.

4.1.7.2.2.1 Three-tip Sage Vegetation Zone

The three-tip sage zone (*Artemisia tripartita*), the second largest steppe zone in Washington, covers over 2.4 million acres on the northern margins of the Columbia Basin and in parts of the east slope of the Cascade (Cassidy 1997). This vegetation zone occurs most predominantly in the Crab, Upper Middle Mainstem Columbia River, Okanogan, and Methow subbasins (Figure_19).

Climax Vegetation:

The characteristic undisturbed vegetation of this zone forms a continuous herbaceous layer with a taller discontinuous layer of three-tip sage. Big sagebrush is confined to disturbed sites. Snowberry (*Symphoricarpos albus)* and bitterbrush are rare (Daubenmire 1970). Three-tip sage looks very much like big sagebrush but is about half as tall, so the sagebrush component of this zone is less visually imposing than in zones where big sagebrush is the dominant shrub.

This zone is large, and the variability in herbaceous dominants reflects its broad precipitation range. The most mesic sites are dominated by Idaho fescue with lesser amounts of bluebunch wheatgrass, threadleaf sedge (*Carex filifolia),* Sandberg bluegrass (*Poa sandbergii*), and needle and thread (*Stipa occidentalis*). On the drier end of the spectrum, bluebunch wheatgrass and Sandberg bluegrass tend to be the dominants, though Idaho fescue usually remains in significant amounts. Forbs are diverse and include many perennials common to other meadow steppe zones. The average shrub cover is about 12 percent and ranges from near 0 percent to greater than 30 percent. Consequently, the native vegetation generally falls under the definition of a grassland (less than 10 percent shrub cover) or shrub savanna (10 to 25 percent shrub cover). Shrublands are mostly limited to ravines and draws, and extensive shrublands are uncommon (Franklin and Dyrness 1973).

Disturbance:

Fire has relatively little effect on native vegetation in this zone, since three-tip sagebrush and the dominant graminoids resprout after burning. Three-tip sagebrush does not appear to be much affected by grazing, but the perennial graminoids decrease and are eventually replaced by cheatgrass (*Bromus tectorum*), plantain *(Plantago* spp.), big bluegrass (*Poa secunda),* and/or gray rabbitbrush (*Chrysothamnus nauseosus).* In recent years, diffuse knapweed (*Centaurea diffusa)* has spread through this zone and threatens to replace other exotics as the chief increaser after grazing (Roche and Roche 1998). A 1981 assessment of rangelands rated most of this zone in fair range condition, with smaller amounts in good and poor range condition; however, ecological condition is generally worse than range condition (Harris and Chaney 1984).

Open water/wetlands – Less than 3 percent of the entire vegetation zone is composed of open water/wetlands (open water - 0.97 percent; riparian - 1.12 percent; marshes and small ponds – 0.42 percent). Open water and wetlands that lie within this vegetation zone are composed primarily of shallow perennial/ephemeral ponds, lakes, and perennial streams.

Non-forested - The largest proportion (51.58 percent) of this zone is non-forested, as most of the Methow Valley, Okanogan Valley, and the east Cascade foothills have remained in steppe.

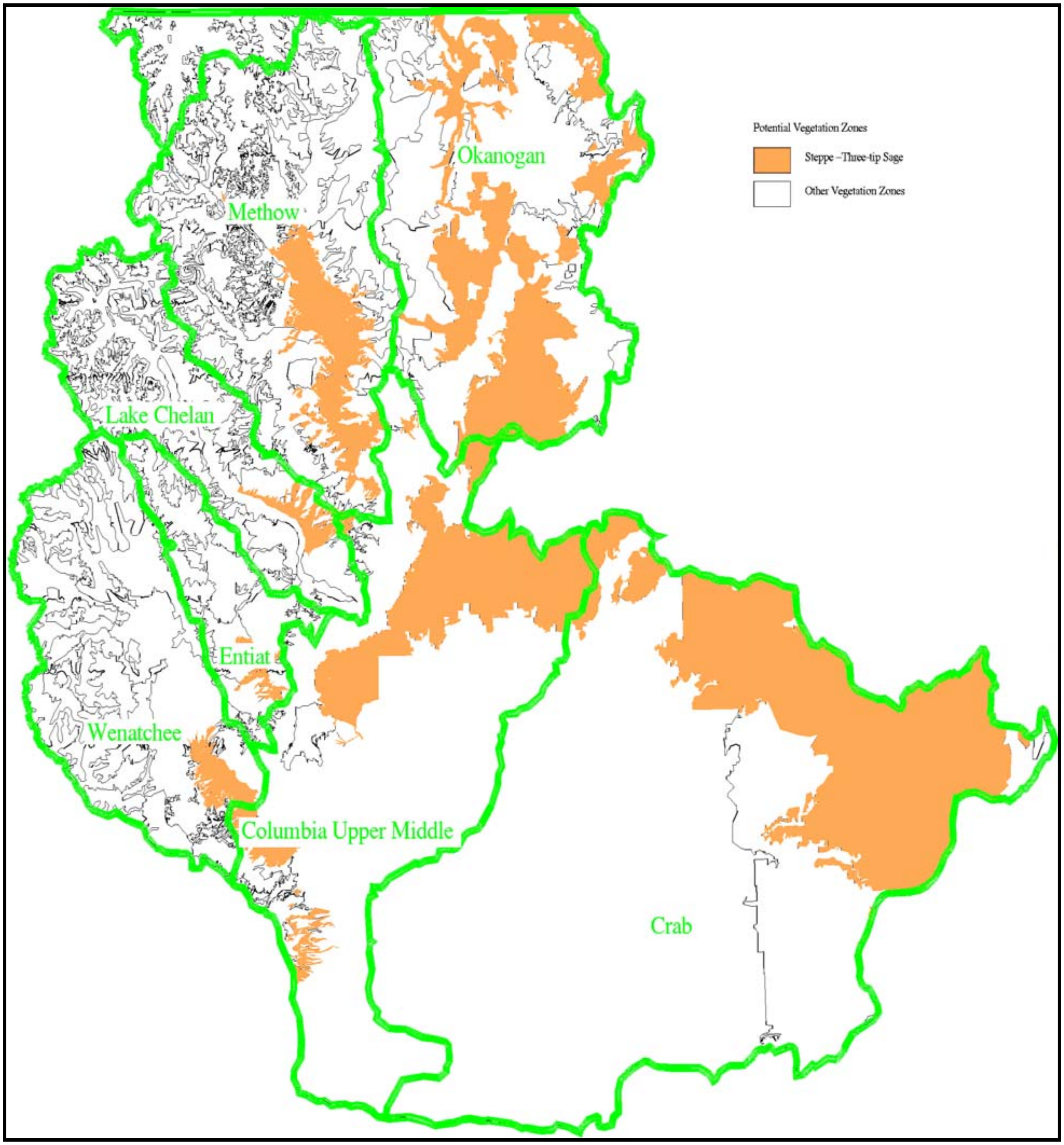

Figure 19. Historic (potential) three-tip sagebrush steppe vegetation zone in the Columbia Cascade Ecoprovince, Washington (Cassidy 1997).

Edaphic and other Special Communities:
Wetlands: Riparian habitats are dominated by black cottonwood (*Populus trichocarpa*) and white alder (*Alnus rhombifolia*). Others: At the margins of the zone and in sheltered ravines, ponderosa pine woodlands may occur.

Land Use and Land Cover:
Agriculture – Approximately 39.26 percent of this entire vegetation zone is in agriculture (irrigated – 2.1 percent; non-irrigated - 35.90 percent; mixed irrigation status - 1.02 percent). The irrigated fields include pastures, row crops, and orchards (Cassidy 1997).
Conservation Status of the Three-Tip Sage Vegetation Zone (Cassidy 1997):

Conservation Status 1 - None

Conservation Status *2* - Status 2 lands in this zone within the Ecoprovince are primarily Wildlife Areas managed or owned by the WDFW. The Sinlahekin Wildlife Area (Okanogan County) follows the Sinlahekin Valley between private lands and WDNR lands and touches the Okanogan National Forest at its southern end. The Methow Wildlife Area (Okanogan County), which occurs as scattered tracts on the perimeter of the Methow Valley, also accounts for much of the status 2 land. Most tracts of the Methow Wildlife Area are situated between the Okanogan National Forest and private land. Smaller amounts of status 2 lands lie in the L. T. Murray Wildlife Area and the Colockum Wildlife Area. Both these areas are large and encompass parts of several zones, so the connectivity of the three-tip sage zone with neighboring zones in the vicinity is high. Both Wildlife Areas are composed of checker-board section blocks alternating with WDNR section blocks. The Coulee Dam National Recreation Area (with segments in Okanogan, Grant, Lincoln, and Ferry Counties) is situated along the banks of the Columbia River. It includes riparian areas and some steppe. The Northrup Canyon State Park and the adjacent Banks Lake Wildlife Area (both in northern Grant County) are other large status 2 lands that include riparian and steppe vegetation. The remaining status 2 lands are smaller and more isolated. They include the Tunk Valley Wildlife Area (Okanogan County), the Central Ferry Wildlife Area (Douglas County), and the Foster Creek Wildlife Area (Douglas County).

Conservation Status 3 - Status 3 lands are mostly owned by the WDNR, followed by the USFS, then the BLM. In Douglas and Okanogan Counties, WDNR lands are consolidated and form nearly continuous blocks that cover township/range sized areas. A several square mile piece of the Wenatchee National Forest in Chelan County north of Lake Chelan is a substantial part of the status 3 lands. BLM lands are mostly in Okanogan, northern Grant, and southeastern Chelan Counties.

Conservation Status 4 – The Colville Indian Reservation covers part of the zone in Okanogan County.

Management Considerations:
With only 1.2 percent of this entire zone in conservation status 2, its representation on reserves is low compared to the rest of the state, but better than most other steppe zones. Although this vegetation zone is severely impacted in this Ecoprovince, many of the status 2 lands elsewhere in this zone are in moderately large contiguous or nearly contiguous blocks and/or adjacent to undeveloped state or National Forest lands (e.g., the Sinlahekin, Methow, L.T. Murray, and Colockum Wildlife Areas). Many of the status 3 lands are also in large blocks and adjacent to other status 2 or 3 lands (e.g., the pieces within the Wenatchee National Forest and the WDNR section blocks checker-boarded within wildlife areas). Few of the status 2 lands are on the deep loess of Douglas, Lincoln, Whitman, and Adams Counties where the best agricultural land occurs. The areas with the greatest management emphasis on biodiversity are mostly in the Okanogan and Methow Valleys and the central Cascade foothills.

Focusing biodiversity management efforts on the best agricultural sections of this zone is likely to be expensive because of the high economic value of these lands. However, restoration of fauna associated with deep soil sites or lush grasslands (e.g., the sharp-tailed grouse) may require the expense. The thinly soiled channeled scablands and areas of glacial scouring and deposition among valuable farmland in Adams, Whitman, Lincoln Counties have less agricultural value. These lands have largely escaped cultivation, provide wildlife corridors across the Columbia Basin, and contain ponds valuable for wildlife. Northern Douglas County has small oases of deeper soil sites that have escaped cultivation because of uneven topography and large boulders stranded by glaciers and floods. These oases may be serving as refuges for plants and animals in the zone, and the associated topography may reduce the value of the land for farming (Cassidy 1997).

Compared to the other steppe zones, the three-tip sage zone has the second highest percentage of its area as status 3 lands. Many of the status 3 tracts occur as relatively large contiguous blocks (e.g., the WDNR lands in northern Douglas County) or are interspersed with status 2 lands. Thus, status 3 land managers, particularly the WDNR, will have a major influence on future biodiversity management in this-zone.

4.1.7.2.2.2 Central Arid Steppe Vegetation Zone

General:
The 7.4 million acres of the central arid steppe vegetation zone account for half of the 14.8 million acres of steppe zones in Washington and 18 percent of the 42 million acres in the state. Of the steppe zones that occur in Washington, the central arid steppe is the most widespread outside of Washington; it occurs in southern Idaho, central Oregon, the northern Great Basin in Utah, and parts of Montana (Cassidy 1997).

The central arid steppe vegetation zone is the dominant vegetation type in the entire Ecoprovince. This vegetation zone occurs most extensively in the Crab, Upper Middle Mainstem Columbia River, and Okanogan subbasins (Figure_20). Lesser amounts of this vegetation zone occurred in the remaining subbasins in the Ecoprovince.

Climax Vegetation:
The characteristic climax vegetation is dominated by big sagebrush, bluebunch wheatgrass, and Sandberg bluegrass (Daubenmire 1970). Other grass species occur in much smaller amounts, including needle and thread, Thurbers needlegrass (*S. thurberiana*), Cusick's bluegrass (*Poa cusickii*), and/or bottlebrush squirreltail grass (*Sitanion* hystrix). Forbs play a minor role. A cryptogamic crust of lichens and mosses grows between the dominant bunchgrasses and shrubs. Without disturbance, particularly trampling by livestock, the cryptogamic crust often completely covers the space between vascular plants. Most plants respond to the summer dry period by flowering by June, followed by senescence of their above-ground parts. Some of the taller shrubs with deep roots are able to utilize deeper water supplies and remain photosynthetically active through the summer. Big sagebrush, the latest bloomer, flowers in October near the beginning of the fall rainy season.

This big sagebrush/bluebunch wheatgrass association is often perceived and described as shrubland. Big sagebrush is indeed prominent because of its height, but in the absence of grazing and fire suppression it rarely covers enough area to create a true shrubland (i.e., one with greater than 25 percent shrub cover). Shrub cover is generally between 5 and 20 percent, so most stands are more correctly described as shrub savanna (10 to 25 percent shrub cover) or, less often, as grasslands (less than 10 percent shrub cover). True shrublands in the Columbia Basin are generally confined to ravines and draws and areas of fire suppression and overgrazing. At the hottest, driest, and lowest elevations (in the Hanford basin area), however, big sagebrush/Sandberg bluegrass communities may form true shrublands that are apparently

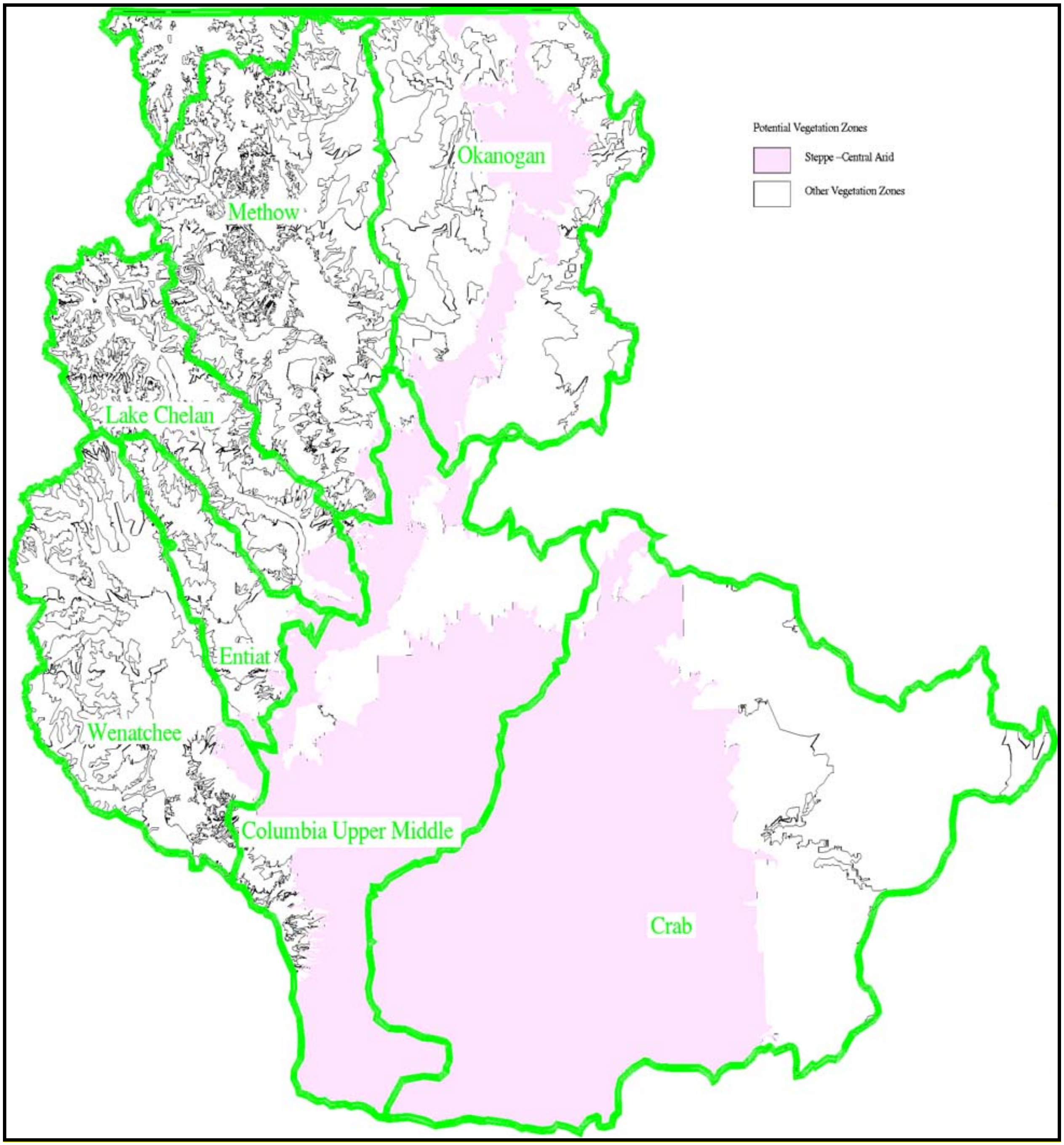

Figure 20. Historic (potential) central arid steppe vegetation zone in the Columbia Cascade Ecoprovince, Washington (Cassidy 1997).

natural. Cheatgrass, an introduced annual, is so well adapted to the climate of this zone that, once established, it can apparently persist indefinitely as a dominant of climax communities in the absence of further disturbance. Big sagebrush/cheatgrass shrub savanna associations on the Hanford Nuclear Reservation have persisted in the absence of grazing or cultivation for decades and are apparently stable.

Disturbance:
Big sagebrush is killed by fire, leaving the relatively unaffected grasses as dominants (Daubenmire 1975). Cattle and horses preferentially graze Cusick's bluegrass followed by Bluebunch wheatgrass, then other grasses. They avoid big sagebrush, which tends to increase with grazing unless livestock density is so high that its branches are broken. In areas with a history of heavy grazing and fire suppression, true shrublands are common and may even be the predominant cover on non-agricultural land. Most of the native grasses and forbs are poorly adapted to heavy grazing and trampling by livestock. Grazing eventually leads to replacement of the bunchgrasses with cheatgrass, Nuttall's fescue (*Festuca microstachys*), eight flowered fescue (*F. octofiora),* and Indian wheat (*Plantago patagonica*) (Harris and Chaney 1984).

Cultivated and abandoned fields are initially dominated by Russian thistle (*Salsola kali)* and tumble mustard (*Sisymbrium altissimum).* These tumbleweeds are eventually crowded out by cheatgrass (Mack 1986). Cheatgrass swards can also change the intensity and frequency of fires (from cool, infrequent fires to hot, frequent ones) such that natives are excluded from becoming re-established when grazing is removed. In recent years, several knapweeds (*Centaurea spp*.), have become increasingly widespread. Russian star thistle (*Centaurea repens)* is particularly widespread, especially along and near major watercourses (Roche and Roche 1988 in Cassidy 1997). A 1981 assessment of range conditions rated most of rangelands in this zone in poor to fair range condition except land on the Yakima Training Center (Department of Defense) and the Fitzner/Eberhardt Arid Lands Ecology Reserve (Hanford Nuclear Reservation, Department of Energy), which were in good to excellent range condition (but ecological condition is usually worse than range condition).

Edaphic and other Special Communities:
This large zone encompasses numerous habitats influenced by edaphic and topographic factors that support floral associations different from the characteristic big sagebrush/bluebunch wheatgrass association. Sand: Sandy soils support needle-and-thread communities with codominants of big sagebrush, bitterbrush, Sandberg bluegrass, and/or three-tip sagebrush. Indian ricegrass (*Oryzopsis hymenoides*) is locally common in sandy areas. Drifting sand communities along the Columbia River in the Priest Rapids area include gray cryptantha (*Cryptantha leucophaea*), turpentine cymopterus (*Cymopterus terebinthinus*), and white abronia (*Abronia mellifera)* (Mastroguiseppe and Gill 1983). Lithosols: Shallow soil supports communities dominated by buckwheat species, Sandberg bluegrass, and rigid sagebrush. Saline/alkaline: Extensive playas like those found in desert regions further south are not found in Washington State, but small saline or alkaline areas are scattered through the Basin. Saline and alkaline soils most commonly support saltgrass communities, with codominants ryegrass and/or greasewood (*Sarcobatus vermiculatus*)*.* Spiny hopsage (*Atriplex spinosa*) communities are locally common but their soil association is poorly understood (Franklin and Dyrness 1973). Wetlands: Natural springs support a variety of lush communities that are very important to wildlife in this dry zone. Species composition is variable, but species commonly encountered are mock orange (*Philadelphus Lewisii),* yellow monkey flower *(Mimulus guttatus*), swamp willow-herb (*Epilobium palustre*), common chokecherry, smooth sumac*,* woods rose *(Rosa Woodsii*), willows, serviceberry (*Amelanchier alnifolia),* and black cottonwood. Rocky Mountain juniper dominates a few springs and washes near the Columbia River, but is otherwise rare in the central arid steppe. Irrigation has vastly increased the amount of marshy and riparian vegetation. Cattail (*Typha* spp.) communities grow in ditches alongside irrigated fields. Russian olive (*Eleagnus angustifolia*), originally introduced to enhance wildlife habitat, has become the dominant riparian tree throughout much of the Basin (Franklin and Dyrness 1973). Topographic: North-facing slopes often support different climax communities. Three-tip sagebrush/Idaho fescue and three-tip sagebrush/bluebunch wheatgrass communities, sometimes mixed with big

sagebrush, are commonly found of north-facing slopes above 1,500 feet. Bitterbrush is often mixed with big sagebrush near the western edge of the zone. On north-facing slopes at the western edge of the zone, bitterbrush, big sagebrush, and three-tip sagebrush, may occur together.

Land Use and Land Cover:
Bare ground - 0.09 percent. These are mostly basalt cliffs; rarely extensive sand dunes. (Most sand dunes have a sufficient amount of vegetation that they fall into the "non-forested, sparse cover" class.) To a ground-based observer, basalt cliffs are a prominent feature of the Columbia Basin. They are also an important wildlife habitat feature.

Agriculture - At least 45.49 percent of the entire vegetation zone is in agriculture (Irrigated - 27.34 percent; Non-irrigated - 17.65 percent; Mixed irrigation status - 0.50 percent). This steppe zone is the only one in which irrigated agriculture exceeds non-irrigated agriculture. Irrigated fields along the Columbia River are often dominated by orchards and vineyards. Fields in the center of the Basin are often row crop circles of a quarter mile to a mile in diameter. Non-irrigated fields are on deeper soil in northern Grant and Douglas Counties. Winter wheat and other small grains are the most common non-irrigated crops.

Open water/wetlands - Approximately 4.62 percent of the entire vegetation zone is in open water/wetland habitats (open water - 2.78 percent; marshes, small ponds, irrigation canals - 0.68 percent; riparian - 1.17 percent). Open water includes the surface of the major rivers (the Columbia and Okanogan) and several lakes. NHI data (2003) suggests that there is considerably less open water/wetlands in this Ecoprovince.

Conservation Status of the Central Arid Steppe Vegetation Zone (Cassidy 1997):

Conservation Status 1 - None

Conservation Status 2 - Status 2 lands include: Osoyoos Lake State Veterans Memorial Park, Indian Dam Wildlife Area, several small TNC parcels (Okanogan County); Wells Wildlife Area, Central Ferry Wildlife Area, Rock Island State Park (Douglas County); a mall part of the Coulee Dam National Recreation Area (near Coulee Dam city); Chelan Butte Wildlife Area, Entiat Wildlife Area, and Swakane Wildlife Area (Chelan County); Sun Lakes State Park, Lenore Lake Wildlife Area, Steamboat Rock State Park, Stratford Wildlife Area, the numerous scattered units of the North Columbia Basin Wildlife Area (Grant County); Colockum Wildlife Area, Quilomene Wildlife Area, Schaake Wildlife Area, Gingko State Park (Kittitas County); L. T. Murray Wildlife Area (Yakima, Kittitas Counties); and the Columbia National Wildlife Refuge (scattered parcels in Grant and Adams Counties).

These numerous Status 2 lands are scattered within the zone, but the largest contiguous tracts lie at the base of the east central Cascade and in the center of the Basin.

Conservation Status 3 - These lands are predominantly WDNR Trust lands, followed by lesser amounts of BLM and USFS lands. WDNR lands are mostly regularly spaced section blocks. Some of the WDNR lands have been consolidated into larger clusters, such as those in southern Douglas and northern Grant Counties, or are intermixed in a checkerboard pattern with Wildlife Areas and National Wildlife Refuges. The largest tracts are in northern Okanogan County, southern Douglas County, and in southern Grant County. USFS lands are composed of lower-elevation pieces of the Wenatchee National Forest in Chelan County and the Okanogan National Forest north of State Route 20.

Conservation Status 4 - Lands in this category are predominantly privately owned within this Ecoprovince.

Management Considerations:
This zone has the second lowest proportion (84.9 percent) of status 4 lands among the steppe zones. The conservation status of this zone is further enhanced by the size and connectivity of many of the status 2 land and the de facto conservation status some of its larger status 4 Federal lands.

A long-term management priority is the need for creation and/or maintenance of the connections between steppe within this zone and steppe and forest adjacent to this zone. The Columbia River splits the Columbia Basin into an east and west side, and forms a natural barrier to many animal species. Status 2 lands on the west side are generally well-connected to one another by other status 2 lands, status 3 lands, or relatively undeveloped status 4 lands

Another important management consideration is maintenance of the continuity of the major riparian areas and protection of the link between riparian wetlands and adjacent steppe. The big rivers and streams of the central arid steppe vegetation zone are critical to wildlife in this zone of low rainfall. Besides the obvious presence of water, these rivers are associated with many important wildlife habitat features. Cliffs provide roosts for some bat species and nest sites for some bird species. Cliff-dwelling bats and birds forage in the adjacent steppe and over the river. The cliffs are in little danger of development, but cliff-dwelling animals may be affected by habitat alteration of the surrounding steppe and the riparian strip. Species that rely on the combination of sheer cliffs and large rivers have no alternate refuge.

4.1.7.2.2.3 Big Sagebrush/Fescue Vegetation Zone

General:
This vegetation zone is transitional between the central arid steppe zone and neighboring meadow steppe zones (the Palouse and three-tip sage zones). The zone covers the central parts of Adams and Lincoln Counties and the central portion of the Crab subbasin (Figure_21). Its annual precipitation of 12 inches is similar to that of the central arid steppe zone but its higher elevation and cooler temperatures increase the effective precipitation (Cassidy 1997).

Climax Vegetation:
Native vegetation is similar to that of the central arid steppe zone, except that Idaho fescue joins bluebunch wheatgrass as a co-dominant bunchgrass. A cryptogamic crust of mosses and lichens covers the ground between the vascular plants (Daubenmire 1970, Franklin and Dyrness 1973).

Disturbance:
Most of the native bunchgrasses and forbs are poorly adapted to heavy grazing and trampling by livestock. Grazing tends to lead to increasing dominance by cheatgrass. Several exotic knapweed species have become more common in recent years (Harris and Chaney 1984). A 1981 survey estimated most of the remaining rangeland to be in generally poor to fair range condition (but ecological condition is generally worse than range condition).

Agriculture – Over 75 percent of the entire vegetation zone is in agriculture (Irrigated - 5.18 percent; Non-irrigated - 69.86 percent; Mixed irrigation status -0.07 percent). Most sites on loess soil have been sown to winter wheat. Irrigated pastures and some crops are mostly along valleys, especially along Crab Creek, Lake Creek and near Lind.

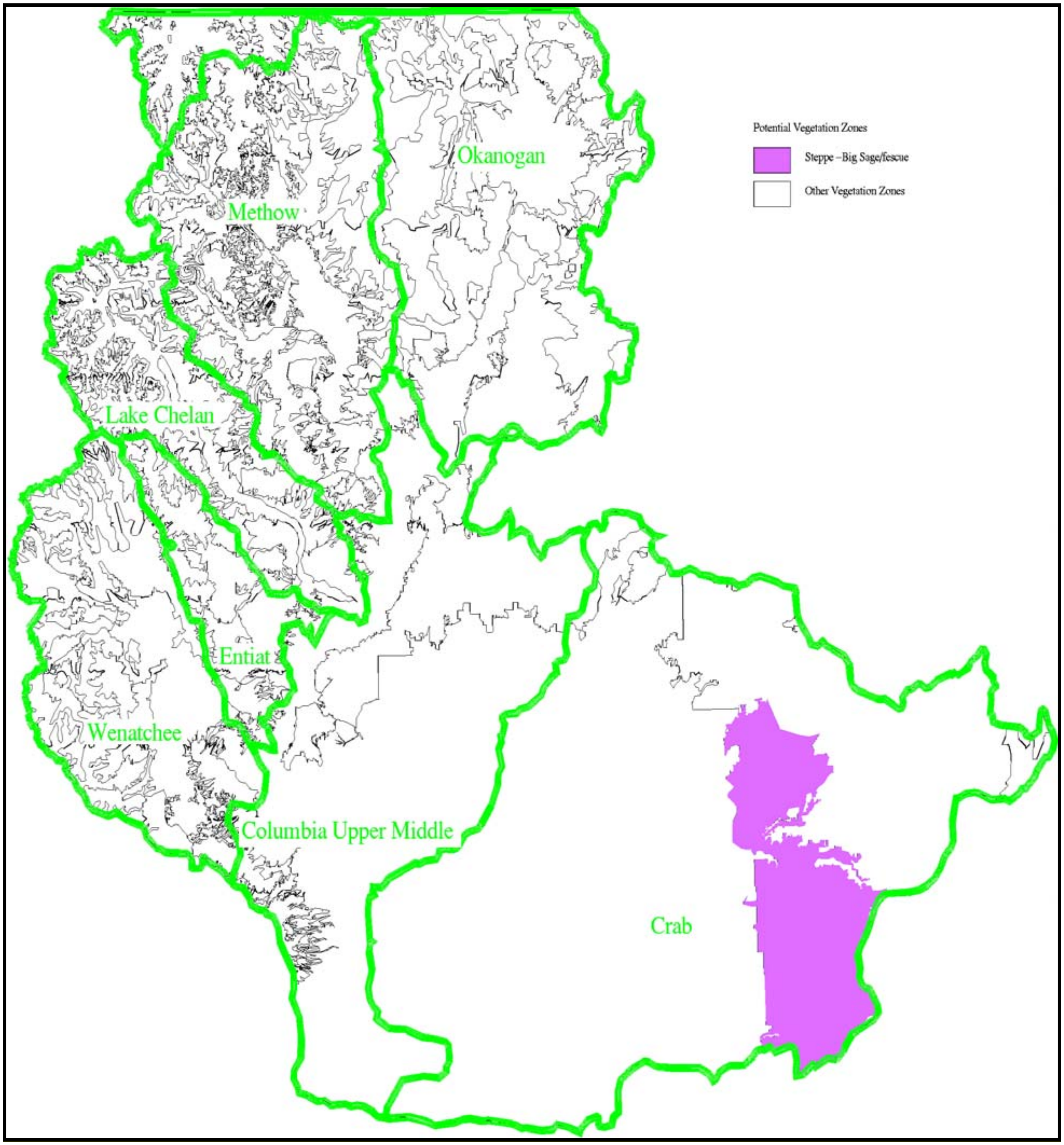

Figure 21. Historic (potential) big sagebrush/fescue vegetation zone in the Columbia Cascade Ecoprovince, Washington (Cassidy 1997).

Edaphic and other Special Communities:

Lithosols: Several old flood channels (the channeled scablands) cut through the deep loess. Communities of Sandberg bluegrass, rigid sagebrush, and buckwheat form on the shallowest soils (Daubenmire 1970). Saline/alkaline: Poorly drained saline or alkaline soils support communities dominated by saltgrass, sometimes with wildrye or greasewood codominants (Daubenmire 1970).

Current Land Use and Land Cover:
Open water/wetlands – Less than one percent of this vegetation zone is in open water/wetland habitat (0.59 percent) (Open water - 0.14 percent; Marshes, small ponds - 0.05 percent; Riparian - 0.40 percent). The open water is primarily in the form of channeled scabland lakes and ponds. Wetlands are mostly narrow riparian strips along drainages.

Non-forested – Slightly more than 24 percent of the vegetation zone is composed of non-forested areas (Grasslands - 21.48 percent; Shrub savanna - 2.53 percent). Most of the non-forested vegetation of this zone occurs in the channeled scablands in the northern part of the zone in Lincoln County. Virtually none of the zone within the Ecoprovince (Adams County) is left uncultivated.

Conservation Status of the Big Sage/Fescue Steppe Vegetation Zone (Cassidy 1997):

*Cons*ervation Status 1- None

*Conserv*ation Status 2 - The sole parcel of land in conservation status 2 is owned by TNC and is situated in Rocky Coulee in northern Adams County (no status 2 lands occur in this vegetation zone within the Ecoprovince).

Conservation Status 3 - These lands consist almost entirely of regularly spaced section blocks owned by the WDNR. They are usually leased and either plowed or grazed. A very small amount of land is owned by the BLM.

Conservation Status 4 - All private (Cassidy 1997).

Management Considerations:
A greater proportion of this vegetation zone than any other steppe zone, except the Palouse, has been converted to agriculture. It ranks second (after the Palouse) among steppe zones in the proportion of its area in private ownership. The single status 2 parcel, a plot owned by TNC, is isolated from any other conservation status 2 lands by many miles of private land. Wildlife corridors are primarily along the uncultivated coulees in Lincoln County. These coulees link the three-tip sage vegetation zone with the central arid steppe vegetation zone.

After Palouse steppe, native communities in the big sage/fescue vegetation zone, especially on deep soil sites, are more at risk of being completely lost than any others in the state. Since the WDNR is the major public land owner in the zone, any improvement of biodiversity protection on deep soil sites will depend heavily on WDNR land management policies (Cassidy 1997). Clearly, this vegetation zone warrants additional protection measures.

Status and Trends:
Alteration of fire regimes, fragmentation, livestock grazing, and the addition of more than 800 exotic plant species have changed the character of shrubsteppe habitat. It is difficult to find stands which are still in relatively natural condition. The greatest changes from historic conditions are the reduction of bunchgrass cover in the understory and an increase in sagebrush and rabbitbrush cover. Soil compaction is also a significant factor in heavily grazed lands affecting water percolation, runoff and soil nutrient content.

In some areas, western juniper woodlands have greatly expanded their range, now occupying much more of the sagebrush ecosystem than in pre-European settlement times. The reasons for the expansion are complex and include interactions between climate change and changing land use, but fire suppression and grazing have played a prominent role in this dramatic shift in structure and dominant vegetation.

Quigley and Arbelbide (1997) concluded that big sagebrush and mountain sagebrush cover types are significantly smaller in area than before 1900, and that bitterbrush/bluebunch wheatgrass cover type is similar to the pre-1900 extent. They concluded that basin big sagebrush and big sagebrush-warm potential vegetation type's successional pathways are altered, that some pathways of antelope bitterbrush are altered, and that most pathways for big sagebrush-cool are unaltered. Overall this habitat has seen an increase in exotic plant importance and a decrease in native bunchgrasses. More than half of the Pacific Northwest shrubsteppe habitat community types listed in the National Vegetation Classification are considered imperiled or critically imperiled (Anderson *et al.* 1998).

4.1.7.2.3 Recommended Future Condition

4.1.7.2.3.1 Shrub-dominated Shrubsteppe

The general recommended future condition of sagebrush dominated shrubsteppe habitat includes expansive areas of high quality sagebrush with a diverse understory of native grasses and forbs (non-native herbaceous vegetation less than 10 percent). More specific desired conditions include large unfragmented multi-structured patches of sagebrush with shrub cover varying between 10 and 30 percent. Good-condition shrubsteppe habitat has very little exposed bare ground, and supports mosses and lichens (cryptogammic crust) that carpet the area between taller plants. Similarly, subbasin land managers will manage diverse shrubsteppe habitats to protect and enhance desirable shrub species such as bitterbrush while limiting the spread of noxious weeds and increaser native shrub species such as rabbitbrush.

Ecoprovince planners have identified general ecological/management conditions that, if met, will provide suitable habitat for multiple wildlife species at the Ecoprovince scale within the shrubsteppe habitat type. Mule deer (*Odocoileus hemionus hemionus*), Brewer's sparrow (*Spizella breweri*), sage thrasher (*Oreoscoptes montanus*), sage grouse (*Centrocercus urophasianus*), and pygmy rabbit (*Brachylagus idahoensis*) were selected to represent the range of habitat conditions required by wildlife species that utilize sagebrush dominated shrubsteppe (shrubland) habitat within the Ecoprovince. Speciefic species information is included in Appendix_F. These wildlife species may also serve as a performance measure to monitor and evaluate the results of implementing future management strategies and actions.

Subbasin wildlife/land managers will review the conditions described below to plan and, where appropriate, guide future enhancement/protection actions on shrubsteppe habitats. Specific desired future conditions, however, are identified and developed within the context of individual management plans at the subbasin level.

Condition 1 – Sagebrush dominated shrubsteppe habitat: Sage thrasher was selected to represent shrubsteppe obligate wildlife species that require sagebrush dominated shrubsteppe habitats and that are dependent upon areas of tall sagebrush within large tracts of shrubsteppe habitat (Knick and Rotenberry 1995; Paige and Ritter 1999; Vander Haegen *et al.* 2001). Suitable habitat includes 5 to 20 percent sagebrush cover greater than 2.5 feet in height, 5 to 20 percent native herbaceous cover, and less than 10 percent non-native herbaceous cover.

Similarly, the Brewer's sparrow was selected to represent wildlife species that require sagebrush dominated sites. Brewer's sparrow prefers a patchy distribution of sagebrush clumps, 10-30 percent cover (Altman and Holmes 2000), lower sagebrush height (between 20 and 28 inches), (Wiens and Rotenberry 1981), 10 to 20 percent native grass cover (Dobler

1994), less than 10 percent non-native herbaceous cover, and bare ground greater than 20 percent (Altman and Holmes 2000). It should be noted, however, that Johnsgard and Rickard (1957) reported that shrublands comprised of snowberry, hawthorne, chokecherry, serviceberry, bitterbrush, and rabbitbrush were also used by Brewer's sparrows for nesting in southeast Washington. Specific, quantifiable habitat attribute information for this mixed shrub landscape could not be found.

Condition 2 – Diverse shrubsteppe habitat: Mule deer were selected to represent species that require and prefer diverse, dense (30 to 60 percent shrub cover less than 5 feet tall) shrubsteppe habitats (Ashley *et al.* 1999) comprised of bitterbrush, big sagebrush, rabbitbrush, and other shrub species (Leckenby 1969; Kufeld *et al.* 1973; Sheehy 1975; Jackson 1990) with a palatable herbaceous understory exceeding 30 percent cover (Ashley *et al.* 1999).

Similarly, the pygmy rabbit is dependent upon sagebrush, primarily big sagebrush (*Artemisia tridentata*), and is usually found in areas where big sagebrush grows in very dense (at least 30 percent shrub cover less than 5 feet tall) stands. Tall, dense sagebrush clumps are essential (Orr 1940). Soft, deep soils (at least 20 inches deep) are required for burrowing.

4.1.7.2.3.2 Steppe/Grassland-dominated Shrubsteppe

The general recommended future condition of steppe/grassland dominated shrubsteppe habitat includes contiguous tracts of native bunchgrass and forb plant communities with less than five percent shrub cover and less than ten percent exotic vegetation. In xeric, brittle environments and sites dominated by shallow lithosols soils, areas between bunchgrass culms should support mosses and lichens (cryptogamic crust). In contrast, more mesic (greater than12 inches annual precipitation), deep soiled sites could sustain dense (greater than 75 percent cover) stands of native grasses and forbs (conclusions drawn from Daubenmire 1970).

Grasshopper sparrow (*Ammodramus savannarum*) and sharp-tailed grouse (*Tympanuchus phasianellus*) were chosen to represent the range of habitat conditions required by steppe/grassland obligate wildlife species. Ecoprovince planners recommend the following range of conditions:

- Greater than 40 percent native bunchgrass cover
- 10 to 30 percent native forb cover
- Visual obstruction readings (VOR) of at least 6 inches
- Less than 10 percent native non-deciduous shrub cover
- Less than 10 percent noxious weed cover
- Multi-structured fruit/bud/catkin-producing deciduous trees and shrubs dispersed throughout the landscape (10 to 40 percent of the total area), or within 1 mile of sharp-tailed grouse nesting/broodrearing habitats

Similarly, Sage grouse were selected to represent species that require/prefer diverse sagebrush habitat with medium to high shrub cover and residual grass. Sage grouse prefer slopes less than 30 percent (Call and Maser 1985), sagebrush/bunchgrass stands having medium to high canopy cover (10-30 percent), forb/grass cover at least 15 percent and less than 10 percent non-native herbaceous cover.

Change in the extent of shrubsteppe habitat from circa 1850 to 1999 is illustrated at the 6th – level HUC in Figure_22 (NHI 2003). Red color tones indicate negative change while blue color tones indicate positive change. The positive change is likely the result of shrub encroachment on grassland habitats due to over-grazing and fire suppression. In contrast, the negative change is due primarily to conversion of shrubsteppe to agriculture.

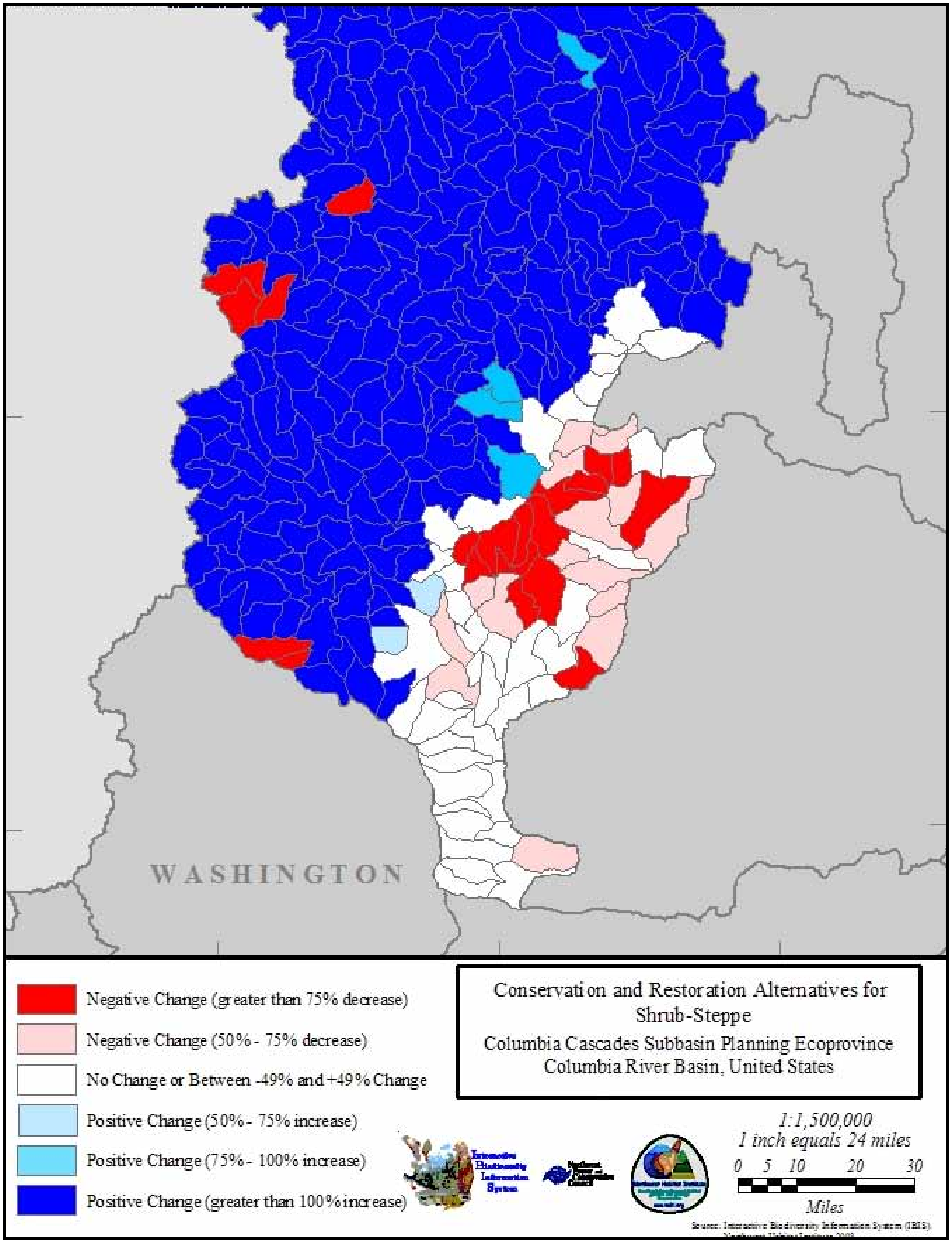

Figure 22. Shrubsteppe habitat type conservation and restoration alternatives (NHI 2003).

Although the data are displayed at the 6th – level HUC, it does not necessarily mean that the entire HUC was historically, or is currently comprised completely of the shrubsteppe habitat type. The data simply indicates that the shrubsteppe habitat type occurred somewhere within a particular HUC.

The data displayed in Figure_22 can be used by Ecoprovince/subbasin planners to identify and prioritize conservation and restoration areas and strategies. For example, planners may develop a hierarchal approach to protecting shrubsteppe habitats where HUCs that have exhibited positive change receive a higher initial prioritization than those that have experienced a negative change. Ecoreprovince planners could then cross-link this information with other data such as ECA and GAP protection status to develop comprehensive strategies to identify and prioritize critical areas and potential protection actions.

The data could also be used to identify areas formerly occupied by grassland habitats and/or grassland vegetation zones that are currently shrubsteppe. If protecting/increasing grassland habitats is a higher priority than shrubsteppe habitats within the Ecoprovince or particular subbasin, areas could be identified and prioritized in which encroaching shrubsteppe habitats would be returned to grasslands. Management strategies to accomplish this, such as the use of controlled burns, could then be developed and linked to specific goals and objectives.

4.1.7.3 Eastside (Interior) Riparian Wetlands

4.1.7.3.1 Historic

Prior to 1850, riparian habitats were found at all elevations and on all stream gradients; they were the lifeblood for most wildlife species with up to 80 percent of all wildlife species dependent upon these areas at some time in their lifecycle (Thomas 1979). Many riparian habitats were maintained by beaver activity which was prominent throughout the west. Beaver-dammed streams created pools that harbored fish and other species; their dams also reduced flooding and diversified and broadened the riparian habitat. The other important ecological process which affected riparian areas was natural flooding that redistributed sediments and established new sites for riparian vegetation to become established.

Riparian vegetation was restricted in the arid Intermountain West, but was nonetheless fairly diverse. It was characterized by a mosaic of plant communities occurring at irregular intervals along streams and dominated singularly or in some combination by grass-forbs, shrub thickets, and mature forests with tall deciduous trees. Common shrubs and trees in riparian zones included several species of willows, red-osier dogwood, hackberry, mountain alder, Wood's rose, snowberry, currant, black cottonwood, water birch, paper birch, aspen, peachleaf willow, and mountain alder. Herbaceous understories were very diverse, but typically included several species of sedges along with many dicot species.

Riparian areas have been extensively impacted within the Columbia Plateau such that undisturbed riparian systems are rare (Knutson and Naef 1997). Impacts have been greatest at low elevations and in valleys where agricultural conversion, altered stream channel morphology, and water withdrawal have played significant roles in changing the character of streams and associated riparian areas. Losses in lower elevations include large areas once dominated by cottonwoods that contributed considerable structure to riparian habitats. In higher elevations, stream degradation occurred with the trapping of beaver in the early 1800s, which began the gradual unraveling of stream function that was greatly accelerated with the introduction of livestock grazing. Woody vegetation has been extensively suppressed by grazing in some areas, many of which continue to be grazed. Herbaceous vegetation has also been highly altered with the introduction of Kentucky bluegrass that has spread to many riparian areas, forming a sod at the exclusion of other herbaceous species. The implications of riparian area degradation and alteration are wide ranging for bird populations which utilize these habitats for nesting, foraging and resting. Secondary effects which have impacted insect fauna have reduced or altered potential foods for birds as well.

Within the past 100 years, an estimated 95 percent of this habitat has been altered, degraded, or destroyed by a wide range of human activities including river channelization, unmanaged livestock grazing, clearing for agriculture, water impoundments, urbanization, timber harvest, exotic plant invasion, recreational impacts, groundwater pumping, and fire (Krueper Unknown). Together, these activities have dramatically altered the structural and functional integrity of western riparian habitats (Johnson *et al.* 1977; Dobyns 1981; Bock *et al.* 1993; Krueper 1993; Fleischner 1994; Horning 1994; Ohmart 1994, 1995; Cooperrider and Wilcove 1995; Krueper 1996). At present, natural riparian communities persist only as isolated remnants of once vast, interconnected webs of rivers, streams, marshes, and vegetated washes.

Quigley and Arbelbide (1997) concluded that the cottonwood-willow cover type covers significantly less in area now than before 1900 in the Inland Pacific Northwest. The authors concluded that although riparian shrubland occupied only 2 percent of the landscape, they estimated it to have declined to 0.5 percent of the landscape. Approximately 40 percent of riparian shrublands occurred above 3,280 feet msl prior to 1900; now nearly 80 percent is found above that elevation. This change reflects losses to agricultural development, road development, dams, and other flood-control activities. The current riparian shrublands contain many exotic plant species and generally are less productive than historically. Quigley and Arbelbide (1997) found that riparian woodland was always rare and the change in extent from the past is substantial.

The NHI riparian habitat data are incomplete; therefore, riparian floodplain habitats are not well represented on NHI maps (accurate habitat type maps, especially those detailing riparian/wetland habitats, are needed to improve assessment quality and support management strategies/actions). Subbasin wildlife managers, however, believe that significant physical and functional losses have occurred to these important riparian habitats from hydroelectric facility construction and inundation, agricultural development, and livestock grazing. Changes in the distribution of riparian habitat from circa 1850 (historic) to 1999 (current) are illustrated in Figure_23 and Figure_24.

4.1.7.3.2 Current

General:

Riparian wetland habitat dominated by woody plants is found throughout eastern Washington. Mountain alder-willow riparian shrublands are major habitats in the forested zones of eastern Washington. Eastside lowland willow and other riparian shrublands are the major riparian types throughout eastern Washington at lower elevations. Black cottonwood riparian habitats occur throughout eastern Washington at low to middle elevations. Quaking aspen wetlands and riparian habitats are widespread but rarely a major component throughout eastern Washington. Ponderosa pine-Douglas-fir riparian habitat occurs only around the periphery of the Columbia Basin in Washington and up into lower montane forests.

Riparian wetland habitat appears along perennial and intermittent rivers and streams. This habitat also appears in impounded wetlands and along lakes and ponds. Their associated streams flow along low to high gradients. The riparian and wetland forests are usually in fairly narrow bands along the moving water that follows a corridor along montane or valley streams. The most typical stand is limited to 100-200 feet from streams. Riparian forests also appear on

Figure 23. Historic riparian wetland distribution in the Columbia Cascade Ecoprovince, Washington (NHI 2003).

Figure 24. Historic riparian wetland distribution in the Columbia Cascade Ecoprovince, Washington (NHI 2003).

sites subject to temporary flooding during spring runoff. Irrigation of streamsides and toe slopes provides more water than precipitation and is important in the development of this habitat, particularly in drier climatic regions. Hydrogeomorphic surfaces along streams supporting this habitat have seasonally to temporarily flooded hydrologic regimes. Eastside riparian wetland habitats are found from 100 to 9,500 feet in elevation.

Eastside riparian wetland habitat occurs along streams, seeps, and lakes within the eastside mixed conifer forest, ponderosa pine forest and woodlands, western juniper and mountain Mahogany woodlands, and part of the shrubsteppe habitat. This habitat may be described as occupying warm montane and adjacent valley and plain riparian environments.

Eastside riparian wetland habitat structure includes shrublands, woodlands, and forest communities. Stands are closed to open canopies and often multi-layered. A typical riparian habitat would be a mosaic of forest, woodland, and shrubland patches along a stream course. The tree layer can be dominated by broadleaf, conifer, or mixed canopies. Tall shrub layers, with and without trees, are deciduous and often nearly completely closed thickets. These woody riparian habitats have an undergrowth of low shrubs or dense patches of grasses, sedges, or forbs. Tall shrub communities (20-98 feet, occasionally tall enough to be considered woodlands or forests) can be interspersed with sedge meadows or moist, forb-rich grasslands. Intermittently flooded riparian habitat has ground cover composed of steppe grasses and forbs. Rocks and boulders may be a prominent feature in this habitat.

Vegetation:
Information found in the NHI (2003) database suggests that black cottonwood (Populus balsamifera ssp. trichocarpa), quaking aspen (P. tremuloides), white alder (Alnus rhombifolia), peachleaf willow (Salix amygdaloides) and, in northeast Washington, paper birch (Betula papyrifera) are dominant and characteristic tall deciduous trees. Water birch (B. occidentalis), shining willow (Salix lucida ssp. caudata) and, rarely, mountain alder (Alnus incana) are co-dominant to dominant mid-size deciduous trees. Each can be the sole dominant in stands. Conifers can occur in this habitat, rarely in abundance, more often as individual trees. The exception is ponderosa pine and Douglas-fir that characterize a conifer-riparian habitat in portions of the shrubsteppe zones.

A wide variety of shrubs is found in association with forest/woodland versions of this habitat. Red-osier dogwood (*Cornus sericea*), mountain alder, gooseberry (*Ribes* spp.), rose (*Rosa* spp.), common snowberry (*Symphoricarpos albus*) and Drummonds willow (*Salix drummondii*) are important shrubs in this habitat. Bog birch (*B. nana*) and Douglas spiraea (*Spiraea douglasii*) can occur in wetter stands. Red-osier dogwood and common snowberry are shade-tolerant and dominate stand interiors, while these and other shrubs occur along forest or woodland edges and openings. Mountain alder is frequently a prominent shrub, especially at middle elevations. Tall shrubs (or small trees) often growing under or with white alder include chokecherry (*Prunus virginiana*), water birch, shining willow, and netleaf hackberry (*Celtis reticulata*).

Shrub-dominated communities contain most of the species associated with tree communities. Willow species (*Salix bebbiana, S. boothii, S. exigua, S geyeriana*, or *S. lemmonii*) dominate many sites. Mountain alder can be dominant and is at least codominant at many sites. Chokecherry, water birch, serviceberry (*Amelanchier alnifolia*), black hawthorn (*Crataegus douglasii*), and red-osier dogwood can also be codominant to dominant. Shorter shrubs, Woods rose, spiraea, snowberry, and gooseberry are usually present in the undergrowth.

The herb layer is highly variable and is composed of an assortment of graminoids and broadleaf herbs. Native grasses (*Calamagrostis canadensis, Elymus glaucus, Glyceria* spp., and *Agrostis* spp.) and sedges (*Carex aquatilis, C. angustata, C. lanuginosa, C. lasiocarpa, C. nebrascensis, C. microptera, and C. utriculata*) are significant in many habitats. Kentucky bluegrass (*Poa pratensis*) can be abundant where heavily grazed in the past. Other weedy grasses, such as orchard grass (*Dactylis glomerata*), reed canarygrass (*Phalaris arundinacea*), timothy (*Phleum pratense*), bluegrass (*Poa bulbosa, P. compressa*), and tall fescue (*Festuca arundinacea*) often dominate disturbed areas. A short list of the great variety of forbs that grow in this habitat includes Columbian monkshood (*Aconitum columbianum*), alpine leafybract aster (*Aster foliaceus*), ladyfern (*Athyrium filix-femina*), field horsetail (*Equisetum arvense*), cow parsnip (*Heracleum maximum*), skunkcabbage (*Lysichiton americanus*), arrowleaf groundsel (*Senecio triangularis*), stinging nettle (*Urtica dioica*), California false hellebore (*Veratrum californicum*), American speedwell (*Veronica americana*), and pioneer violet (*Viola glabella*).

Disturbance:
This habitat is tightly associated with stream dynamics and hydrology. Flood cycles occur within 20-30 years in most riparian shrublands although flood regimes vary among stream types. Fires recur typically every 25-50 years but fire can be nearly absent in colder regions or on topographically protected streams. Rafted ice and logs in freshets may cause considerable damage to tree boles in mountain habitats. Beavers crop younger cottonwood and willows and frequently dam side channels in these stands. These forests and woodlands require various flooding regimes and specific substrate conditions for reestablishment. Grazing and trampling is a major influence in altering structure, composition, and function of this habitat; some portions are very sensitive to heavy grazing.

Natural systems evolve and become adapted to a particular rate of natural disturbances over long periods. Land uses alter stream channel processes and disturbance regimes that affect aquatic and riparian habitat. Human-induced disturbances are often of greater magnitude and/or frequency compared to natural disturbances. These higher rates may reduce the ability of riparian and stream systems and the fish and wildlife populations to sustain themselves at the same productive level as in areas with natural rates of disturbance.

Other characteristics also make riparian habitats vulnerable to degradation by human-induced disturbances. Their small size, topographic location, and linear shape make them prone to disturbances when adjacent uplands are altered. The unique microclimate of riparian and associated aquatic areas supports some vegetation, fish, and wildlife that have relatively narrow environmental tolerances. This microclimate is easily affected by vegetation removal within or adjacent to the riparian area, thereby changing the habitat suitability for sensitive species.

Succession and Stand Dynamics:
Riparian vegetation undergoes "typical" stand development that is strongly controlled by the site’s initial conditions following flooding and shifts in hydrology. The initial condition of any hydrogeomorphic surface is a sum of the plants that survived the disturbance, plants that can get to the site, and the amount of unoccupied habitat available for invasions. Subsequent or repeated floods or other influences on the initial vegetation select species that can survive or grow in particular life forms. A typical woody riparian habitat dynamic is the invasion of woody and herbaceous plants onto a new alluvial bar away from the main channel. If the bar is not scoured in 20 years, a tall shrub and small deciduous tree stand will develop. Approximately 30 years without disturbance or change in hydrology will allow trees to overtop shrubs and form woodland. Another 50 years without disturbance will allow conifers to invade and in another 50 years a mixed hardwood-conifer stand will develop. Many deciduous tall shrubs and trees

cannot be invaded by conifers. Each stage can be reinitiated, held in place, or shunted into different vegetation by changes in stream or wetland hydrology, fire, grazing, or an interaction of those factors.

Conservation Status of Eastside (Interior) Riparian-Wetlands:
Specific conservation status of riparian wetlands is unknown, but assumed to be the same as the protection status afforded to adjacent vegetation zones.

Management and Anthropogenic Impacts:
Management effects and land use on woody riparian vegetation can be obvious; for example, removal of vegetation by development of hydroelectric facilties, roads, and logging. Management effects can also be subtle; for example, removal of beavers from a watershed, removal of large woody debris, or construction of a weir dam for fish habitat. In general, excessive livestock or native ungulate use leads to less woody cover and an increase in sod-forming grasses particularly on fine-textured soils. Undesirable forb species, such as stinging nettle and horsetail, increase with livestock use as well. Knutson and Naef (1997) described the potential effects of various land uses on riparian habitats; for example, forest practices can alter riparian area microclimates and reduce large woody debris (Table_15).

Status and Trends:
Quigley and Arbelbide (1997) concluded that the cottonwood-willow cover type covers significantly less in area now than before 1900 in the Inland Pacific Northwest. The authors concluded that although riparian shrubland was a minor part of the landscape, occupying 2 percent, they estimated it to have declined to 0.5 percent of the landscape. Approximately 40 percent of riparian shrublands occurred above 3,280 feet in elevation prior to 1900; now nearly 80 percent is found above that elevation. This change reflects losses to agricultural development, road development, dams, and other flood control activities. The current riparian shrublands contain many exotic plant species and generally are less productive than historically.

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In general, excessive livestock or native ungulate use leads to less woody cover and an increase in sod-forming grasses particularly on fine-textured soils. Undesirable forb species, such as stinging nettle and horsetail, increase with livestock use.

Table 15. Summary of potential effects of various land uses on riparian habitat elements needed by fish and wildlife (Knutson and Naef 1997).

Potential Changes in Riparian Elements Needed by Fish and Wildlife	Land Use						
	Forest Practices	Agriculture	Unmanaged Grazing	Urban-ization	Dams	Recreation	Roads
Riparian Habitat							
Altered microclimate	X	X	X	X		X	X
Reduction of large woody debris	X	X	X	X	X	X	X
Habitat loss/fragmentation	X	X	X	X	X	X	X
Removal of riparian vegetation	X	X	X	X	X	X	X
Reduction of vegetation regeneration	X	X	X	X	X	X	X
Soil compaction/ deformation	X	X	X	X		X	X
Loss of habitat connectivity	X	X	X	X		X	X
Reduction of structural and functional diversity	X	X	X	X		X	X
Stream Banks and Channel							
Stream channel scouring	X	X	X	X		X	X
Increased stream bank erosion	X	X	X	X	X	X	X
Stream channel changes	X	X	X	X	X	X	X
Stream channelization	X	X		X			
Loss of fish passage	X	X	X	X	X		X
Loss of large woody debris	X	X	X	X	X	X	X
Reduction of structural and functional diversity	X	X	X	X	X		X
Hydrology and Water Quality							
Changes in basin hydrology	X	X		X	X		X
Reduced water velocity	X	X	X	X	X		
Increased surface water flows	X	X	X	X		X	X
Reduction of water storage capacity	X	X	X	X			X
Water withdrawal		X		X	X	X	
Increased sedimentation	X	X	X	X	X	X	X
Increased stream temperatures	X	X	X	X	X	X	X
Water contamination	X	X	X	X		X	X

Natural systems evolve and become adapted to a particular rate of natural disturbances over long periods. Land uses alter stream channel processes and disturbance regimes that affect aquatic and riparian habitat (Montgomery and Buffington 1993). Anthropogenic-induced disturbances are often of greater magnitude and/or frequency compared to natural disturbances. These higher rates may reduce the ability of riparian and stream systems and the fish and wildlife populations to sustain themselves at the same productive level as in areas with natural rates of disturbance.

Other characteristics also make riparian habitats vulnerable to degradation by human-induced disturbances. Their small size, topographic location, and linear shape make them prone to disturbances when adjacent uplands are altered. The unique microclimate of riparian and associated aquatic areas supports some vegetation, fish, and wildlife that have relatively narrow environmental tolerances. This microclimate is easily affected by vegetation removal within or adjacent to the riparian area, thereby changing the habitat suitability for sensitive species (Thomas *et al.* 1979; O'Connell *et al.* 1993).

4.1.7.3.3 Recommended Future Condition

At the Ecoprovince scale, wildlife/land managers focused on riparian wetland habitat due to its prevalence throughout the Ecoprovince, close association with salmonid habitat requirements, and relationship to water quality issues. Subbasin level planners have the option to address lacustrine and palustrine wetland habitats at the local level.

Ecoprovince/subbasin planners identified general ecological/management conditions that, if met, will provide suitable habitat for multiple wildlife species at the Ecoprovince scale within the riparian wetland habitat type (Appendix E, Table_50). Ecoprovince/subbasin planners selected red-eyed vireo (*Vireo olivaceus*), yellow-breasted chat (*Icteria virens*), willow flycatcher (*Empidonax trailli*), Lewis' woodpecker (*Melanerpes lewis*), and beaver (*Castor canadensis*) to represent the range of habitat conditions required by wildlife species that utilize eastside (interior) riparian wetland habitat within the Ecoprovince. Specific species information is included in Appendix_F. These wildlife species may also serve as a performance measure to monitor and evaluate the results of implementing future management strategies and actions.

Ecoprovince wildlife/land managers will review the conditions described below to plan and, where appropriate, guide future enhancement/protection actions on riparian wetland habitats. Specific desired future conditions, however, are identified and developed within the context of individual management plans at the subbasin level.

Wildlife/land managers have a wide array of conditions to consider. Recognizing the variation between existing riparian wetland habitat and the dynamic nature of this habitat type, recommended conditions for riparian wetland habitat focus on the following habitat/ anthropogenic attributes:

1. The presence and/or height of native hydrophytic shrubs and trees
2. Shrub and/or tree canopy structure, tree species and diameter (DBH)
3. Distance between roosting and foraging habitats
4. Human disturbance

Ecoprovince wildlife/habitat managers recommend the following range of conditions for the specific riparian wetland habitat attributes described below:

- Greater than 60 percent tree canopy closure
- Mature deciduous trees greater than 160 feet in height and 21 inches DBH
- Greater than 10 percent young cottonwoods

- Tree cover less than 20 percent
- 30 to 80 percent native shrub cover
- Multi-structured shrub canopy greater than 3 feet in height
- Snags greater than 16 inches DBH

Condition 1 – Multi-structured, dense understory: Willow flycatcher was selected to represent species that require dense patches of native vegetation in the shrub layer and interspersed with openings of herbaceous vegetation. Willow flycatchers require 40-80 percent shrub cover, shrubs greater than 3 feet in height, and tree cover less than 30 percent.

Condition 2 – Deciduous riparian zone with high canopy closure: Beaver was selected to represent species that require 40-60 percent tree/shrub canopy closure and shrub height greater than 6.6 feet. Beavers also require trees less than 6 inches DBH.

Condition 3 – Mature deciduous forest with open canopy: Lewis' woodpecker was selected to represent species that require or depend on mature cottonwood forest for its reproductive life requisites. Lewis' woodpeckers require trees greater than 21 inches DBH, 10-40 percent canopy cover, and 30-80 percent shrub cover.

Change in extent of the riparian wetland habitat type from circa 1850 to 1999 is not included because of inaccurate NHI (2003) data/GIS products.

4.1.7.4 Agriculture

Agricultural habitat varies substantially in composition among the cover types it includes. Cultivated cropland includes at least 50 species of annual and perennial plants, and hundreds of varieties ranging from vegetables such as carrots, onions, and peas to annual grains such as wheat, oats, barley, and rye. Row crops of vegetables and herbs are characterized by bare soil, plants, and plant debris along bottomland areas of streams and rivers and areas having sufficient water for irrigation. Annual grains, such as barley, oats, and wheat are typically produced in almost continuous stands of vegetation on upland and rolling hill terrain without irrigation.

Improved pastures are used to produce perennial herbaceous plants for grass seed and hay. Alfalfa and several species of fescue and bluegrass, orchardgrass (*Dactylis glomerata*), and timothy (*Phleum pratensis*) are commonly seeded in improved pastures. Grass seed fields are single-species stands, whereas pastures maintained for haying are typically composed of several species.

The improved pasture cover type is one of the most common agricultural uses in and is produced with and without irrigation. Unimproved pastures are predominantly grassland sites often abandoned fields that have little or no active management such as irrigation, fertilization, or herbicide applications. These sites may or may not be grazed by livestock. Unimproved pastures include rangelands planted to exotic grasses that are found on private land, state wildlife areas, federal wildlife refuges, and CRP sites. Grasses commonly planted on CRP sites include crested wheatgrass (*Agropyron cristatum*), tall fescue (*F. arundinacea*), perennial bromes (*Bromus* spp.), and wheatgrasses.

Intensively grazed rangelands have been seeded to intermediate wheatgrass (*Elytrigia intermedia*), crested wheatgrass to boost forage production, or are dominated by increaser exotics such as Kentucky wheatgrass or tall oatgrass (*Arrhenatherum elatius*). Other unimproved pastures have been cleared and intensively farmed in the past, but are allowed to convert to other vegetation. These sites may be composed of uncut hay, litter from previous seasons, standing dead grass and herbaceous material, invasive exotic plants including tansy ragwort (*Senecio jacobea*), thistle (*Cirsium* spp.), Himalaya blackberry (*Rubus discolor*), and Scot's broom (*Cytisus scoparius*) with patches of native black hawthorn, snowberry, spirea (*Spirea* spp.), poison oak (*Toxicodendron diversilobum*), and various tree species, depending on seed source and environment.

Because agriculture is not a focal wildlife habitat type and there is little opportunity to effect change in agricultural land use at the landscape scale, Ecoprovince and subbasin planners did not conduct a full-scale analysis of agricultural conditions. However, agricultural lands converted to CRP can significantly contribute toward benefits to wildlife habitat and other species that utilize agricultural lands (Appendix E, Table_51). The extent of agricultural areas prior to 1850 and today (including CRP lands) is illustrated in Figure_25 and Figure_26.

4.2 Primary Factors Impacting Focal Habitats and Wildlife Species

The principal post-settlement conservation issues affecting focal habitats and wildlife populations include habitat loss and fragmentation resulting from conversion to agriculture, habitat degradation and alteration from livestock grazing, invasion of exotic vegetation, and alteration of historic fire regimes. Anthropogenic changes in shrub and grass dominated communities has been especially severe in the state of Washington, where over half the native shrubsteppe has been converted to agricultural lands (Dobler *et al.* 1996). Similarly, little remains of the interior grasslands that once dominated the Ecoprovince.

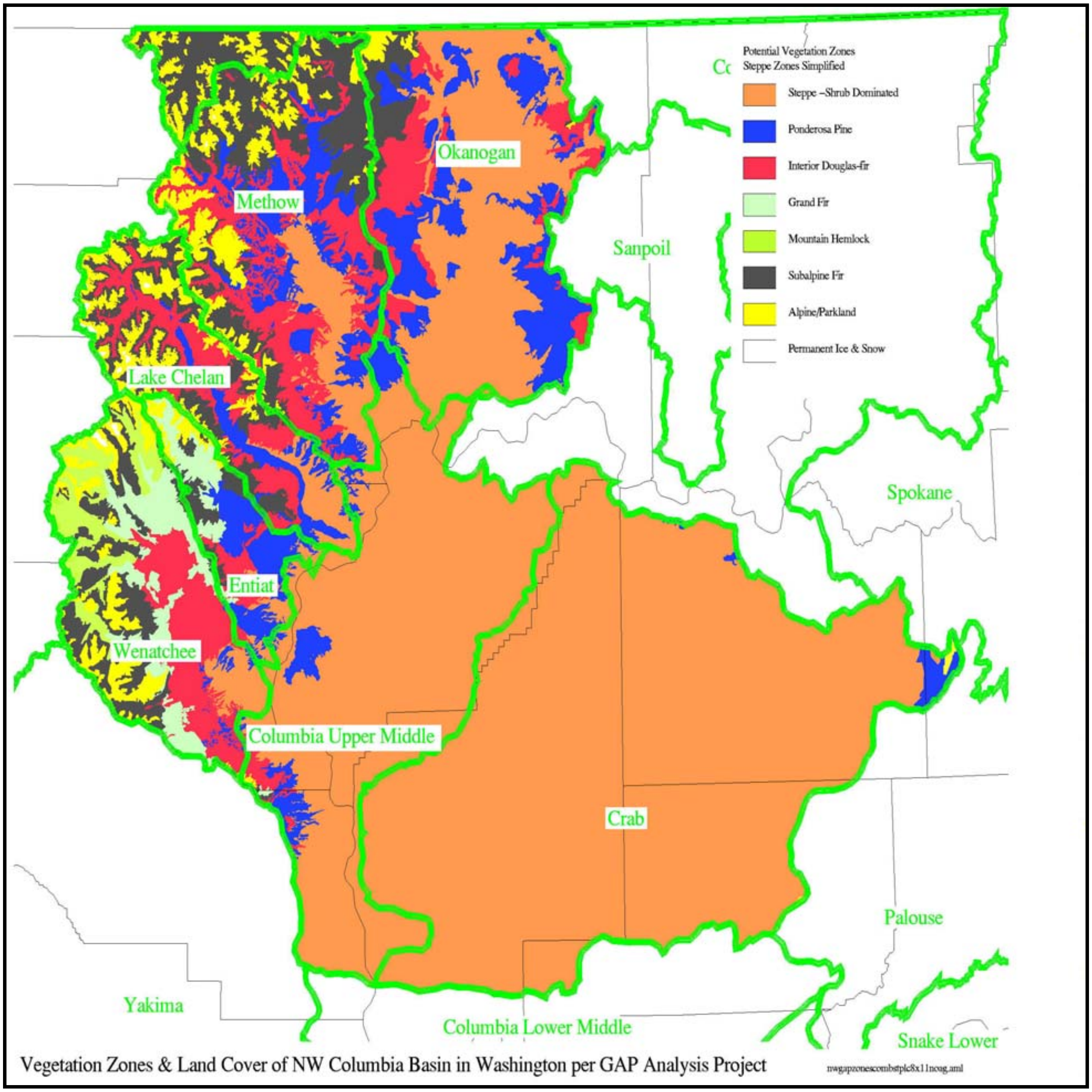


Figure 25. Pre-agricultural vegetation zones of the Columbia Cascade Ecoprovince, Washington (Cassidy 1997).

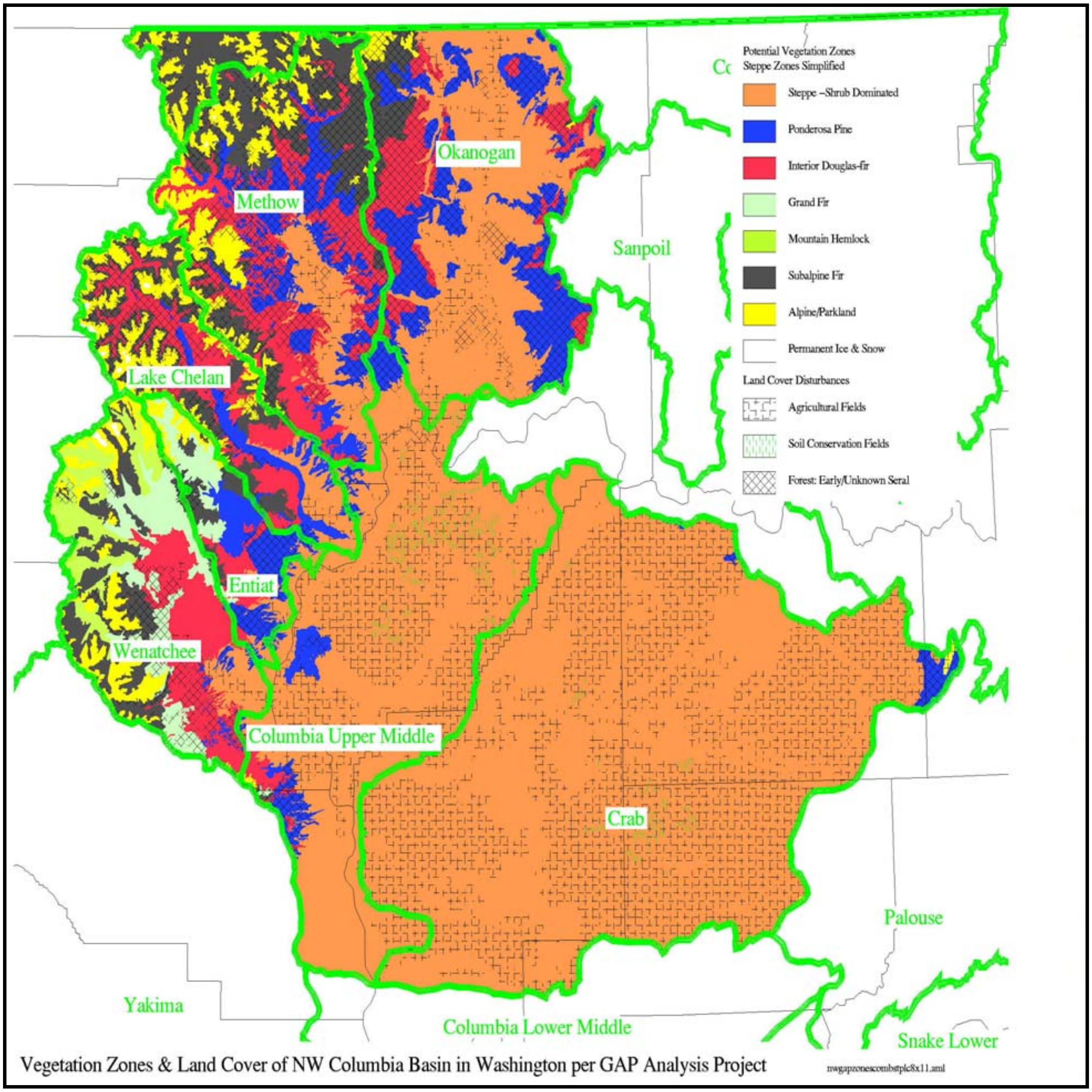


Figure 26. Post-agricultural vegetation zones of the Columbia Cascade Ecoprovince, Washington (Cassidy 1997).

Unlike forest communities that can regenerate after clearcutting, shrubsteppe and interior grasslands that have been converted to agricultural crops are unlikely to return to a native plant communities even if left idle for extended periods because upper soil layers (horizons) and associated microbiotic organisms have largely disappeared due to water and wind erosion and tillage practices. Furthermore, a long history of grazing, fire, and invasion by exotic vegetation has altered the composition of the plant community within much of the extant shrubsteppe and grassland habitat in this region (Quigley and Arbelbide 1997; Knick 1999).

The loss of once extensive interior grasslands and shrubsteppe communities has substantially reduced the habitat available to a wide range of habitat dependent obligate wildlife species including several birds found only in these community types (Quigley and Arbelbide 1997; Saab and Rich 1997). Sage sparrows, Brewer's sparrows, sage thrashers, and sage grouse are considered shrubsteppe obligates, while numerous other species such as grasshopper sparrow and sharp-tailed grouse are associated primarily with steppe/grassland vegetation. In a recent analysis of birds at risk within the interior Columbia Basin, the majority of species identified as of high management concern were shrubsteppe/grassland species. Moreover, according to the BBS, over half these species have experienced long-term population declines (Saab and Rich 1997).

Ecoprovince planners reviewed the subbasin summaries (NPPC 2002a-g) for information on factors impacting focal habitats and limiting wildlife populations and abundance (Table_16). Technical experts involved in providing information for the subbasin summaries identified nine habitat/wildlife-related limiting factors, including mismanaged livestock grazing, agricultural development, the spread of exotic vegetation, fire suppression, road development, hydropower development, residential development/urbanization, mining, and timber harvest.

Residential development and hydropower development were identified as limiting factors in 86 percent of the subbasins, while mining and exotic vegetation were identified in only 43 percent. The limiting factors analysis also indicates that the Entiat and Methow subbasins contain the highest number of limiting factors (seven each) in the Ecoprovince, while the Wenatchee and Crab subbasins contain the fewest (four each). Clearly, residential development, hydropower development, and agriculture are common limiting factors that are pervasive throughout the entire Ecoprovince. Factors impacting focal habitats and/or limiting wildlife populations within the Ecoprovince are discussed in further detail below, followed by a list of limiting factors by habitat type.

4.2.1 Livestock Grazing

The legacy of livestock grazing throughout the entire Columbia Plateau, including the Ecoprovince, has had widespread and severe impacts on vegetation structure and composition. Disturbance plays an important role in determining successional pathways in shrubsteppe communities (Daubenmire 1970; Smith *et al.* 1995). One of the most severe impacts has been the increased spread of exotic plants. Excessive grazing by livestock can reduce the abundance of some native plants while increasing that of others and can allow exotic species to enter and in some cases dominate communities (Branson 1985). The effects of livestock grazing on shrubsteppe vegetation can influence use of sites by birds and other wildlife species, although the direction of influence (positive or negative) may vary (Saab *et al.* 1995). Moreover, invasion of exotic plants changes floristics and vegetation structure and can have adverse effects on site use by some wildlife species (Knick and Rotenberry 1995).

Shrub density and annual cover increase, whereas bunchgrass density decreases with livestock use. Repeated or intense disturbance, particularly on drier sites, leads to cheatgrass dominance

Table 16. Wildlife habitat limiting factors analysis for the Columbia Cascade Ecoprovince, Washington (NPPC 2002a-g).

Subbasin	Limiting Factor									
	Residential Development	Fire Suppression	Livestock Grazing	Road Development	Hydropower Development	Exotic Vegetation	Agriculture	Mining	Timber Harvest	Number of Limiting Factors Identified in Subbasin
Entiat	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	**7**
Lake Chelan	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No	**6**
Wenatchee	No	Yes	No	Yes	No	No	No	Yes	Yes	**4**
Methow	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	**7**
Okanogan	Yes	Yes	No	No	Yes	No	Yes	Yes	Yes	**6**
Upper Middle Mainstem Columbia River	Yes	No	Yes	No	Yes	Yes	Yes	No	No	**5**
Crab	Yes	No	No	Yes	Yes	No	Yes	No	No	**4**
Number of Subbasins in Which Limiting Factor was Identified	**6**	**4**	**4**	**4**	**6**	**3**	**5**	**3**	**4**	

and replacement of native bunchgrasses. Dry and sandy soils are sensitive to grazing, with needle-and-thread replaced by cheatgrass at most sites. In recent years, USDA programs have supported conversion of agricultural fields to modified steppe/grasslands through CRP; however, in most cases these modified grasslands lack floristic and structural diversity.

Grasslands and grazing animals have coexisted for millions of years. Large migratory herbivores, like the bison, are integral to the functioning of grassland ecosystems. Through grazing, these animals stimulate regrowth of grasses and remove older, less productive plant tissue. Thinning of older plant tissues allows increased light to reach younger tissues, which promotes growth, increased soil moisture, and improved water-use efficiency of grass plants (Frank *et al.* 1998:518).

Grazing by domestic livestock can replicate many of these beneficial effects, but the herding and grazing regimes used to manage livestock can also harm grasslands by concentrating their impacts. Given the advantages of veterinary care, predator control, and water and feed supplements, livestock are often present in greater numbers than wild herbivores and can put higher demands on the ecosystem. In addition, herds of domestic cattle, sheep, and goats do not replicate the grazing patterns of herds of wild grazers. Use of water pumps and barbed wire fences has led to more sedentary and often more intense use of grasslands by domestic animals (Frank *et al.* 1998:519, citing McNaughten 1993). Grazing animals in high densities can destroy vegetation, change the balance of plant species, reduce biodiversity, compact soil and accelerate soil erosion, and impede water retention, depending on the number and breed of livestock and their grazing pattern (Evans 1998:263).

Livestock currently graze much of the steppe dominated shrubsteppe habitat. Drier steppe/grasslands, those with shallower soils, steeper topography, or hotter, drier environments, were more intensively grazed and for longer periods than were deep-soil grasslands (Tisdale 1986). Evidently, these drier native bunchgrass grasslands changed irreversibly to persistent introduced annual grasses and forbs. In an effort to increase forage production, some native bunchgrass plant communities and shrubsteppe habitats were either inter-seeded or converted to intermediate wheatgrass, or more commonly, crested wheatgrass (*Agropyron cristatum*), further reducing the floristic quality and the amount of native habitats.

One of the most visible and useful indicators of degradation of grazing lands is soil erosion. High densities of livestock or poor management of herds diminish vegetative cover and contribute to erosion. This eventually will reduce the productivity of the grassland, although some areas with deep soils can withstand high rates of erosion for considerable time.

The long-term effects of grazing in ponderosa pine forests on resident bird species, such as pygmy nuthatch, are difficult to predict. On one hand, grazing can reduce grass cover and plant litter that in turn can enhance survival of pine seedlings and reduce the frequency of low-intensity ground fires. On the other hand, heavy grazing can also change the recruitment dynamics of ponderosa pines that eventually would be used for breeding, roosting, and foraging and also alter the frequency of high-intensity crown fires (Ghalambor 2003).

4.2.2 Agriculture

Conversion of shrubsteppe communities to agricultural purposes throughout the Ecoprovince, and eastern Washington in general, has resulted in a fragmented landscape with few extensive tracts of interior grassland or shrubsteppe remaining (Dobler *et al.* 1996).

Agricultural land uses in the Ecoprovince include dry land wheat farms, irrigated agricultural row crop production, and irrigated agriculture associated with fruit and livestock production (alfalfa and hay). Agriculture conversions concentrated in low elevation valleys have significantly affected valley bottom grasslands, shrublands, and cottonwood dominated riparian areas. Agricultural development has altered or destroyed vast amounts of native steppe/grassland and shrubsteppe habitat in the lowlands and fragmented riparian wetland habitat within the Ecoprovince. Agricultural operations have also increased sediment loads and introduced herbicides and pesticides into streams.

Conversion of any wildlife habitat type to agriculture adversely affects wildlife in two ways: native habitat in most instances is permanently lost, and remaining habitat is isolated and embedded in a highly fragmented landscape of multiple land uses, particularly agriculture.

Although the magnitude of agricultural conversion of Washington's shrubsteppe is impressive, its effect on wildlife may be magnified by a pattern of land alteration that has resulted in extreme fragmentation of remaining habitats. Species tend to evolve in concert with their surroundings, and for shrubsteppe wildlife this means that species adapted to expansive landscapes of steppe and shrubsteppe communities. When landscapes are fragmented by conversion to land use types different from what occurred naturally, wildlife dependent upon the remnant native habitat may be subjected to adverse population pressures, including:

- isolation of breeding populations;
- competition from similar species associated with other, now adjacent, habitats;
- increased predation by generalist predators;
- increased nest loss through parasitism by brown-headed cowbirds;
- creation of population sinks; and
- increased conflict between wildlife species and economic agricultural crops, i.e., crop depredation.

Fragmentation of previously extensive landscapes can influence the distribution and abundance of birds through redistribution of habitat types and through the pattern of habitat fragmentation, including characteristics such as decreased patch area and increased habitat edge (Ambuel and Temple 1983; Wilcove *et al.* 1986; Robbins *et al.* 1989; Bolger *et al.* 1991, 1997). Fragmentation also can reduce avian productivity through increased rates of nest predation (Gates and Gysel 1978; Wilcove 1985), increased nest parasitism (Brittingham and Temple 1983; Robinson *et al.* 1995), and reduced pairing success of males (Gibbs and Faaborg 1990; Villard *et al.* 1993; Hagan *et al.* 1996).

It is not known to what extent these population pressures affect birds and other wildlife species in fragmented shrubsteppe environments, although a recent study from Idaho (Knick and Rotenberry 1995) suggests that landscape characteristics influence site selection by some shrubsteppe birds. Most research on fragmentation effects on birds has occurred in the forests and grasslands of eastern and central North America, where conversion to agriculture and suburban/urban development has created a landscape quite different from that which existed previously. The potential for fragmentation to adversely affect shrubsteppe wildlife in Washington warrants further research.

Even though the conversion of native habitats to agriculture severely impacted native wildlife species such as the sharp-tailed grouse, agriculture did provide new habitat niches that were quickly filled with introduced species such as the ring-necked pheasant (*Phasianus colchicus*) chukar (*Alectoris chukar*), and the gray partridge (*Perdix perdix*). Moreover, native ungulate populations took advantage of new food sources provided by croplands and either expanded their range or increased in number (J. Benson, WDFW, personal communication, 1999). Wildlife species/populations that could adapt to and/or thrived on "edge" habitats increased with the introduction of agriculture until the advent of "clean farming" practices and monoculture cropping systems.

4.2.3 Exotic Vegetation

No study to date has investigated how the establishment or control of non-native plants influences cavity-nesting bird species in ponderosa pine forests (Ghalambor 2003). Some techniques employed to control non-native plants such as prescribed fires are expected to have little or no effect as long as these fires are low intensity ground fires. To the extent that establishment of non-native plants alters the recruitment of trees used for foraging or nesting, such as ponderosa pine, there could be long-term impacts (Ghalambor 2003).

The number and abundance of introduced species is an indicator of biodiversity condition. At the regional scale, the growing threat of invasive species in shrubsteppe and other Ecoprovince habitats may bode ill for carbon storage. For example, recent experiments suggest that crested wheatgrass, a shallow-rooted grass introduced to North American prairies from North Asia to improve cattle forage, stores less carbon than native perennial prairie grasses with their extensive root systems (Christian and Wilson 1999:2397). Noxious weeds, primarily Canada thistle, Russian knapweed, Dalmation toadflax, diffuse knapweed, and introduced annual grasses are pervasive and have taken over thousands of acres of wildlife habitat within the Ecoprovince.

Knapweeds are members of the *Asteraceae* family and are problematic within the Ecoprovince. Diffuse knapweed is a biennial that grows from a taproot. It is now especially abundant in central Washington. It is most common in disturbed areas but can invade natural plant communities (Taylor 1990). Wind, humans, animals, and vehicles spread knapweed seeds. Diffuse knapweed reduces the biodiversity of plant populations, increases soil erosion (Sheley *et al.* 1997), threatens Natural Area Preserves (Schuller 1992) and replaces wildlife forage on range and pasture.

Annual grasses such as cheatgrass, medusa head, and others have become naturalized throughout the Ecoprovince and have either completely displaced or compete heavily with native grasses and forbs in some areas. Although annual grasses can be potential forage for big game and some bird species, they severely impact native plant communities and can add significantly to the fire fuel load resulting in hotter wildfires that increase damage to native vegetation.

4.2.4 Fire

Fire is a natural occurrence in most shrubsteppe ecosystems and has been one of the primary tools humans have used to manage this habitat type. Fire prevents woody vegetation from encroaching, removes dry vegetation, and recycles nutrients. Conversely, fire suppression allows shrubs and trees to encroach/increase on areas once devoid of woody vegetation and/or promotes decadence in undisturbed native steppe/grassland communities. Although fire can benefit steppe/grassland habitat, it can be harmful too—particularly when fires become much more frequent than is natural. If too frequent, fire can remove plant cover and increase soil erosion (Ehrlich *et al.* 1997:201) and can promote the spread of annual grasses to the detriment of native plants (Whisenant 1990).

Fires covering large areas of shrubsteppe habitat can eliminate shrubs and their seed sources and create grassland habitat to the detriment of sage dependent wildlife species such as sage grouse. Fires that follow heavy grazing or repeated early season fires can result in annual grasslands of cheatgrass, medusahead, knapweed, and/or yellow starthistle.

In Ecoprovince forest habitats, fire suppression has resulted in the loss of climax forest communities and, in some instances, wildlife species diversity by allowing the spread of shade tolerant species such as Douglas-fir and grand fir. Prior to fire suppression, wildfires kept shade-tolerant species from encroaching on established forest communities. The lack of fire within the ecosystem has resulted in significant changes to the forest community to the detriment of some wildlife species. Changes in forest habitat components have reduced habitat availability, quality, and utilization for wildlife species dependent on timbered habitats.

Long-term fire suppression can lead to changes in forest structure and composition, and result in the accumulation of fuel levels that can lead to severe crown fires that replace entire stands of trees. The higher elevation forests have evolved with high fire severity regimes, and fire suppression effects are not detectable. Thunderstorms bring lightning ignition to forested areas susceptible to fire. Recreational use accounts for 60 percent of fire ignitions in the Chiwawa River watershed (25-year period approximately 1972-1997) (NPPC 2002c). As forest stands become more layered, homogenous, and loaded, the potential for catastrophic fire increases. Attempts to restore ponderosa pine forests to their pre- European structure and function (i.e. conditions prior to forest suppression) should have positive impacts on some resident bird species, such as pygmy nuthatch, but too little information is currently available (Ghalambor 2003).

Because fire is an important natural process in ponderosa pine forests and is an important factor in creating snags, the restoration of natural fire regimes has been proposed as a management tool (Covington and Moore 1994; Arno *et al.* 1995; Fule and Covington 1995). In particular, the use of prescribed fires to reduce fuel loads has been suggested as being necessary in order to return fire regimes to more “natural” conditions (Covington and Moore 1994; Arno *et al.* 1995). Because frequent, low intensity ground fires play an important role in maintaining the character of natural ponderosa woodlands (Moir *et al.* 1997), prescribed low intensity ground fires are presumed to have beneficial effects on the resident bird species such as pygmy nuthatch. The current level of information makes it difficult to accurately predict the effects of fire on some species of resident birds. However, it seems reasonable to conclude that low intensity ground fires would have little or no negative effects, whereas high intensity crown fires would have significant negative short-term effects because of the reduction in foraging habitat.

4.2.5 Road Development

The transportation system within Ecoprovince is a potential limiting factor to wildlife populations. More than 65 species of terrestrial vertebrates in the interior Columbia River Basin have been identified as being negatively affected by road-associated factors (Wisdom *et al.* 2000), which can negatively affect terrestrial vertebrate habitats and populations as well as water quality and fish populations. Road densities and placement can have a negative impact on elk use of important habitat (Perry and Overly 1977).

Habitat fragmentation, due to road construction and improper culvert placement, has also prevented migration of fish and amphibian species within and/or between some subbasin tributaries. Increasing road densities can reduce big game habitat effectiveness or increase vulnerability to harvest. Motorized access facilitates firewood cutting and commercial harvest, which can reduce the suitability of habitats surrounding roads to species that depend on larger trees, snags, or logs (USFS 2000). Roads also aid the spread of noxious weeds.

According to the *Okanogan Subbasin Summary* (NPPC 2002e), road densities in that subbasin exceed 4 miles/mi^2. Sediment delivery is considered to be greater than natural erosion rates in road densities greater than this (Cederholm *et al.*1981). Sediment delivery from roads also depends on factors such as distance from the stream, slope, vegetative cover, and precipitation.

Overall road density in the Wenatchee subbasin is high in zones of human influence and riparian areas. Roads and motorized trails have significantly altered habitat for many species, particularly for grizzly bear, gray wolf, mule deer, elk, and lynx (NPPC 2002c). Species proximity to roads and trails also impacts their behavior. Road development and agriculture have also impacted riparian function.

4.2.6 Hydropower Development

Hydropower development on the Columbia Rivers provided water to develop the shrubsteppe habitat for irrigated croplands, orchards, vineyards, and pulp tree plantations. The Lower Snake and Columbia River dams impounded thousands of acres of riparian and shrubsteppe habitat, severely impacting wildlife species associated with those habitats. For example, Lewke (1975) estimated that the loss of riparian habitat caused by the impoundment of Lower Granite Dam resulted in a loss of habitat for 11,000 summer and 17,000 winter birds. There has been some recovery, but the carrying capacity for wildlife in the area has been undeniably lowered. Since impoundment, the recovery of riparian habitat has been slowed due to shallow soils along the current banks of the reservoir in comparison to soils formed in a natural riparian ecosystem. An estimated 147,123 habitat units (HUs) were lost as a result of the construction of the Lower Snake River dams and Chief Joseph and Grand Coulee dams (Table_17).

Table 17. Habitat units lost due to hydropower development on the Lower Snake and Columbia Rivers (NPPC 2000).

Chief Joseph		**Grand Coulee**		**Lower Snake River**	
Indicator Species	**HUs**	**Indicator Species**	**HUs**	**Indicator Species**	**HUs**
Sharp-tailed Grouse	2,290	Sage Grouse	2,746	Downy Woodpecker	365
Mule Deer	1,992	Sharp-tailed Grouse	32,723	Song Sparrow	288
Spotted Sandpiper	1,255	Ruffed Grouse	16,502	Yellow Warbler	927
Sage Grouse	1,179	Mourning Dove	9,316	California Quail	20,508
Mink	920	Mule Deer	27,133	Ring-necked Pheasant	2,647
Bobcat	401	White-tailed Deer	21,362	Canada Goose	2,040
Lewis' Woodpecker	286	Riparian Forest	1,632		
Ring-necked Pheasant	239	Riparian Shrub	27		
Canada Goose	213	Canada Goose Nest Sites	74		
Yellow Warbler	58				
TOTAL	**8,833**	**TOTAL**	**111,515**	**TOTAL**	**26,775**

The development and operation of the hydropower system has resulted in widespread changes in riparian, riverine, and upland habitats in the Upper Middle Mainstem Columbia River subbasin. Several habitat types have been reduced or altered while other habitat types, such as open water areas have increased as a result of hydropower development. Effects related to hydropower development and operations on wildlife and its habitats may be direct or indirect. Direct effects include stream channelization, inundation of habitat and subsequent reduction in some habitat types, degradation of habitat from water level fluctuations and construction and maintenance of power transmission corridors. Indirect effects include the building of numerous roads and railways, presence of electrical transmissions and lines, the expansion of irrigation, and increased access to and harassment of wildlife.

4.2.7 Development/Urbanization

In addition to grazing and agriculture, there have been permanent losses of habitats due to urban and rural residential growth. Urban sprawl is a concern for resource managers as indicated by the growing number of ranchettes, subdivisions, subdivided cropland, and floodplain encroachment. These areas often occur near wooded areas, lakes, or streams. The increasing number of dwellings poses a threat to water quality due to the increased amount and dispersion of potential nutrient sources immediately adjacent to waterways.

Residential/urban sprawl has resulted in the loss of large areas of habitat in the Upper Middle Mainstem Columbia River subbasin and increased the harassment of wildlife. Specifically, sprawl has eliminated large areas of lowland wintering range of native wildlife (NPPC 2002f). Disturbance by humans in the form of highway traffic, noise and light pollution, and various recreational activities have the potential to displace wildlife and force them out of their native areas or forces them to use less desirable habitat.

Recreational activities can negatively impact bird populations through the accidental and purposeful taking of individuals, habitat modification, changes in predation regimes, and disturbance (Knight and Cole 1995; Marzluff 1997). Some species of resident birds, such as pygmy nuthatch, may experience moderate decreases in population abundance and productivity in response to impacts associated with established campsites (Ghalambor 2003). Impacts associated with camping that might negatively influence resident birds include changes in vegetation, disturbance of breeding birds, and increases in the number of potential nest predators (Marzluff 1997).

4.2.8 Mining

No study to date has considered the effects of mining on cavity nesting birds. However, mining or any related activity that resulted in a significant loss of snags or reduced the number of large mature trees could have negative consequences. Mining could also have negative consequences on resident birds, such as pygmy nuthatch, by disrupting breeding birds (Ghalambor 2003).

4.2.9 Timber Harvest

The effects of timber harvesting on bird communities as a whole may have both beneficial and negative effects. Because timber harvesting changes the structure, density, age, and vegetative diversity within forests, the new habitats created following timber harvesting activities may be either suitable or unsuitable to different species of birds (Ghalambor 2003). Furthermore, the type of timber harvesting (e.g. clear-cut, partial-cut, strip-cut) may also have differential consequences on the local bird community. Timber harvesting (including the cutting of standing dead trees for firewood) is likely to be the primary human activity influencing snag availability, and therefore the most important risk factor for cavity nesting birds such as pygmy nuthatches.

4.2.10 Summary of Factors Affecting Focal Habitats and Wildlife Species

4.2.10.1 Ponderosa Pine

- Timber harvesting, particularly at low elevations, has reduced the amount of old growth forest and associated large diameter trees and snags.

- Urban and residential development has contributed to loss and degradation of properly functioning ecosystems.
- Fire suppression/exclusion has contributed towards habitat degradation, particularly declines in characteristic herbaceous and shrub understory from increased density of small shade-tolerant trees. High risk of loss of remaining ponderosa pine overstories from stand-replacing fires due to high fuel loads in densely stocked understories.
- Overgrazing has resulted in lack of recruitment of sapling trees, particularly pines.
- Invasion of exotic plants has altered understory conditions and increased fuel loads.
- Fragmentation of remaining tracts has negatively impacted species with large area requirements.
- Hostile landscapes, particularly those in proximity to agricultural and residential areas, may have high density of nest parasites (brown-headed cowbird), exotic nest competitors (European starling), and domestic predators (cats), and may be subject to high levels of human disturbance.
- The timing (spring/summer versus fall) of restoration/silviculture practices such mowing, thinning, and burning of understory removal may be especially detrimental to single-clutch species.
- Spraying insects that are detrimental to forest health may have negative ramifications on lepidopterans and other non-target avian species.

4.2.10.2 Shrubsteppe

- Extensive permanent habitat conversions of shrubsteppe/grassland habitats (e.g., approximately 60 percent of shrubsteppe in Washington [Dobler *et al.* 1996]) to other uses (e.g., agriculture, urbanization).
- Fragmentation of remaining tracts of moderate to good quality shrubsteppe habitat.
- Degradation of habitat from intensive grazing and invasion of exotic plant species, particularly annual grasses such as cheatgrass and woody vegetation such as Russian olive.
- Degradation and loss of properly functioning shrubsteppe/grassland ecosystems resulting from the encroachment of urban and residential development and conversion to agriculture. Best sites for healthy sagebrush communities (deep soils, relatively mesic conditions) are also best for agricultural productivity; thus, past losses and potential future losses are great. Most of the remaining shrubsteppe in Washington is in private ownership with little long-term protection (57 percent).
- Loss of big sagebrush communities to brush control (may not be detrimental relative to interior grassland habitats).
- Conversion of CRP lands back to cropland.
- Loss and reduction of cryptogamic crusts, which help maintain the ecological integrity of shrubsteppe/grassland communities.
- High density of nest parasites (brown-headed cowbird) and domestic predators (cats) may be present in hostile/altered landscapes, particularly those in proximity to agricultural and residential areas subject to high levels of human disturbance.
- Agricultural practices that cause direct or indirect mortality and/or reduce wildlife productivity. There are a substantial number of obligate and semi-obligate avian/mammal species; thus, threats to the habitat jeopardize the persistence of these species.
- Fire management, either suppression or over-use.
- Invasion and seeding of crested wheatgrass and other introduced plant species which reduces wildlife habitat quality and/or availability.

4.2.10.3 Eastside (Interior) Riparian Wetlands

- Loss of habitat due to numerous factors including riverine recreational developments, innundation from impoundments, cutting and spraying of riparian vegetation for eased access to water courses, gravel mining, etc.
- Habitat alteration from 1) hydrological diversions and control of natural flooding regimes (e.g., dams) resulting in reduced stream flows and reduction of overall area of riparian habitat, loss of vertical stratification in riparian vegetation, and lack of recruitment of young cottonwoods, ash, willows, etc., and 2) stream bank stabilization which narrows stream channel, reduces the flood zone, and reduces extent of riparian vegetation.
- Habitat degradation from livestock overgrazing which can widen channels, raise water temperatures, and reduce understory cover.
- Habitat degradation from conversion of native riparian shrub and herbaceous vegetation to invasive exotics such as reed canary grass, purple loosestrife, perennial pepperweed, salt cedar, indigo bush, and Russian olive.
- Fragmentation and loss of large tracts necessary for area-sensitive species such as yellow-billed cuckoo.
- Hostile landscapes, particularly those in proximity to agricultural and residential areas, may have high density of nest parasites (brown-headed cowbird), exotic nest competitors (European starling), and domestic predators (cats), and be subject to high levels of human disturbance.
- High energetic costs associated with high rates of competitive interactions with European starlings for cavities may reduce reproductive success of cavity-nesting species such as Lewis' woodpecker, downy woodpecker, and tree swallow, even when outcome of the competition is successful for these species.
- Recreational disturbances (e.g., ORVs), particularly during nesting season, and particularly in high-use recreation areas.

The World Resources Institute (WRI) summarized a variety of human-induced pressures that affect global ecosystems (Table_18). A corresponding analogy may be drawn for the Columbia Cascade Ecoprovince in that the principal pressure on resources in some areas of the Ecoprovince is simple overuse—too much logging, grazing, or recreational/residential development. Overuse not only depletes the plants and wildlife that inhabit the Ecoprovince, but also can fragment wildlife habitats and disrupt their integrity—all factors that diminish their productive capacity. Outright conversion of forests, shrubsteppe, and wetlands to agriculture or other uses is another principal pressure reshaping terrestrial habitat in the Ecoprovince.

4.3 Summary of Focal Habitats and Species Relationships

Relationships between focal habitats and focal species assemblages are summarized in Figure_27. Changes in the extent and quality of Ecoprovince focal habitat conditions were examined to identify and understand the magnitude of change that occurred in focal habitats and associated wildlife populations since European settlement (circa 1850). Ecoprovince planners documented current habitat conditions and reviewed the habitat/life requisites for each wildlife species assemblage. When compared, current habitat conditions and focal species' habitat needs led to development of a range of recommended future conditions for each focal habitat type.

Table 18. Primary human-induced pressures on ecosystems (WRI 2000:19).

Ecosystem	Pressures	Causes
Agroecosystems	■ Conversion of farmland to urban and industrial uses ■ Water pollution from nutrient runoff and siltation ■ Water scarcity from irrigation ■ Degradation of soil from erosion, shifting cultivation, or nutrient depletion ■ Changing weather patterns	■ Population growth ■ Increasing demand for food and industrial goods ■ Urbanization ■ Government policies subsidizing agricultural inputs (water, research, transport) and irrigation ■ Poverty and insecure tenure ■ Climate change
Forest Ecosystems	■ Conversion or fragmentation resulting from agricultural or urban uses ■ Deforestation resulting in loss of biodiversity, release of stored carbon, air and water pollution ■ Acid rain from industrial pollution ■ Invasion of nonnative species ■ Overextraction of water for ag, urban, and industrial uses	■ Population growth ■ Increasing demand for timber, pulp, and other fiber ■ Government subsidies for timber extraction and logging roads ■ Inadequate valuation of costs of industrial air pollution ■ Poverty and insecure tenure
Freshwater Systems	■ Overextraction of water for agricultural, urban, and industrial uses ■ Overexploitation of inland fisheries ■ Building dams for irrigation, hydropower, and flood control ■ Water pollution from agricultural, urban, and industrial uses ■ Invasion of nonnative species	■ Population growth ■ Widespread water scarcity and naturally uneven distribution of water resources ■ Government subsidies of water use ■ Inadequate valuation of costs of water pollution ■ Poverty and insecure tenure ■ Growing demand for hydropower
Grassland Ecosystems	■ Conversion or fragmentation owing to agricultural or urban uses ■ Induced grassland fires resulting in loss of biodiversity, release of stored carbon, and air pollution ■ Soil degradation and water pollution from livestock herds ■ Overexploitation of game animals	■ Population growth ■ Increasing demand for agricultural products, especially meat ■ Inadequate information about ecosystem conditions ■ Poverty and insecure tenure

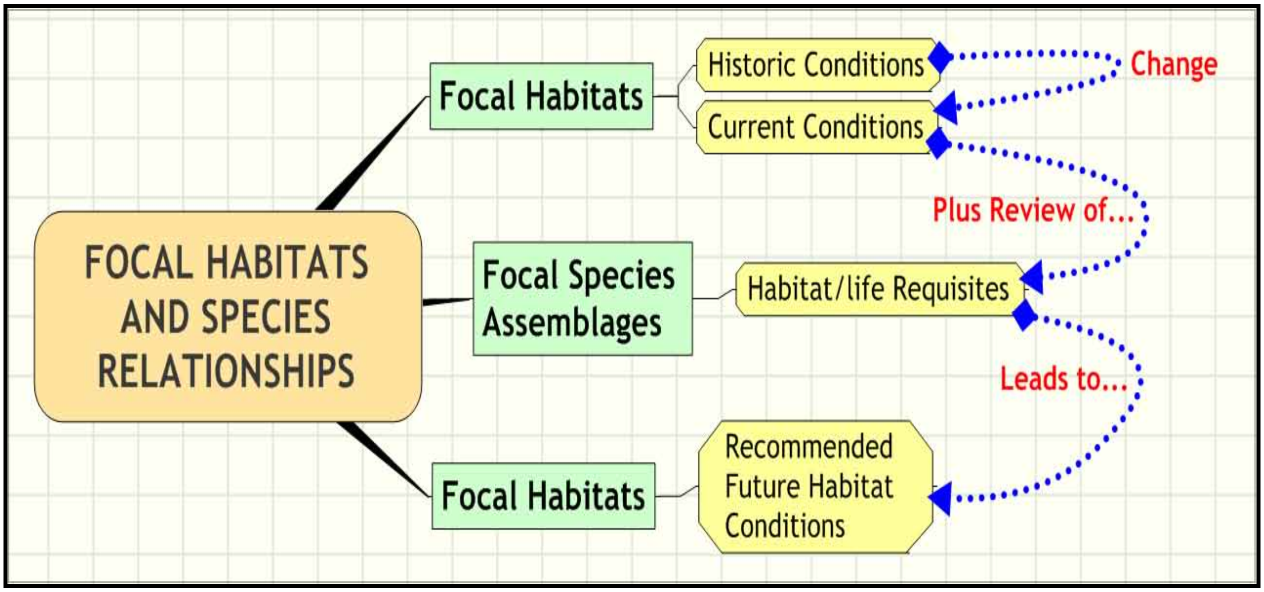


Figure 27. Focal habitats and species assemblage relationships.

5.0 Biological Features

5.1 Focal Wildlife Species Selection and Rationale

Lambeck (1997) defined focal species as a suite of species whose requirements for persistence define the habitat attributes that must be present if a landscape is to meet the requirements for all species that occur there. The key characteristic of a focal species is that its status and trend provide insights to the integrity of the larger ecological system to which it belongs (USFS 2000).

Subbasin planners refer to these species as "focal species" because they are the focus for describing desired habitat conditions and attributes and needed management strategies and/or actions. The rationale for using focal species is to draw immediate attention to habitat features and conditions most in need of conservation or most important in a functioning ecosystem. The corollary is that factors that affect habitat quality and integrity within the Ecoprovince also impact wildlife species (see section 4.2), hence, the decision by Ecoprovince wildlife/land managers to focus on focal habitats with focal species in a supporting role.
Ecoprovince planners consider focal species' life requirements representative of habitat conditions or features that are important within a properly functioning focal habitat type. In some instances, extirpated or nearly extirpated species (e.g., sharp-tailed grouse) were included as focal species if subbasin planners believed they could potentially be reestablished and/or are highly indicative of some desirable habitat condition.

Ecoprovince/subbasin planners (Figure_2) identified a focal species assemblage, (species that inhabitat the same habitat type and require similar habitat attributes) for each focal habitat type (Table_20) and combined life requisite habitat attributes for each species assemblage within each focal habitat to form a recommended "range of management conditions." Wildlife habitat managers will use the recommended range of habitat conditions to identify and prioritize future habitat acquisition, protection, and management strategies and to develop specific habitat management actions/measures for focal habitats. Recommended future habitat conditions based on the life requisite needs of focal wildlife species assemblages for each focal habitat are summarized below.

5.1.1 Ponderosa Pine

Condition 1a – mature ponderosa pine forest: The white-headed woodpecker represents species that require/prefer large patches (greater than 350 acres) of open mature/old growth ponderosa pine stands with canopy closures between 10 - 50 percent and snags (a partially collapsed, dead tree) and stumps for nesting (nesting stumps and snags grater than 31 inches DBH). Abundant white-headed woodpecker populations can be present on burned or cut forest with residual large diameter live and dead trees and understory vegetation that is usually very sparse. Openness however, is not as important as the presence of mature or veteran cone producing pines within a stand (Milne and Hejl 1989).

Condition 1b – mature ponderosa pine forest: The pygmy nuthatch represents species that require heterogeneous stands of ponderosa pine with a mixture of well-spaced, old pines and vigorous trees of intermediate age and those species that depend on snags for nesting and roosting, high canopy density, and large diameter (greater than 18 inches DBH) trees characteristic of mature undisturbed forests. Connectivity between suitable habitats is important for species, such as pygmy nuthatch, whose movement and dispersal patterns are limited to their natal territories.

Condition 2 – multiple-canopy ponderosa pine mosaic: Flammulated owls represent wildlife species that occupy ponderosa pine sites that are comprised of multiple-canopy, mature ponderosa pine stands or mixed ponderosa pine/Douglas-fir forest interspersed with grassy openings and dense thickets. Flammulated owls nest in habitat types with low to intermediate canopy closure (Zeiner *et al.* 1990), two layered canopies, tree density of 508 trees/acre (9-foot spacing), basal area of 250 $ft.^2$/acre (McCallum 1994), and snags greater than 20 inches DBH 3-39 feet tall (Zeiner *et al.* 1990). Food requirements are met by the presence of at least one snag greater than 12 inches DBH/10 acres and 8 trees/acre greater than 21 inches DBH.

5.1.2 Shrubsteppe

Condition 1 – Sagebrush dominated shrubsteppe habitat: Sage thrasher was selected to represent shrubsteppe obligate wildlife species that require sagebrush dominated shrubsteppe habitats and that are dependent upon areas of tall sagebrush within large tracts of shrubsteppe habitat (Knick and Rotenberry 1995; Paige and Ritter 1999; Vander Haegen *et al.* 2001). Suitable habitat includes 5 to 20 percent sagebrush cover greater than 2.5 feet in height, 5 to 20 percent native herbaceous cover, and less than 10 percent non-native herbaceous cover.

Similarly, the Brewer's sparrow was selected to represent wildlife species that require sagebrush dominated sites. Brewer's sparrow prefers a patchy distribution of sagebrush clumps, 10-30 percent cover (Altman and Holmes 2000), lower sagebrush height (between 20 and 28 inches), (Wiens and Rotenberry 1981), 10 to 20 percent native grass cover (Dobler 1994), less than 10 percent non-native herbaceous cover, and bare ground greater than 20 percent (Altman and Holmes 2000). It should be noted, however, that Johnsgard and Rickard (1957) reported that shrublands comprised of snowberry, hawthorne, chokecherry, serviceberry, bitterbrush, and rabbitbrush were also used by Brewer's sparrows for nesting in southeast Washington. Specific, quantifiable habitat attribute information for this mixed shrub landscape could not be found.

Condition 2 – Diverse shrubsteppe habitat: Mule deer were selected to represent species that require and prefer diverse, dense (30 to 60 percent shrub cover less than 5 feet tall) shrubsteppe habitats (Ashley *et al.* 1999) comprised of bitterbrush, big sagebrush, rabbitbrush, and other shrub species (Leckenby 1969; Kufeld *et al.* 1973; Sheehy 1975; Jackson 1990) with a palatable herbaceous understory exceeding 30 percent cover (Ashley *et al.* 1999).

5.1.3 Eastside (Interior) Riparian Wetlands

Subbasin planners chose red-eyed vireo, yellow-breasted chat, willow flycatcher, Lewis' woodpecker, and beaver to represent wildlife species associated with riparian wetland habitats. Ecoprovince wildlife/habitat managers recommend the following range of conditions for the specific riparian wetland habitat attributes described below:

- Greater than 60 percent tree canopy closure
- Mature deciduous trees greater than 160 feet in height and 21 inches DBH
- Greater than 10 percent young cottonwoods
- Tree cover less than 20 percent
- 30 to 80 percent native shrub cover
- Multi-structured shrub canopy greater than 3 feet in height
- Snags greater than 16 inches DBH

Ecoprovince and subbasin planners emphasize ecosystem management through use of focal habitat types while including components of single-species, guild, or indicator species assemblages. This approach is based on the following assumption: a conservation strategy that emphasizes focal habitats at the Ecoprovince scale is more desirable than one that emphasizes individual species.

By combining the "course filter" (focal habitats) with the "fine filter" (focal wildlife species assemblage) approach, Ecoprovince and subbasin planners believe there is a much greater likelihood of maintaining, protecting and/or enhancing key focal habitat attributes and providing functioning ecosystems for wildlife. This approach not only identifies priority focal habitats, but also describes the most important habitat conditions and attributes needed to sustain obligate wildlife populations within these focal habitats. Although conservation and management is directed towards focal species, establishment of conditions favorable to focal species will also benefit a wider group of species with similar habitat requirements.

Focal species can also serve as performance measures to evaluate ecological sustainability and processes, species/ecosystem diversity, and results of management actions (USFS 2000). Monitoring of habitat attributes and focal species will provide a means of tracking progress towards conservation. Monitoring will provide essential feedback for demonstrating adequacy of conservation efforts on the ground, and guide the adaptive management component that is inherent in this approach.

Subbasin planners selected focal wildlife species using a combination of several factors including:

1. primary association with focal habitats for breeding;
2. specialist species that are obligate or highly associated with key habitat elements/conditions important in functioning ecosystems;
3. declining population trends or reduction in their historic breeding range (may include extirpated species);
4. special management concern or conservation status such as threatened, endangered, species of concern and management indicator species; and
5. professional knowledge on species of local interest.

A total of fourteen bird species and three mammalian species were chosen as focal or indicator species to represent three priority habitats in the Ecoprovince (Table_19). Focal species selection rationale and important habitat attributes are described in further detail in Table_20.

Table 19. Focal species selection matrix for the Columbia Cascade Ecoprovince, Washington.

Common Name	Focal Habitat[1]	Status[2]		Native Species	PHS	Partners in Flight	Game Species
		Federal	State				
Sage thrasher	SS	n/a	C	Yes	Yes	Yes	No
Brewer's sparrow		n/a	n/a	Yes	No	Yes	No
Grasshopper sparrow		n/a	n/a	Yes	No	Yes	No
Sharp-tailed grouse		SC	T	Yes	Yes	Yes	No
Sage grouse		C	T	Yes	Yes	No	No
Pygmy rabbit		E	E	Yes	Yes	No	No
Mule deer		n/a	n/a	Yes	Yes	No	Yes
Willow flycatcher	RW	SC	n/a	Yes	No	Yes	No
Lewis woodpecker		n/a	C	Yes	Yes	Yes	No
Red-eyed vireo		n/a	n/a	Yes	No	No	No
Yellow-breasted chat		n/a	n/a	Yes	No	No	No
American beaver		n/a	n/a	Yes	No	No	Yes
Pygmy nuthatch	PP	n/a	n/a	Yes	No	No	No
Gray flycatcher		n/a	n/a	Yes	No	No	No
White-headed woodpecker		n/a	C	Yes	Yes	Yes	No
Flammulated owl		n/a	C	Yes	Yes	Yes	No
Red-winged blackbird	HW	n/a	n/a	Yes	No	No	No

[1] SS = Shrubsteppe; RW = Riparian Wetlands; PP = Ponderosa pine; HW = Herbaceous Wetlands
[2] C = Candidate; SC = Species of Concern; T = Threatened; E = Endangered

5.2 Focal Wildlife Species

This section contains abbreviated information on focal species. The reader is encouraged to review additional focal species life history information included in Appendix_F (some life history information such as historic distribution, historic and current population status may not be available for all focal species).

5.2.1 Ponderosa Pine Focal Species Information

5.2.1.1 White-headed woodpecker

5.2.1.1.1 General Habitat Requirements

White-headed woodpeckers prefer a conifer forest with a relatively open canopy (50–70 percent cover) and an availability of snags (a partially collapsed, dead tree) and stumps for nesting. The birds prefer to build nests in trees with large diameters with preference increasing with diameter. The understory vegetation is usually very sparse within the preferred habitat and local populations are abundant in burned or cut forest where residual large diameter live and dead trees are present. In general, open ponderosa pine stands with canopy closures between 30-50 percent are preferred. The openness, however, is not as important as the presence of mature or veteran cone producing pines within a stand (Milne and Hejl 1989).

Highest abundances of white-headed woodpeckers occur in old-growth stands, particularly ones with a mix of two or more pine species. They are uncommon or absent in monospecific ponderosa pine forests and stands dominated by small-coned or closed-cone conifers (e.g., lodgepole pine or knobcone pine). Additional habitat attribute information can be viewed in Table_20.

Table 20. Focal species selection rationale and habitat attributes for the Columbia Cascade Ecoprovince, Washington.

Focal Species	Focal Habitat Type	Key Habitat Relationships		Comments	Life Requisite	Selection Rationale
		Conservation Focus	Habitat Attribute (Vegetative Structure)			
Sage thrasher	Shrubsteppe	sagebrush height	sagebrush cover 5-20%	not area-sensitive (needs > 40 ac); not impacted by cowbirds; high moisture sites w/ tall shrubs	Food, Reproduction	The sage thrasher is a shrubsteppe obligate species and an indicator of healthy, tall sagebrush dominated shrubsteppe habitat.
			sagebrush height > 80 cm		Food, Reproduction	
			herbaceous cover 5-20%		Food, Reproduction	
			other shrub cover > 10%		Food, Reproduction	
			non-native herbaceous cover < 10%		Food, Reproduction	
Brewer's sparrow	Shrubsteppe	sagebrush cover	sagebrush cover 10-30%		Food, Reproduction	The Brewer's sparrow is a shrubsteppe obligate species and is an indicator of healthy sagebrush dominated shrubsteppe habitat.
			sagebrush height > 60 cm		Food, Reproduction	
			herbaceous cover > 10%		Food, Reproduction	
			open ground > 20%		Food, Reproduction	
			non-native herbaceous cover < 10%		Food, Reproduction	
Grasshopper sparrow	Shrubsteppe	Native steppe/ grasslands	native bunchgrass cover > 15% and comprising > 60% of the total grass cover		Food, Reproduction	The grasshopper sparrow is an indicator of healthy steppe habitat dominated by native bunch grasses.
Sharp-tailed grouse	Shrubsteppe	Deciduous trees and shrubs	mean VOR > 6"		Reproduction	Sharp-tailed grouse is a management priority species and an indicator of healthy steppe/shrubsteppe habitat w/ healthy imbedded mesic draws.
			> 40% grass cover		Reproduction	
			> 30% forb cover		Reproduction	

Focal Species	Focal Habitat Type	Key Habitat Relationships		Comments	Life Requisite	Selection Rationale
		Conservation Focus	Habitat Attribute (Vegetative Structure)			
			< 5% cover introduced herbaceous cover		Reproduction	
			> 50% optimum area providing nest/brood cover		Reproduction	
			> 0.25 km between nest/brood rearing habitat and winter habitat		Reproduction	
			> 75% cover deciduous shrubs and trees		Winter	
			> 10% optimum area providing winter habitat		Winter	
Sage grouse	Shrubsteppe	diverse herbaceous understory, sagebrush cover	sagebrush cover 10-30%	area sensitive; needs large blocks	Reproduction	shrubsteppe obligate; State threatened, Federal Candidate species
			forb cover > 10%		Food	
			open ground cover > 10%			
			non-native herbaceous cover < 10%			
Pygmy rabbit	Shrubsteppe	deep, rock-free soil	sagebrush cover 21-36%	area sensitive, needs large blocks	Reproduction	Shrubsteppe obligate; Federal, State endangered species
			shrub height 32"			
Mule deer	Shrubsteppe	antelope bitterbrush	30-60% canopy cover of preferred shrubs < 5 ft.		Food	The mule deer is a management priority species and an indicator of healthy diverse shrub layer in east-slope shrubsteppe habitat.
			number of preferred shrub species > 3			
			mean height of shrubs > 3 ft.			
			30-70% canopy cover of all shrubs < 5 ft.			
Willow flycatcher	Eastside (Interior)	shrub density	dense patches of native vegetation in the shrub layer > 35 $ft.^2$ in size and interspersed with	> 20 ac; frequent cowbird host; sites >	Reproduction	Indicator of healthy, diverse riparian wetland habitat

Focal Species	Focal Habitat Type	Key Habitat Relationships		Comments	Life Requisite	Selection Rationale
		Conservation Focus	Habitat Attribute (Vegetative Structure)			
	Riparian Wetlands		openings of herbaceous vegetation	0.6 mi from urban/residential areas and > 3 mi from high-use cowbird areas		
			shrub layer cover 40-80%		Reproduction	
			shrub layer height > 3 ft. high		Reproduction	
			tree cover < 30%		Reproduction	
Lewis' woodpecker	Eastside (Interior) Riparian Wetlands	large cottonwood trees/snags	> 0.8 trees/ac > 21" dbh	Dependent on insect food supply; competition from starlings detrimental	Food	Indicator of healthy cottonwood stands with snags
			canopy cover 10-40%			
			shrub cover 30-80-%			
Red-eyed vireo	Eastside (Interior) Riparian Wetlands	canopy foliage and structure	canopy closure > 60%		Food, Reproduction	The red-eyed vireo is an obligate species in riverine cottonwood gallery forests and an indicator of healthy canopy cover.
			riparian zone of mature deciduous trees > 160 ft.		Food, Reproduction	
			> 10% of the shrub layer should be young cottonwoods		Food, Reproduction	
Yellow-breasted chat	Eastside (Interior) Riparian Wetlands	dense shrub layer	shrub layer 1-4 m tall	vulnerable to cowbird parasitism; grazing reduces understory structure	Food, Reproduction	The yellow-breasted chat is an indicator of healthy shrub dominated riparian habitat and is a management priority species in the Canadian Okanogan.
			30-80% shrub cover		Food, Reproduction	
			scattered herbaceous openings		Food, Reproduction	
			tree cover < 20%		Food, Reproduction	

Focal Species	Focal Habitat Type	Key Habitat Relationships		Comments	Life Requisite	Selection Rationale
		Conservation Focus	Habitat Attribute (Vegetative Structure)			
Beaver	Eastside (Interior) Riparian Wetlands	canopy closure	40-60% tree/shrub canopy closure		Food	The beaver is an indicator of healthy regenerating aspen stands and an important habitat manipulator.
			trees < 6" dbh; shrub height ≥ 6.6 ft.			
		permanent water	stream channel gradient ≤ 6% with little to no fluctuation		Water (cover for food and reproductive requirements)	
		shoreline development	woody vegetation ≤ 328 ft. from water		Food	
Red-winged blackbird	Herbaceous Wetlands	Open water with emergent wetlands				Wetland obligate species
Pygmy nuthatch	Ponderosa Pine	large trees	> 10/ac > 21" dbh with > 2 trees > 31" dbh	large snags for nesting; large trees for foraging	Food, Reproduction	The pygmy nuthatch is a species of management concern and is an obligate for healthy old-growth Ponderosa pine forest with an abundant snag component.
			> 1.4 snags/ac > 8" dbh with > 50% > 25"			
Gray flycatcher	Ponderosa Pine	shrubsteppe/ pine interface; pine savannah w/ shrub-bunchgrass understory	Nest tree diameter 18" dbh		Reproduction	The gray flycatcher is an indicator of healthy fire-maintained regenerating ponderosa pine forest.
			Tree height 52'		Food	
White-headed woodpecker	Ponderosa Pine	large patches of old growth forest with large trees and snags	> 10 trees/ac > 21" dbh w/ > 2 trees > 31" dbh	large high-cut stumps; patch size smaller for old-growth forest; need > 350 ac or > 700 ac	Reproduction	The white-headed woodpecker is a species of management concern and it is an obligate species for large patches of healthy old-growth Ponderosa pine forest.

Focal Species	Focal Habitat Type	Key Habitat Relationships		Comments	Life Requisite	Selection Rationale
		Conservation Focus	Habitat Attribute (Vegetative Structure)			
Flammulated owl	Ponderosa Pine	interspersion; grassy openings and dense thickets	> 10 snags / 40 ha > 30 cm dbh and 1.8m tall	thicket patches for roosting; grassy openings for foraging	Food	The flammulated is an indicator of a healthy landscape mosaic in Ponderosa pine and Ponderosa pine/Douglas-fir forest and it is a Washington State priority species.

5.2.1.1.2 Limiting Factors

Logging has removed much of the old growth cone producing pines throughout this species' range, which provide winter food and large snags for nesting. The impact from the decrease in old growth cone producing pines is even more significant in areas where no alternate pine species exist for the white-headed woodpecker to utilize.

Fire suppression has altered the stand structure in many of the forests. Lack of fire has allowed dense stands of immature ponderosa pine as well as the more shade tolerant Douglas-fir to establish. This has led to increased fuel loads resulting in more severe stand replacing fires where both the mature cone producing trees and the large suitable snags are destroyed. These dense stands of immature trees has also led to increased competition for nutrients as well as a slow change from a ponderosa pine climax forest to a Douglas-fir dominated climax forest.

Predation does not appreciably affect the woodpecker population. Chipmunks are known to prey on the eggs and nestlings of white-headed woodpeckers. There is also limited predation by the great horned owl on adult white-headed woodpeckers.

5.2.1.1.3 Current Distribution

White-headed woodpeckers live in montane, coniferous forests from southern British Columbia in Canada, to eastern Washington, southern California and Nevada and northern Idaho in the United States (Figure_28).

5.2.1.1.4 Population Trend Status

White-headed woodpecker abundance appears to decrease north of California. They are uncommon in Washington and Idaho and rare in British Columbia. However, they are still common in most of their original range in the Sierra Nevada and mountains of southern California.

This species is of moderate conservation importance because of its relatively small and patchy year-round range and its dependence on mature, montane coniferous forests in the West. Knowledge of this woodpecker's tolerance of forest fragmentation and silvicultural practices will be important in conserving future populations. Breeding Bird Survey population trend data are illustrated in Figure_29.

5.2.1.1.5 Structural Condition Associations

Structural conditions (NHI 2003) associated with white-headed woodpeckers are summarized in Table_21. White-headed woodpeckers feed and reproduce (F/R) in and are generally associated (A) with a multitude of structural conditions within the ponderosa pine habitat type. Similarly, white-headed woodpeckers are present (P), but not dependent upon sapling/pole successional forest. According to NHI (2003) data, white-headed woodpeckers are not closely associated (C) with any specific ponderosa pine structural conditions.

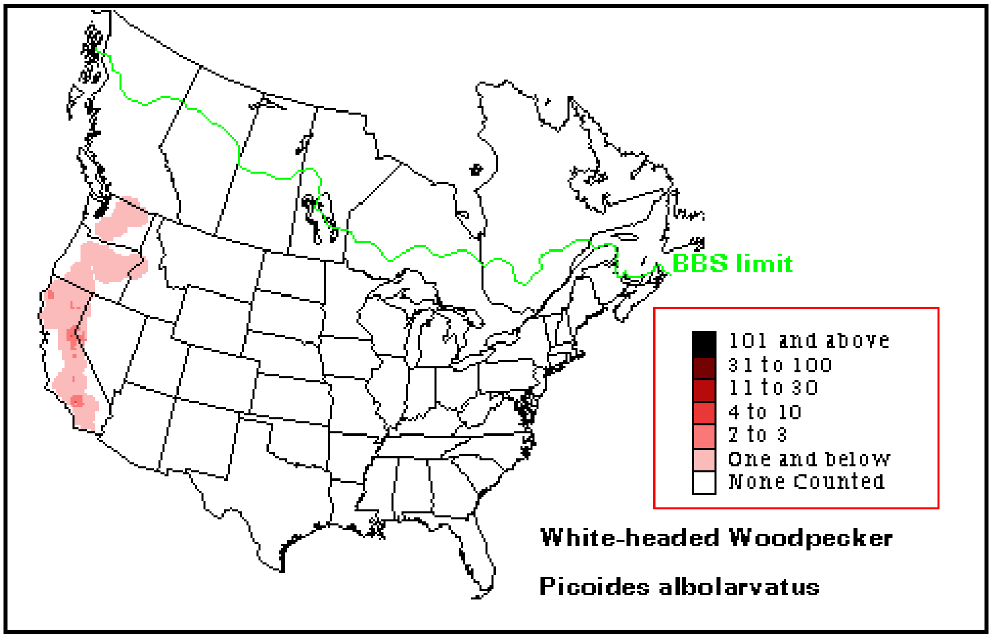


Figure 28. White-headed woodpecker current distribution/year-round range (Sauer *et al.* 2003).

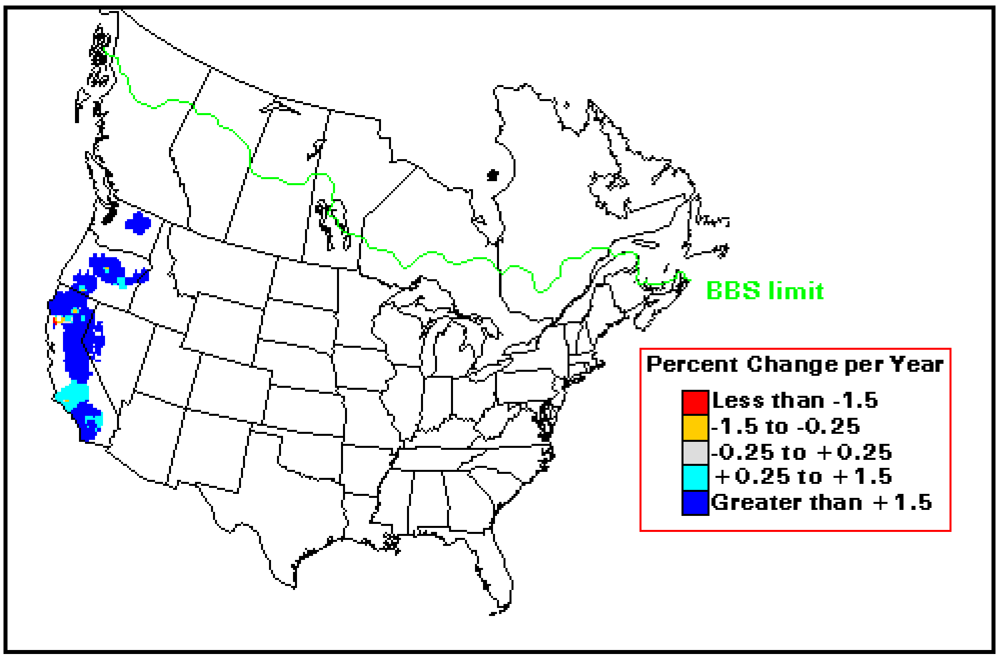


Figure 29. White-headed woodpecker BBS population trend: 1966-1996 (Sauer *et al.* 2003).

Table 21. White-headed woodpecker structural conditions and association relationships (NHI 2003).

Common Name	Focal Habitat	Structural Condition (SC)	SC Activity	SC Assoc.
White-headed Woodpecker	Ponderosa Pine	Giant Tree-Multi-Story	F/R-HE	A
		Grass/Forb-Closed	F/R-HE	A
		Grass/Forb-Open	F/R-HE	A
		Large Tree-Multi-Story-Closed	F/R-HE	A
		Large Tree-Multi-Story-Moderate	F/R-HE	A
		Large Tree-Multi-Story-Open	F/R-HE	A
		Large Tree-Single Story-Closed	F/R-HE	A
		Large Tree-Single Story-Moderate	F/R-HE	A
		Large Tree-Single Story-Open	F/R-HE	A
		Medium Tree-Multi-Story-Closed	F/R-HE	A
		Medium Tree-Multi-Story-Moderate	F/R-HE	A
		Medium Tree-Multi-Story-Open	F/R-HE	A
		Medium Tree-Single Story-Closed	F/R-HE	A
		Medium Tree-Single Story-Moderate	F/R-HE	A
		Medium Tree-Single Story-Open	F/R-HE	A
		Sapling/Pole-Closed	F/R-HE	P
		Sapling/Pole-Moderate	F/R-HE	P
		Sapling/Pole-Open	F/R-HE	P
		Shrub/Seedling-Closed	F/R-HE	A
		Shrub/Seedling-Open	F/R-HE	A
		Small Tree-Multi-Story-Closed	F/R-HE	A
		Small Tree-Multi-Story-Moderate	F/R-HE	A
		Small Tree-Multi-Story-Open	F/R-HE	A
		Small Tree-Single Story-Closed	F/R-HE	A
		Small Tree-Single Story-Moderate	F/R-HE	A
		Small Tree-Single Story-Open	F/R-HE	A

5.2.1.2 Flammulated Owl

5.2.1.2.1 General Habitat Requirements

The flammulated owl is a Washington State candidate species. Limited research on the flammulated owl indicates that its demography and life history, coupled with narrow habitat requirements, make it vulnerable to habitat changes. The flammulated owl occurs mostly in mid-level conifer forests that have a significant ponderosa pine component (McCallum 1994b) between elevations of 1,200 and 5,500 feet in the north, and up to 9,000 feet in the southern part of its range in California (Winter 1974).

Flammulated owls are typically found in mature to old, open canopy yellow pine (ponderosa pine and Jeffrey pine [*Pinus jeffreyi*]), Douglas-fir, and grand fir (Bull and Anderson 1978; Goggans 1986; Howie and Ritchie 1987; Reynolds and Linkhart 1992; Powers *et al.* 1996). It is a species dependent on large diameter ponderosa pine forests (Hillis *et al.* 2001) and are obligate secondary cavity nesters (McCallum 1994b), requiring large snags in which to roost and nest. Flammulated owls nest in habitat types with low to intermediate canopy closure

(Zeiner *et al.* 1990). The owls selectively nest in dead ponderosa pine snags, and prefer nest sites with fewer shrubs in front than behind the cavity entrance, possibly to avoid predation and obstacles to flight. Specific habitat attribute information is located in Table_20.

5.2.1.2.2 Limiting Factors

Logging disturbance and the loss of breeding habitat associated with it has a detrimental effect on the birds (USDA 1994a). The owls prefer late seral forests. The main threat to the species is the loss of nesting cavities as this species cannot create its own nest and relies on existing cavities. Management practices such as intensive forest management, forest stand improvement, and the felling of snags and injured or diseased trees (potential nest sites) for firewood effectively remove most of the cavities suitable for nesting (Reynolds *et al.* 1989). However, the owls will nest in selectively logged stands, as long as they contain residual trees (Reynolds *et al.* 1989).

Wildfire suppression has allowed many ponderosa pine stands to proceed to the more shade resistant fir forest types, which is less suitable habitat for these species (Marshall 1957; Reynolds *et al.* 1989).

Roads and fuelbreaks, often placed on ridgetops, result in removal of snags for safety considerations (hazard tree removal) and firewood can result in the loss of existing and recruitment nest trees.

Pesticides including aerial spraying of carbaryl insecticides to reduce populations of forest insect pests may affect the abundance of non-target insects important in the early spring diets of flammulated owls (Reynolds *et al.* 1989). Although flammulated owls rarely take rodents as prey, they could be at risk, like other raptors, of secondary poisoning by anticoagulant rodenticides. Possible harmful doses could cause hemmorhaging upon the ingestion of anticoagulants such as Difenacoum, Bromadiolone, or Brodifacoum (Mendenhall and Pank 1980).

Competitors include spotted owl (*Strix occidentalis*) and other larger owls, accipiters, long-tailed weasels (*Mustela frenata*) (Zeiner *et al.* 1990), felids, and bears (McCallum 1994b). Nest predation has also been documented by northern flying squirrel (*Glaucomys sabrinus*) in the Pacific Northwest (McCallum 1994a). Saw-whet owls (*Aegolius acadicus*), screech owls, and American kestrels (*Falco sparverius*) compete for nesting sites, but flammulated owls probably have more severe competition with non-raptors, such as woodpeckers, other passerines, and squirrels for nest cavities (Zeiner *et al.* 1990, McCallum 1994b). Birds from the size of bluebirds (*Sialia mexicana*) upward are potential competitors. Owl nests containing bluebird eggs and flicker (*Colaptes auratus*) eggs suggest that flammulated owls evict some potential nest competitors (McCallum 1994b). Any management plan that supports pileated woodpecker (*Dryocopus pileatus*) and northern flicker populations will help maintain high numbers of cavities, thereby minimizing this competition (Zeiner *et al.* 1990). Flammulated owls may compete with western screech-owls and American kestrels for prey (Zeiner *et al.* 1990) as both species have a high insect component in their diets. Common poorwills (*Phalaenoptilus nuttallii*), nighthawks (*Chordeiles minor*), and bats may also compete for nocturnal insect prey especially in the early breeding season (April and May) when the diet of the owls is dominated by moths. (McCallum 1994b).

Exotic species impact flammulated owl populations. Flicker cavities are often co-opted by European starlings, reducing the availability of nest cavities for both flickers and owls (McCallum 1994a). Africanized honey bees will nest in in tree cavities (Merrill and Visscher

1995) and may be a competitor where natural cavities are limiting, particulary in southern California where the bee has expanded its range north of Mexico.

5.2.1.2.3 Current Distribution

Flammulated owl distribution is illustrated in Figure_30. Flammulated owls are uncommon breeders east of the Cascades in the ponderosa pine belt from late May to August. There have been occasional records from western Washington, but they are essentially an east side species. Locations where they may sometimes be found include Blewett Pass (straddling Chelan and Kittitas Counties), Colockum Pass area (Kittitas County), and Satus Pass (Klickitat County) (Figure_31).

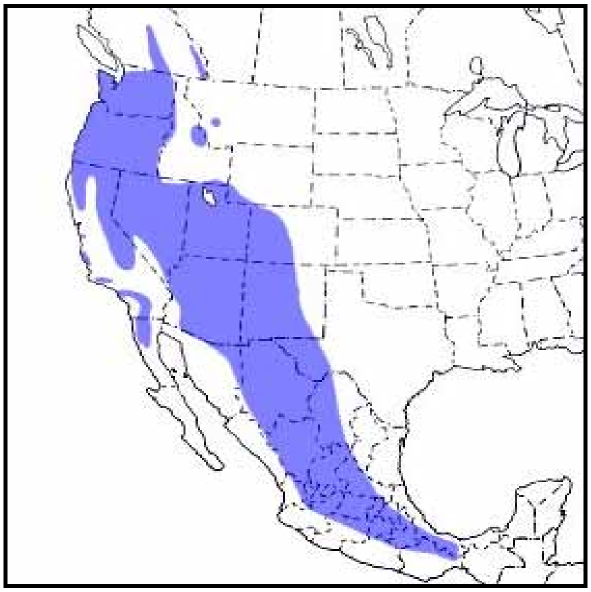


Figure 30. Flammulated owl distribution, North America (Kaufman 1996).

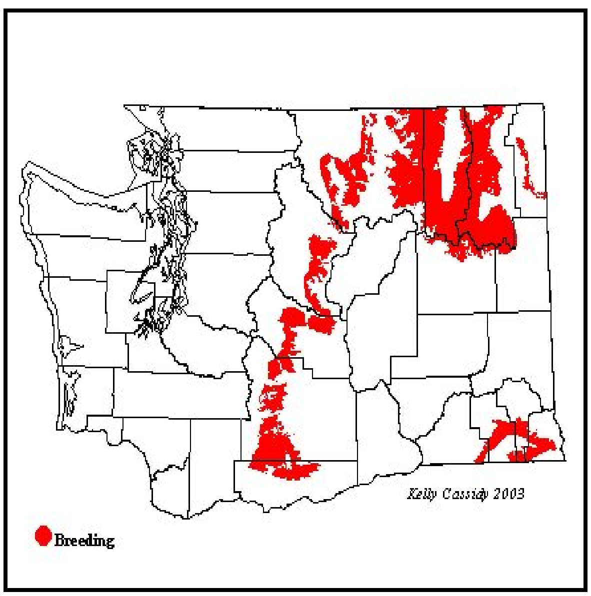


Figure 31. Flammulated owl distribution, Washington (Kaufman 1996).

5.2.1.2.4 Population Trend Status

Because old-growth ponderosa pine is rarer in the northern Rocky Mountains than it was historically, and little is known about local flammulated owl distribution and habitat use, the USFS has listed the flammulated owl as a sensitive species in the Northern Region (USDA 1994b). It is also listed as a sensitive species by the USFS in the Rocky Mountain, Southwestern, and Intermountain Regions, and receives special management consideration in the States of Montana, Idaho, Oregon, and Washington (Verner 1994).

So little is known about flammulated owl populations that even large scale changes in their abundance would probably go unnoticed (Winter 1974). Several studies have noted a decline in flammulated owl populations following timber harvesting (Marshall 1939; Howle and Ritcey 1987). However, more and more nest sightings occur each year, but this is most likely due to the increase in observation efforts.

5.2.1.2.5 Structural Condition Associations

Structural conditions (NHI 2003) associated with flammulated owl are summarized in Table_22. Flammulated owls feed and reproduce (F/R) in and are closely associated (C) with medium to large, multi-story, moderate to closed canopy ponderosa pine forest conditions. Similarly, flammulated owls are associated (A) with medium to large multi-story/open canopy forest and will utilize dense stands of small trees. In contrast, flammulated owls are present (P), but not dependent upon open canopy forest (NHI 2003). Of the three ponderosa pine focal species, flammulated owls are the most structural dependent species.

Table 22. Flammulated owl structural conditions and association relationships (NHI 2003).

Common Name	Focal Habitat	Structural Condition (SC)	SC Activity	SC Assoc.
Flammulated Owl	Ponderosa Pine	Giant Tree-Multi-Story	F/R-HE	C
		Large Tree-Multi-Story-Closed	F/R-HE	C
		Large Tree-Multi-Story-Moderate	F/R-HE	C
		Large Tree-Multi-Story-Open	F/R-HE	A
		Large Tree-Single Story-Closed	F/R-HE	P
		Large Tree-Single Story-Moderate	F/R-HE	P
		Medium Tree-Multi-Story-Closed	F/R-HE	C
		Medium Tree-Multi-Story-Moderate	F/R-HE	C
		Medium Tree-Multi-Story-Open	F/R-HE	A
		Medium Tree-Single Story-Closed	F/R-HE	P
		Medium Tree-Single Story-Moderate	F/R-HE	P
		Small Tree-Multi-Story-Closed	F/R-HE	A
		Small Tree-Multi-Story-Moderate	F/R-HE	A
		Small Tree-Multi-Story-Open	F/R-HE	P

5.2.1.3 Gray Flycatcher

5.2.1.3.1 General Habitat Requirements

Information for this section is unavailable.

5.2.1.3.2 Limiting Factors

Gray flycatchers would be vulnerable to land clearing, but generally found in very arid environments that are not usually converted to agriculture (USFS 1994). Clearing of pinyon-juniper for mining of coal and oil shale deposits or in favor of grassland for livestock grazing, or widespread harvesting of pinyon-juniper could be detrimental (O'Meara *et al.* 1981 in Sterling 1999).

5.2.1.3.3 Current Distribution

Gray flycatchers are found in extreme southern British Columbia (Cannings 1992) and south-central Idaho south to southern California, southern Nevada, central Arizona, south-central New Mexico, and locally western Texas (Terres 1980; AOU 1983).

Gray flycatchers during the non-breeding season occur in southern California, central Arizona, south to Baja California and south-central mainland of Mexico (Terres 1980).

5.2.1.3.4 Population Trend Status

North American BBS shows a survey-wide significantly increasing trend of 10.2 percent average per year (n = 89), for the period of 1966 to1996; a nonsignificant decline of -1.0 percent average per year (n = 22) from 1966 to1979; and a significant increase from 1980 to 1996 of 10.0 percent average per year (n = 84) (Figure_32). Data for Oregon reflect a strong long-term increase of 7.9 percent average per year (n = 29), 1966-1996. Sample sizes are too low for accurate trend estimates in other states (Sauer *et al.* 1997). Gray flycatcher breeding season abundance is illustrated in Figure_33.

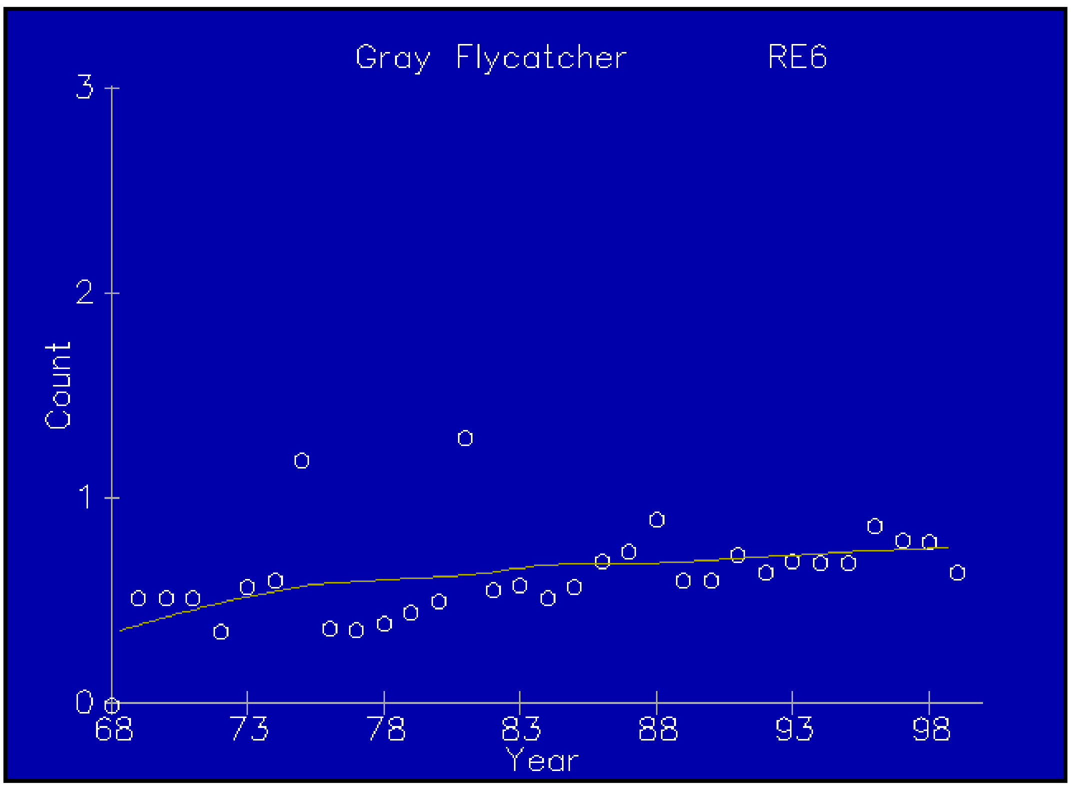


Figure 32. Gray flycatcher population trends from BBS data (Sauer *et al.* 1997).

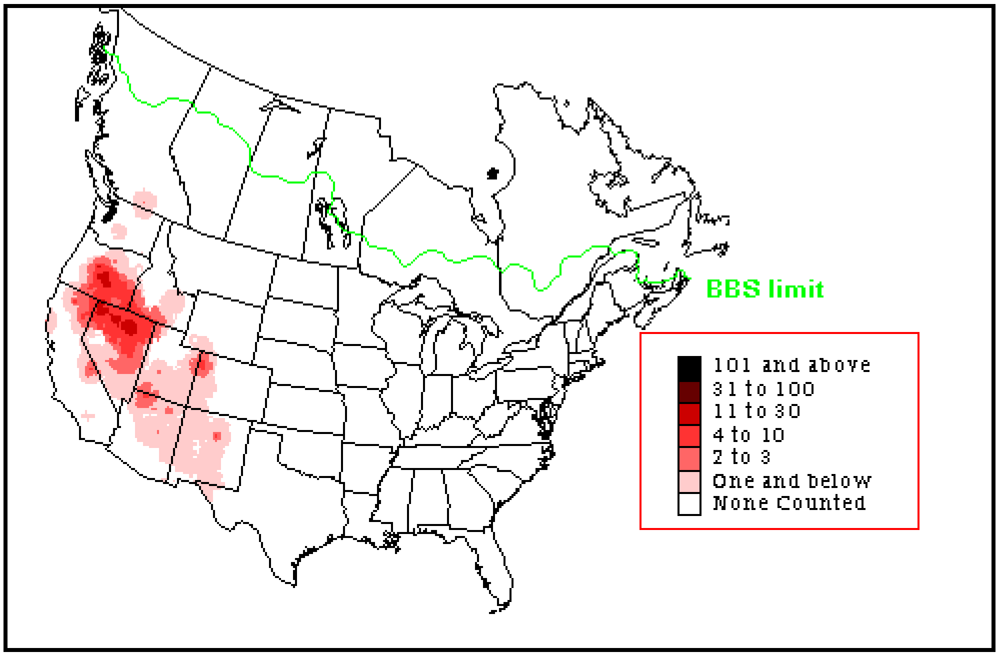


Figure 33. Gray flycatcher breeding season abundance from BBS data (Sauer *et al.* 1997).

Christmas Bird Count (CBC) data for 1959 to 1988 show a significant survey wide increase of 4.3 percent average per year, and a significant increase in Arizona (4.6 percent average per year, n = 28). The trend for California is apparently stable over the same period (nonsignificant increase of 0.2 percent average per year, n = 21; Sauer *et al.* 1996). Christmas Bird Count abundance data are illustrated in Figure 34.

Reportedly declining as a wintering bird in southern California; extensions in Washington and California at western edges of the gray flycatcher breeding range were noted in the 1970s (USFS 1994).

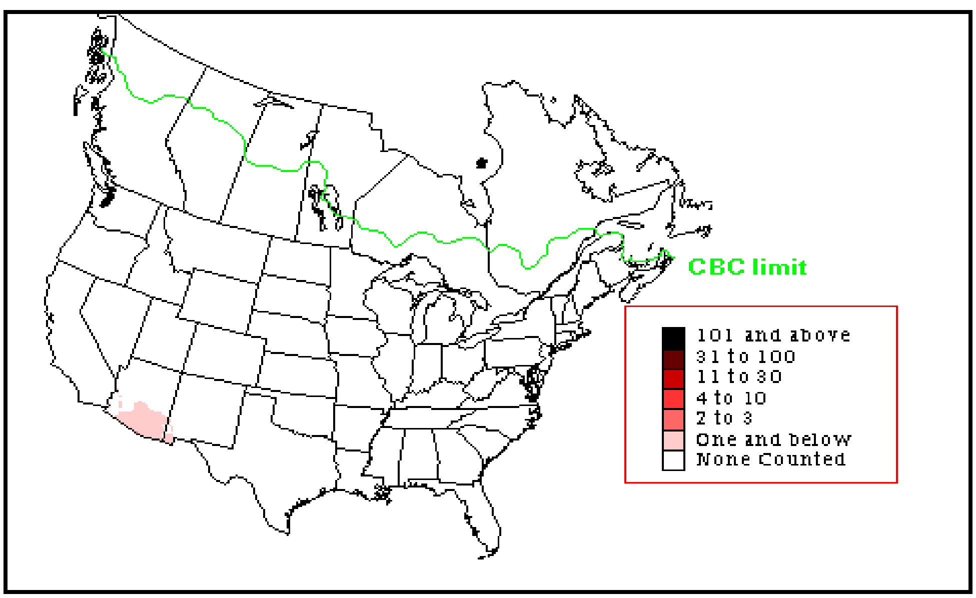


Figure 34. Winter season abundance from CBC data (Sauer *et al.* 1996).

5.2.1.3.5 Structural Condition Associations

Gray flycatchers are closely associated (C) with medium tree, single story, open canopy conditions in the ponderosa pine habitat type. This structural condition provides critical breeding habitat (B) and is the most significant structural condition associated with this species (NHI 2003). Gray flycatchers are also generally associated (A) and somewhat dependent upon five structural conditions. Three include medium open canopy shrub understories while two involve either moderate canopy conditions or small tree structural conditions. Flycatchers are present (P) in, but not dependent upon various other structural conditions as described in Table 23.

Table 23. Gray flycatcher structural conditions and association relationships (NHI 2003).

Common Name	Focal Habitat	Structural Condition (SC)	SC Activity	SC Assoc.
Gray Flycatcher	Ponderosa Pine	Large Tree-Multi-Story-Open	B	P
		Large Tree-Single Story-Moderate	B	P
		Large Tree-Single Story-Open	B	P
		Medium Tree-Multi-Story-Open	B	P
		Medium Tree-Single Story-Moderate	B	A
		Medium Tree-Single Story-Open	B	C
		Sapling/Pole-Open	B	P
		Small Tree-Single Story-Moderate	B	P
		Small Tree-Single Story-Open	B	A
		Medium Shrub-Closed Shrub Overstory-Mature	B	P
		Medium Shrub-Closed Shrub Overstory-Old	B	P
		Medium Shrub-Closed Shrub Overstory-Seedling/Young	B	P
		Medium Shrub-Open Shrub Overstory-Mature	B	A
		Medium Shrub-Open Shrub Overstory-Old	B	A
		Medium Shrub-Open Shrub Overstory-Seedling/Young	B	A

5.2.1.4 Pygmy Nuthatch

5.2.1.4.1 General Habitat Requirements

Among all breeding birds within ponderosa pine forests, the density of pygmy nuthatches is most strongly correlated with the abundance of ponderosa pine trees (Balda 1969). In Colorado, 93 percent of breeding bird atlas observations occurred in coniferous forests, 70 percent of those in ponderosa pines. Indeed the distribution of pygmy nuthatches in Colorado coincides with that of ponderosa pine woodlands in the state (Jones 1998).

Several studies identify the pygmy nuthatch as the most abundant or one of the most abundant species in ponderosa forests (e.g., Mt. Charleston, Nevada; Arizona’s mountains and plateaus; New Mexico; Colorado statewide; and Baja California) (Reassumes 1941; Brandt 1951; Norris 1958; Stallcup 1968; Balda 1969; Farris 1985; Travis 1992; Kingery 1998) as well as in other yellow long-needled pines such as those of coastal California and Popocatépetl, Mexico (Norris 1958; Paynter 1962).

In California's mountains, it favors open park-like forests of ponderosa and Jeffrey pines in the Sierra Nevada Mountains (Gaines 1988) but also ranges to 10,000 feet in open stands of large lodgepole pine in the White Mountains of California (Shuford and Metropulos 1996). In the Mogollon Rim region of central Arizona, it breeds and feeds in vast expanses of ponderosa pine that extend throughout the Colorado plateau, and, is also common in shallow snow-melt ravines that course through the pine forests. These snow-melt drainages contain white fir (*Abies concolor*), Douglas-fir, Arizona white pine (*Pinus strobiformis*), quaking aspen (*Populus tremuloides*), and an understory of maples (*Acer* sp.) (Kingery and Ghalambor 2001).

In New Mexico, it is most common in ponderosa pine, including ponderosa/oak and ponderosa/Douglas-fir forests (Kingery and Ghalambor 2001). In Washington, it uses Douglas-fir zones rarely, and then only those in or near ponderosa pines (Smith *et al.* 1997). In Summit County, Colorado, a small group of pygmy nuthatches occupies a small section of lodgepole pine at the edge of an extensive lodgepole forest (Kingery and Ghalambor 2001).

In coastal California (Sonoma, Marin, Monterey, and San Luis Obispo Counties) pygmy nuthatches occur in the "coastal fog belt" (Burridge 1995) in Bishop pine (*Pinus muricata*), Coulter pine (*Pinus coulteri*), natural and planted groves of Monterey pine (*Pinus radiate*) (Roberson 1993; Shuford 1993), other pine plantations (Burridge 1995), and wherever ponderosa pines grow (e.g., Santa Lucia Mountains, Monterey County) (Roberson 1993).

In Mexico, where it occurs in arid pine forests of the highlands, it follows pines to their upper limits at tree line on Mount Popocatépetl (Paynter 1962) and Pico Orizaba (Cox 1895). Almost no other contemporary information is available on the habitat preferences of pygmy nuthatches in Mexican mountain ranges. It is known to favor pine and pine-oak woodlands; these pine species include ponderosa-type pines: *Pinus engelmanii, P. arizonica, P. montezumae* and non-ponderosa-types *Pinus teocote, P. hartwegii, P. leiophylla,* and *P. cooperi*. Associated Mexican tree species in pygmy nuthatch habitat include oaks (*Quercus rugosa, Q. castanea, Q. durifolia,* and *Q. hartwegii*), madrones (*Arbutus xalapensis* and *A. glandulosa*), and alders (*Alnus firmifolia*) (Nocedal 1984, 1994). It also occurs, in small numbers, in fir (*Abies religiosa*) forests (Nocedal 1984, 1994).

5.2.1.4.2 Limiting Factors

There is good evidence for at least two main limiting factors in pygmy nuthatch populations: 1) the availability of snags for nesting and roosting, and 2) sufficient numbers of large cone-producing trees for food.

Pygmy nuthatches are dependent on snags for nesting and roosting, and reduced snag availability has been shown to have negative effects on populations. Because pygmy nuthatches nest and roost in excavated tree cavities, the importance of snags is manifested during both the breeding and non-breeding season. During the breeding season, numerous studies have documented a decline in the number of breeding pairs and a reduction in population density on sites where timber harvesting reduced the number of available snags. During the non-breeding season, studies show that timber harvests that remove the majority of snags, cause communally roosting groups to use atypical cavities with poorer thermal properties.

Pygmy nuthatches choosing roost sites during the non-breeding season use a different set of characteristics compared to nest sites. A considerable reduction in snag densities may affect overwinter survivorship and possibly reproduction by forcing pygmy nuthatches to use cavities in snags they would normally avoid (Hay and Güntert 1983; Matthysen 1998). More research on the differences among snags is clearly needed in order to distinguish those factors that make some snags more desirable than others.

Pygmy nuthatch populations rely heavily on the availability of pine seeds and arthropods that live on pines. In comparison to other nuthatches and woodpeckers, pygmy nuthatches forage more amongst the foliage of live trees rather than on the bark. The preferred foraging habitat for pygmy nuthatches appears to contain a high canopy density, low canopy patchiness, and increased vertical vegetation density, a common feature of mature undisturbed forests.

Pygmy nuthatch populations are very sedentary. Young birds have been observed to move just 950 feet from their natal territories. Such limited dispersal reduces the number of individuals that emigrate and immigrate from local populations, which in turn reduces gene flow and demographic stability. Thus, in contrast to the majority of North America's songbirds, movement and dispersal patterns in pygmy nuthatch populations are limited to a relatively small geographic area. Therefore, pygmy nuthatches may need a greater amount of connectivity between suitable habitat in comparison to other resident birds.

In a recent review of the effects of recreation on songbirds within ponderosa pine forests, Marzluff (1997) hypothesized that "nuthatches" would experience moderate decreases in population abundance and productivity in response to impacts associated with established campsites (although pygmy nuthatch was not specifically identified). Impacts associated with camping that might negatively influence nuthatches include changes in vegetation, disturbance of breeding birds, and increases in the number of potential nest predators (Marzluff 1997). However, other recreational activities associated with resorts and recreational residences might moderately increase nuthatch population abundance and productivity (Marzluff 1997). This positive effect on nuthatch populations is likely to occur through food supplementation, such as bird feeders, that are frequently visited by pygmy nuthatches.

5.2.1.4.3 Current Distribution

The pygmy nuthatch is resident in ponderosa and similar pines from south central British Columbia and the mountains of the western United States to central Mexico. The patchy distribution of pines in western North America dictates the patchy distribution of the pygmy nuthatch throughout its range. The reliance on pines distinguishes pygmy nuthatches from other western nuthatches such as the red-breasted and white breasted, which are associated with fir/spruce and deciduous forests respectively (Ghalambor and Martin 1999). The following is a review of the distribution of populations in the United States, Canada, and Mexico (based on Kingery and Ghalambor 2001).

The pygmy nuthatch occurs in southern interior British Columbia, particularly in Okanagan and Similkameen valleys and adjacent plateaus (Campbell *et al.* 1997) south into the Okanagan Highlands and the northeast Cascades of Washington. It is scattered along the eastern slope of the Cascades from central Washington (Jewett *et al.* 1953; Smith *et al.* 1997) into Oregon and in the Blue Mountains in southwest Washington (Garfield County only) (Smith *et al.* 1997) but widespread in Oregon along the west slope of the Cascades (Gabrielson and Jewett 1940; Jewett *et al.* 1953; Gilligan *et al.* 1994). It ranges south from the Cascades in Oregon into northern California and south into the Sierra Nevadas and nearby mountains of Nevada (Brown 1978). In the southern Sierra Nevadas it is found on the east and west side of the range in the Mono Craters and Glass Mountain region (Gaines 1988; Shuford and Metropulos 1996) and in the White Mountains of Nevada and California (Norris 1958; Brown 1978; Shuford and Metropulos 1996). It is also found throughout the mountain ranges of southern California, including the Sierra Madres in Santa Barbara County, the Mt. Pinos area (Kern and Ventura

Counties), the San Gabriel and San Bernardino Mountains in Los Angeles and San Bernardino Counties (Norris 1958), the San Jacinto and Santa Rosa Mountains in Riverside County (Norris 1958), and in the Laguna and Cuyamaca Mountains, as well as Mt. Palomar, Volcan and Hot Springs Mountains of San Diego County (San Diego County Breeding Bird Atlas preliminary data). The range extends south into the Sierra Juarez and Sierra San Pedro Mártir Mountains in Baja California Norte, Mexico (Grinnell 1928; Norris 1958;).

In eastern Washington, the pygmy nuthatch is common in the pine forests of Spokane County (Jewett *et al.* 1953; Smith *et al.* 1997) and adjacent Kootenai County, Idaho (Burleigh 1972).

5.2.1.4.4 Population Trend Status

Survey-wide estimates of all BBS routes suggest pygmy nuthatch populations are stable (Sauer *et al.* 2000). However, these estimates are based on small samples that do not provide a reliable population trend nor reliable trends for any states or physiographic regions, due to too few routes, too few birds, or high variability (Sauer *et al.* 2000). The lack of reliable data is particularly the case in the Black Hills, where there are too few data to perform even the most basic trend analysis (Sauer *et al.* 2000). Where long-term data are available for particular populations, natural fluctuations in population numbers have been documented. For example, a constant-effort nest-finding study in Arizona recorded a major population crash. On this site between 1991 and 1996 the number of nests found each year varied from 23-65 (mean = 50.2), whereas in the same site from 1997 to 1999, only 2-5 nests were found each year (Kingery and Ghalambor 2001). Likewise, Scott's (1979) study also portrays a pygmy nuthatch population swing, but no clear factor has been identified as being responsible for rapid changes in population numbers. No definitive explanation currently exists for why some pygmy nuthatch populations may be prone to large fluctuations, but it is suspected that an intolerance to cold winter temperatures and/or a poor cone crop may play a role.

5.2.1.4.5 Structural Condition Associations

Pygmy nuthatches are dependent upon large tree open to moderate canopy ponderosa pine stands for feeding and reproduction (F/R). NHI (2003) data clearly indicate this species' need for mature ponderosa pine forest conditions. The pygmy nuthatch is the only avian focal species that is exclusively closely associated (C) with structural conditions (Table 24).

Table 24. Pygmy nuthatch structural conditions and association relationships (NHI 2003).

Common Name	Focal Habitat	Structural Condition (SC)	SC Activity	SC Assoc.
Pygmy Nuthatch	Ponderosa Pine	Giant Tree-Multi-Story	F/R-HE	C
		Large Tree-Multi-Story-Moderate	F/R-HE	C
		Large Tree-Multi-Story-Open	F/R-HE	C
		Large Tree-Single Story-Moderate	F/R-HE	C
		Large Tree-Single Story-Open	F/R-HE	C

5.2.1.5 Ponderosa Pine Focal Species Structural Condition Summary

Ponderosa pine structural conditions are summarized by association in Figure 35. As shown, the species assemblage selected to represent this habitat type is generally associated (A) and/or present (P) in most structural conditions and dependent or closely associated (C) with only five structural conditions. This infers that the species assemblage is comprised primarily of "generalist" species with only the flammulated owl and pygmy nuthatch exhibiting a close association or link with ponderosa pine structural conditions making them somewhat of a habitat specialist. Because of the relatively large number of structural conditions associated (A) with

Ecoprovince ponderosa pine habitat focal species, the presence of viable populations of white-headed woodpeckers, flammulated owls, gray flycatchers, and pygmy nuthatches within the ponderosa pine habitat type would suggest that the ponderosa pine habitat is functional from a structural condition/Key Environmental Correlate (KEC) perspective.

Furthermore, the structural conditions summarized in Figure 35 and associated tables can also be used to define the range of recommended structural conditions to manage ponderosa pine forests, identify specific stand elements that require closer scrutiny, evaluate additional species that are closely associated (C) with recommended structural conditions, and guide temporal and spacial ponderosa pine forest management considerations. For example, elk reproduction is associated with small tree multi-story-closed canopy. Therefore, managers can us the data to identify specific areas needing protection from human disturbance during critical elk calving periods.

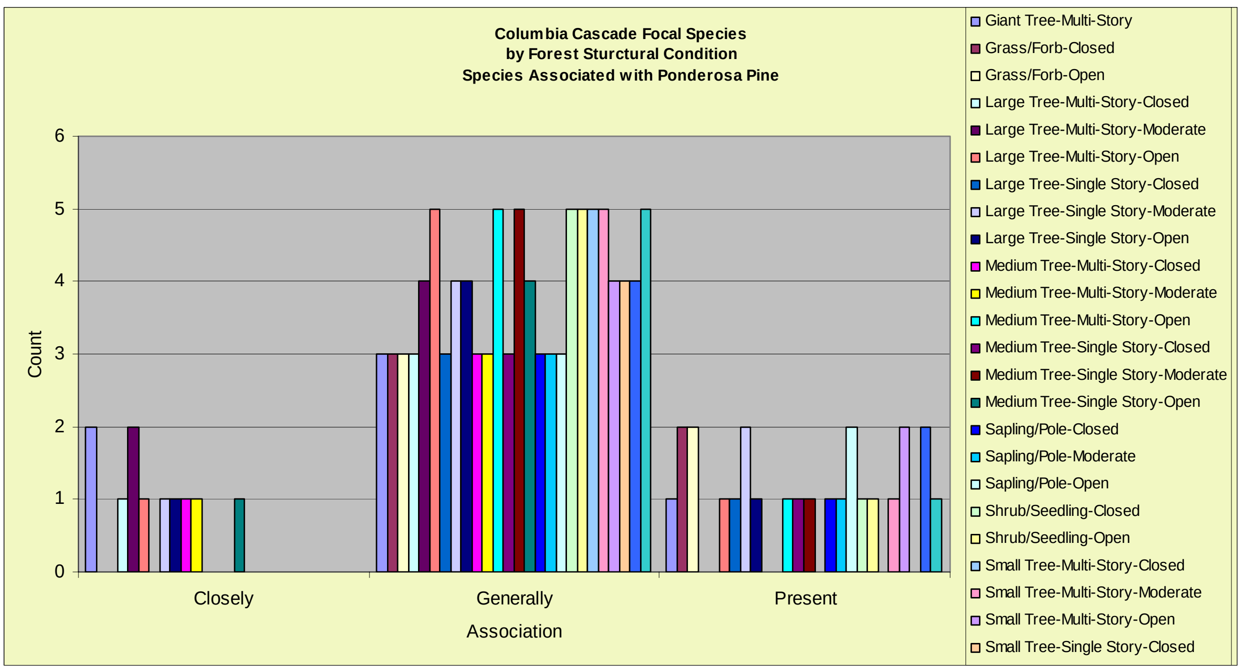


Figure 35. Ponderosa pine focal species structural condition associations (NHI 2003).

5.2.1.5 Ponderosa Pine Key Ecological Functions

A key ecological function (KEF) is:

> "*the major ecological role played by a species. Examples include herbivory, symbiotic dispersal of seeds and spores, primary creation of tree cavities and ground burrows, nutrient cycling, and many others. To keep a system 'fully functional,' one could strive to maintain all categories of naturally-occurring functions among all native species. In the NHI database, KEFs are denoted for each species using a standard classification system of 85 KEF categories. A limitation of the concept is that there has been little research done to quantify the rates of key ecological functions, such as number of cavities excavated by primary cavity excavators per acre per year, or tonnage of soil worked by burrowing and digging animals per acre per year, etc.*"

Key ecological functions performed by ponderosa pine focal species are listed in Table 25 (see section 5.3 for further discussion on KEFs). Beaver, white-headed woodpecker, pygmy nuthatch, and mule deer perform key ecological functions within this habitat type (NHI 2003). Although not all KEFs are represented by members of the focal species assemblage, the ponderosa pine habitat type is functional because other wildlife species provide functional redundancy as illustrated in Figure 36. Northwest Habitat Institute biologists have set the functional redundancy threshold at three species – less than three species performing a KEF suggests it is a critical function to watch as high redundancy imparts greater resistance of the community to changes in its overall functional integrity.

Although only seven key ecological functions are being examined, managers are encouraged to review all KEFs associated with focal habitat types and non-focal habitats alike. For example, wildlife that consume terrestrial invertebrates (KEC 1.1.2.1.1) have decreased by almost 40 percent (Appendix B). This could have a significant impact on forest health as it pertains to moth and beetle outbreaks/control.

Table 25. Key ecological functions performed by ponderosa pine focal species (NHI 2003).

KEF	KEF Description	Common Name	Number of Focal Species
5.1	physically affects (improves) soil structure, aeration (typically by digging)	American beaver	1
3.9	primary cavity excavator in snags or live trees	White-headed woodpecker, Pygmy nuthatch	2
3.6	primary creation of structures (possibly used by other organisms)	American beaver	1
3.5	creates feeding, roosting, denning, or nesting opportunities for other organisms	None	0
1.1.1.9	fungivore (fungus feeder)	Mule deer	1
1.1.1.4	grazer (grass, forb eater)	Mule deer	1
1.1.1.3	browser (leaf, stem eater)	American beaver, Mule deer	2

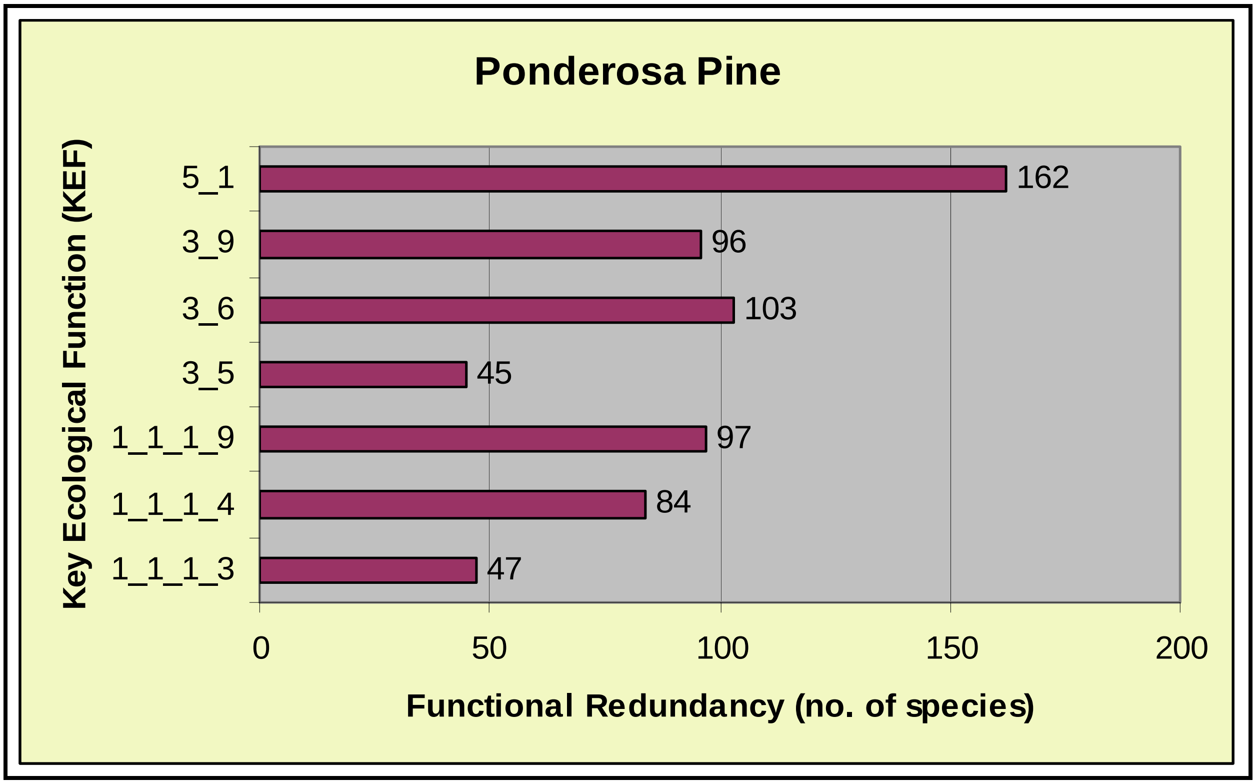


Figure 36. Functional redundancy within the ponderosa pine habitat type (NHI 2003).

5.2.2 Shrubsteppe Focal Species Information

5.2.2.1 Pygmy Rabbit

5.2.2.1.1 General Habitat Requirements

Pygmy rabbits are dependent upon sagebrush, primarily big sagebrush, and are usually found in areas where big sagebrush grows in very dense stands. Tall, dense sagebrush clumps are essential (Orr 1940).

At Sagebrush Flat, Washington, big sagebrush is the dominant shrub species (Gahr 1993). In one pygmy rabbit area in Idaho, bitterbrush and big sagebrush are present in equal amounts (19 percent coverage of each) (Green and Flinders 1980b). In Oregon, sagebrush species account for 23.7 percent of the cover at pygmy rabbit sites. Overall shrub cover at pygmy rabbit sites averaged 28.8 percent with a range of 21.0-36.2 percent.

Several studies have compared shrub cover and height between burrow locations and randomly selected locations (Table_26). While the values reported by these studies are not the same, a product of different measurement techniques, all indicate that sagebrush cover is a major habitat feature selected by pygmy rabbits. Where measured, burrow sites always had greater shrub cover and taller shrubs than random sites. Historically, conditions suitable for pygmy rabbits were probably uncommon, limited to areas with deep, moisture-retaining soil or areas where disturbance provided opportunities for sagebrush to invade and flourish, relieved from the competition of grasses.

Most typically, heavy grazing increases the density of big sagebrush. Most of Washington's pygmy rabbit sites have a long history of grazing. One pygmy rabbit site in Washington (Burton

Table 26. Comparisons of shrub cover and density between pygmy rabbit burrow sites and non-burrow sites (WDFW 1995).

Location	Mean shrub cover (%)	Mean shrub height (cm)	Reference
Sagebrush Flat burrow sites	32.7	82	Gahr (1993)
Sagebrush Flat random sites	17	53.4	
Idaho burrow sites	46	56	Green and Flinders (1980b)
Idaho random sites	unknown	25	
Oregon burrow sites	28.8	84	Weiss and Verts (1984)
Oregon random sites	17.7	53	

Draw) has a history of cultivation. When cultivation ended years ago, big sagebrush invaded the fields and provided heavy shrub cover (Dobler and Dixon 1990).The burrowing and grazing activity of pygmy rabbits may increase sagebrush cover. The area around active pygmy rabbit burrows is heavily grazed by the rabbits (Wilde 1978). In Wilde's words, "*growth and reproduction of sagebrush at pygmy rabbit burrows may be increased* (Janson 1946; Wilde in prep.). *Whether this is due to burrowing activity, per se, or to browsing* (Pearson 1965) *is unknown*." Gahr found that percent cover of bunchgrasses was less at burrow sites (3.2 percent) than at random sites around burrows (8.9 percent).

Habitat suitable for pygmy rabbits must allow the animals to burrow. Burrows are usually under big sagebrush and only rarely are located in an opening in the vegetation (Green 1978; Wilde 1978). However, pygmy rabbits have been observed using abandoned badger (*Taxidea taxus*) and yellow-bellied marmot (*Marmota flaviventris*) burrows, as well as natural cavities, holes in volcanic rock, rock piles, and abandoned buildings (Green 1979; 1980; Wilde 1978). These are used in association with typical burrows in deep soil amidst sagebrush. They probably do not represent a habitat alternative capable of replacing dense sagebrush and deep soils.

Since pygmy rabbits excavate their own burrows, soil structure is a key habitat feature. Generally, soft, deep soils are required for burrowing. However, three burrows excavated by Wilde (1978) extended below the hardpan. Alluvial fans may provide the soil requirement in some cases (Orr 1940; Green and Flinders 1980b). Oregon burrow sites are located where soils are significantly deeper and looser than adjacent sites (Weiss and Verts 1984). Pygmy rabbits will select sites where wind-borne soil deposits are deeper (Wilde 1978).

Kehne (1991) documented soil and other characteristics at 80 active burrow sites at Sagebrush Flat. The soils at Sagebrush Flat are derived from loess, or wind-borne parent materials. Carbonates, which make soils less compact, looser and generally easier to dig, were found at an average of 28 inches deep. This depth is shallower than expected in this precipitation zone. Burrows at Sagebrush Flat tend to be in deep soils; 96 percent are in soils at least 20 inches deep. A limiting layer of basalt, duripan, weak pan, or gravel often underlays the soil. A family control characterization of soil types indicates that burrows are found in coarse-silty (46 percent), fine-loamy (28 percent), ashy (17 percent), and coarse-loamy (9 percent) soils.

Landform, as well as soil characteristics, plays a part in burrow site selection. The rabbits use the contours of the soil, most often digging into a slope (Wilde 1978; Kehne 1991). At Sagebrush Flat, 77 percent of 80 active burrows were on mound/intermound or dissected topography (Kehne 1991). Although they do use level sites, even here they often utilize a small rise or change in contour for the burrow entrance. Gahr (1993) found that topography influenced the distribution and abundance of burrow sites at Sagebrush Flat. The study area was divided along 40 and 60-foot contour intervals with drainage bottoms defining the base elevation. More burrows were found along four main drainage systems running northeast to southwest. There was almost a four-fold increase in burrow density in the 40-foot interval compared to the 60-foot interval.

Gahr (1993) was able to partition some of the data collected in her study of pygmy rabbits at Sagebrush Flat. The occupied habitat at Sagebrush Flat has been divided by a fence for many years. The approximately 2,800 acres area north of the fence has been grazed by cattle and horses at varying intensities and duration for many decades. At the time of Gahr's study, the area was being grazed by cattle for 3 months each fall. The 680-acre area south of the fence has not been grazed since at least 1957 (Guinn 1993). Gahr found no differences in the densities of burrow systems and burrow sites between the grazed and not recently grazed areas at Sagebrush Flat. Both burrow systems and burrow sites were distributed proportional to the area available in each type. However, there are differences in proportions of the areas in different soil conditions. Guinn (1993) reported these differences in terms of "range sites" which have not been characterized for their value to pygmy rabbits. The northern unit of the grazed section was estimated to be about 80 percent loamy sites, the southern section about 60 percent loamy and 25 percent shallow sites. The area not recently grazed was estimated to be comprised of about one third each shallow and loamy sites.

Gahr also found that the average home range size of adult males in the grazed area was significantly larger than that of adult males in the area not recently grazed. Adult males in the grazed area made more frequent long distance movements to search out females for breeding. This suggested that the density of adult females may have been lower in the grazed area. The ratio of animals trapped in the grazed and not recently grazed areas was lower than expected based on land area. Trapping effort for the two areas was not standardized so this result is not conclusive.

5.2.2.1.2 Limiting Factors

Most of the former pygmy rabbit habitat in Washington has been altered to the point that it can no longer support pygmy rabbits. Additional losses may occur in the future through conversion of shrubsteppe to cropland, sagebrush removal for cattle grazing, or wildfire. This is especially likely in areas where pygmy rabbits occur but have not yet been discovered.

Even if the five existing pygmy rabbit habitats are maintained in their current condition, populations will remain vulnerable to extirpation. The historic pressures of habitat loss appear to be less important today, mainly due to recognition of the pygmy rabbit's endangered status. However, existing populations are believed to be below the level necessary for long-term viability. Populations comprised of few individuals are vulnerable to extirpation from a variety of factors, often acting in concert. Shaffer (1981) grouped threats to small populations into four categories: demographic stochasticity, environmental stochasticity, natural catastrophies, and genetic stochasticity. Demographic stochasticity is the natural random variation in survival and reproductive success of individuals in a population. Environmental stochasticity is variation in environmental factors such as food sources, disease vectors, predator and parasite populations, climate, and so forth. Natural catastrophes include fire, volcano eruptions, floods, landslides, and other devastating events. Genetic stochasticity results from changes in gene frequencies due to founder effect, random fixation, or inbreeding. Many of these factors vary naturally over time and do not pose a threat to large populations. However, small populations can be extinguished by unfavorable extremes of one or a combination of these factors.

Comparisons of initial population sizes for extant and extinct rabbit populations suggest that populations for this group need to be much larger than those of many other mammals to be secure (Soulé 1987). The wide fluctuations that have been evident in pygmy rabbit populations (Janson 1946; Bradfield 1975; Weiss and Verts 1984) suggest that it is a species, like other lagomorphs, that needs to be maintained at higher population levels than many other vertebrates to be considered secure.

The Washington pygmy rabbit has reduced genetic variability compared with other pygmy rabbit populations. Based on a microsatellite analysis of museum skin samples from Sagebrush Flat, it appears that this reduction in genetic variability has existed for at least 50 years. Furthermore, genetic variability within Washington has continued to decline during the past 50 years in wild pygmy rabbits.

Green and Flinders (1980b) noted the importance of habitat connectivity and travel corridors. The ability of pygmy rabbits to rebound after periods of unfavorable conditions depends, in part, on landscape features that allow animals to disperse and recolonize suitable habitats. Long-term population maintenance, without human intervention, will likely depend upon establishment of habitat corridors linking the existing small, isolated populations. Such habitat linkages would increase the probability that the habitat which now supports a population would continue to be occupied by pygmy rabbits in the future.

Range fires can eliminate sagebrush from large areas and are a potential threat to existing pygmy rabbit populations. Sagebrush is slow to re-establish after a range fire. A Benton County pygmy rabbit habitat discovered in 1979 was destroyed by fire soon after its discovery. Sagebrush Flat, which contains Washington's largest known pygmy rabbit population, is an area penetrated by open, poor quality roads that are used for social activities where fires are sometimes built.

5.2.2.1.3 Current Distribution

The pygmy rabbit is found throughout much of the sagebrush area of the Great Basin as well as some of the adjacent intermountain areas (Figure_37) (Green and Flinders 1980a). The eastern boundary extends to southwestern Montana and western Wyoming (Campbell *et al.* 1982). The southeastern boundary extends to southwestern Utah (Janson 1946; Pritchett *et al.* 1987) and includes the only occurrence of the species outside the limits of the Pleistocene Lake Bonneville (Columbia River) drainage. Central Nevada (Nelson 1909) and northeastern California (Orr 1940) form the southern and western limits. The northern boundary of the species' core range historically reached to the southern foothills of the Blue Mountain Plateau in eastern Oregon (Bailey 1936). However, Washington populations are farther north, extending into Douglas County. Within its range, the pygmy rabbit's distribution is far from continuous. It is patchily distributed, being found only in areas where sagebrush is tall and dense, and the soil is relatively deep.

The pygmy rabbit's Washington range is disjunct from the core range of the species, and likely has been for some time (Lyman 1991; Grayson 1987). The pygmy rabbit's current range is thought to be smaller than during its post-glacial population high, which occurred more than 7,000 years ago (Butler 1972). In the Northwest, a discontinuity developed when the pygmy rabbit's core range shrunk southward toward the central part of eastern Oregon (Weiss and Verts 1984). This discontinuity has left Washington populations isolated in a portion of their prehistoric range (Lyman 1991). The paleontological record verifies pygmy rabbits in Washington over 100,000 years ago. Documented localities of prehistoric occurrence indicate a former range slightly larger than what is documented from historic times. These records do not

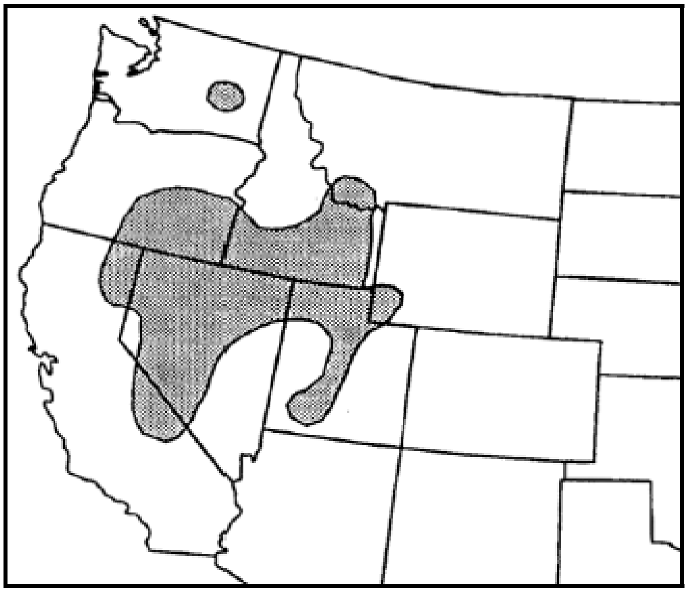


Figure 37. Current range of the pygmy rabbit (WDFW 1995).

establish the prehistoric link to populations in either Oregon or Idaho, a link which must have occurred (Lyman 1991). Habitat changes, which reflect climate change over thousands of years, likely account for the isolation of Washington populations. The range of extant populations in Washington is provided in Figure_38 and historic pygmy rabbit locations are depicted in Table_27.

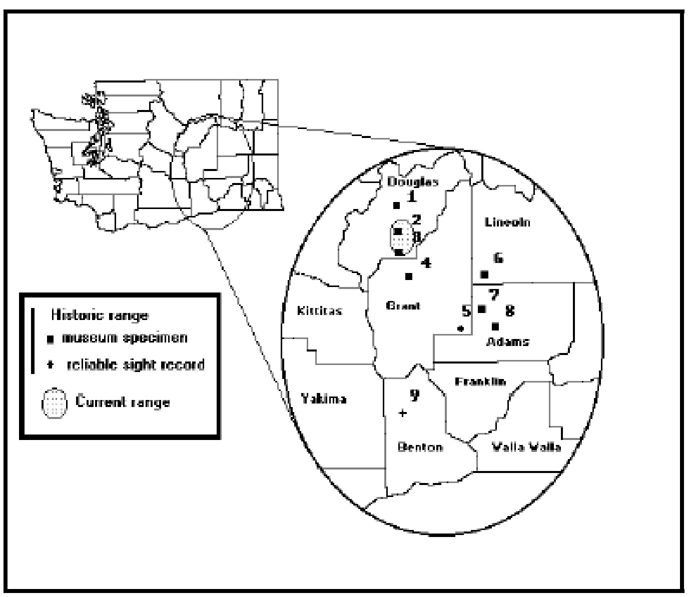


Figure 38. Distribution of the pygmy rabbit in Washington. Numbers refer to entries in Table 2 (WDFW 1995).

Table 27. Historic pygmy rabbit localities in Washington based on museum specimens and reliable reports (WDFW 1995).

Location	County	Map #[1]	Date(s)	Source[2]
Schrag	Adams	7	1956	WSU 56-45 (Drake)
Lind	Adams	8	1923	USNM 243294, 243344 (Finley)
Lind	Adams	8	1924	CSUF #643 (Lane)
Rattlesnake slope	Benton	9	1979	R. Fitzner (pers. comm.)
Hanford Reservation	Benton			
10 km E of Mansfield	Douglas	1	1950	PSM 2300 (Clanton)
Sulphur Canyon	Douglas	2	1979	PSM 25856 (Lloyd)
Sagebrush Flat	Douglas	3	1949	PSM 1992-7 (Clanton)
Sagebrush Flat	Douglas	3	1949	WSU 49-357-362, 49-375 (Hudson)
Sagebrush Flat	Douglas	3	1952	WSU 52-40, UBC 3058 (Hudson)
Sagebrush Flat	Douglas	3	1962	PSM 8955-6 (Johnson)
Sagebrush Flat	Douglas	3	1988	F. Dobler (pers. comm.)
Burton Draw	Douglas	shaded	1987	R. Friesz (pers. comm.)
Coyote Canyon	Douglas	shaded	1988	R. Friesz (pers. comm.)
Whitehall	Douglas	shaded	1988	C. Garber (pers. comm.)
Clay Site	Douglas	shaded	1988	R. Friesz (pers. comm.)
4.8 km NW of Ephrata	Grant	4	1949	PSM 2229 (Clanton)
Warden	Grant	5	1921	Couch (1923)
13 km W of Odessa	Lincoln	6	1949	PSM 2230 (Clanton)

[1] Map # refers to Figure 38.

[2] Museum abbreviations as follows: James R. Slater Museum of Natural History, University of Puget Sound, Tacoma, Washington (PSM); Conner Museum, Washington State University, Pullman, Washington (WSU); University of British Columbia, Vancouver, B.C. (UBC); U.S National Museum, Washington D.C. (USNM); California State University, Fresno (CSUF). Specimen numbers are followed by collector's name in parentheses.

5.2.2.1.4 Population Trend Status

In 1995, five pygmy rabbit populations were known to exist in Douglas and northern Grant Counties; a sixth population was found in 1997. Between 1997 and 2001, five of the six populations disappeared; by March 2001, only one area, Sagebrush Flat, was known to still have rabbits. Small populations at several sites were extirpated for unknown reasons; other populations were extirpated by known wildfires.

Wilde (1978) concluded that pygmy rabbits have a lower potential for rapid increase in numbers than other lagomorphs. Pygmy rabbits do not appear to be able to produce extra litters in response to favorable environmental conditions. It is, perhaps, their dependence upon a long-lived, slow-recovering food source (sagebrush) which has produced this population inertia. There is, however, evidence of marked population fluctuations in some areas. Local population declines have been reported during studies in Idaho, Utah, Oregon, and Wyoming (Janson 1946; Bradfield 1975; Weiss and Verts 1984).

With the collapse of the pygmy rabbit population in the wild, WDFW evaluated a number of options. Leaving a few remaining rabbits in the wild would encumber the population with extreme risk. Wildlife biologists believed the best option was to maintain the unique Washington pygmy rabbit was to collect rabbits from the wild that represent the unique genetic makeup of Washington pygmy rabbits and begin a captive breeding program to raise and release Washington pygmy rabbits.

In May 2001, WDFW implemented a captive breeding program. The goal is to develop a captive population to ensure the maintenance of Washington's unique pygmy rabbits and to reintroduce sufficient numbers of captive-bred rabbits to re-establish populations in suitable habitat. Not all pygmy rabbits were collected from the wild; the decision was to take only enough rabbits to begin a captive breeding program.

Within the past 75 years, available evidence suggests a marked decline in the pygmy rabbit's Washington range, now believed to be restricted to Douglas County and Grant County north of Quincy. Verified localities (Figure 38) indicate a past distribution which included portions of five counties. Virtually nothing is known about the abundance of the pygmy rabbit at any of these localities or the extent of area they occupied.

Taylor and Shaw (1929) reported the pygmy rabbit as fairly common in the coulees and slopes of Adams County. Booth (1947) reported them very scarce, occurring only in small, limited areas in the arid parts of Adams and Grant Counties. Dalquest (1948) considered the species rare and of local occurrence, restricted to the central portion of the Columbia Plateau. Buechner (1953), in reviewing the dramatic agricultural changes occurring in eastern Washington, predicted that the pygmy rabbit would disappear entirely in Washington. Maughn and Poelker (1976) indicated that due to its specialized habitat requirements, the pygmy rabbit was suffering a decline in numbers from habitat destruction.

The five pygmy rabbit populations found during the late 1980s existed in pockets of suitable habitat in Douglas County. These populations were probably isolated from one another since there is little to no sagebrush landscape connecting them. Gahr (1993) suggested that although maximum movement distances found at Sagebrush Flat may not represent the absolute maximum possible of pygmy rabbits, movement of rabbits between the occupied sites was unlikely.

Three of the populations were extremely small (estimated at fewer than 30 active burrows), and one is estimated to comprise from 70 to 80 active burrows. The Sagebrush Flat population was the largest known population in Washington, with an estimated 588 active burrows. Since pygmy rabbits use multiple burrows and share some burrows, the number of rabbits is fewer than the number of active burrows. Gahr (1993) used two techniques to estimate rabbit numbers at Sagebrush Flat. Using data on shared and unshared burrows, Gahr estimated the Sagebrush Flat population to be 78 pygmy rabbits, with a possible range of 55 to 142. Using a second, independent technique based on radio telemetry data, Gahr estimated the population to be 107 pygmy rabbits.

The number of populations and numbers of pygmy rabbits have been declining since 1997. In 1995, five pygmy rabbit populations were known to exist in Douglas County and a sixth population was found in 1997. Between 1997 and 2000, five of the six populations disappeared; by March 2001, only one area, Sagebrush Flat, was known to still have rabbits. Small populations at several sites were extirpated for unknown reasons; other populations were extirpated by known wildfires. Numbers of active burrows on standardized plots at Sagebrush Flat have declined from 229 in 1995 to zero in 2001. Random searches did reveal some active burrows at Sagebrush Flat in March and April 2001. WDFW monitored known active burrows during December 2002 and found active burrows in one of the 3 general areas previously known. In this area, 6 of 7 burrows active during the 2001-2002 survey were still active, and 5 newly active or constructed burrows were located. Additional scattered unknown active burrow may occur through movement of rabbits throughout the year.

5.2.2.1.5 Structural Condition Associations

Northwest Habitat Institute structural condition data (2003) and other literature clearly indicate that pygmy rabbits are habitat specialists and are closely associated (C) and dependent upon mature and old growth sagebrush stands for breeding (B) activities. This species is also generally associated (A), during breeding season, with medium height, closed to open canopy sagebrush stands that have a seedling/young plant component (Table_28).

Table 28. Pygmy rabbit structural conditions and association relationships (NHI 2003).

Common Name	Focal Habitat	Structural Condition (SC)	SC Activity	SC Assoc.
Pygmy Rabbit	Shrubsteppe	Medium Shrub-Closed Shrub Overstory-Mature	B	C
		Medium Shrub-Closed Shrub Overstory-Old	B	C
		Medium Shrub-Closed Shrub Overstory-Seedling/Young	B	A
		Medium Shrub-Open Shrub Overstory-Mature	B	C
		Medium Shrub-Open Shrub Overstory-Old	B	C
		Medium Shrub-Open Shrub Overstory-Seedling/Young	B	A

5.2.2.2 Sage Thrasher

5.2.2.2.1 General Habitat Requirements

Sage thrashers are a shrubsteppe obligate species and are dependent upon areas of tall, dense sagebrush within large tracts of shrubsteppe habitat (Knock and Rotenberry 1995; Paige and Ritter 1998; Vander Haegen 2003). The presence of sage thrashers is positively associated with percent shrub cover and negatively associated with increased annual grass cover (Dobler *et al.* 1996). Occurrence of sage thrashers in sagebrush habitat has been correlated with increasing sagebrush, shrub cover, shrub patch size, and decreasing disturbance (Knick and Rotenberry 1995).

Recommended habitat conditions for sage thrashers include areas of shrubsteppe greater than 40 acres where average sagebrush cover is 5-20 percent and height is greater than 31 inches, sagebrush should be patchily distributed rather than dispersed, and mean herbaceous cover should be 5-20 percent with less than 10 percent cover of non-native annuals (Altman and Holmes 2000). Habitat attributes and parameters are summarized in Table_20.

5.2.2.2.2 Limiting Factors

Habitat loss and fragmentation, range management practices, livestock grazing, introduced vegetation, fire, and predation are the primary factors affecting sage thrashers populations. As with other shrubsteppe obligate species, removal of sagebrush and conversion to other land uses is detrimental (Castrale 1982). Large-scale reduction and fragmentation of sagebrush habitats is occurring in many areas due to land conversion to tilled agriculture, urban and suburban development, and road and powerline right- of-ways establishment. In Washington, the conversion of native shrubsteppe to agriculture has resulted in a 50 percent loss in historic breeding habitat. Concomitant with habitat loss has been fragmentation of remaining shrubsteppe. Research in Washington suggests that sage thrashers may be less sensitive to habitat fragmentation than other shrubsteppe obligates as birds were found to nest in shrubsteppe patches less than 24 acres (Vander Haegen *et al.* 2000). However, birds nesting in small habitat fragments may experience higher rates of nest predation than birds nesting in larger areas of contiguous habitat (Vander Haegen 2003).

Range management practices such as mowing, burning, and herbicide treatments have reduced the quantity and quality of sagebrush habitat (Braun *et al.* 1976; Cannings 1992; Reynolds *et al.* 1999). Range improvement programs remove sagebrush (particularly once grazed sagebrush becomes overly dense) by burning, herbicide application, and mechanical treatment, replacing sagebrush with annual grassland to promote forage for livestock. Burning can result in longer-lasting sagebrush control than chaining (Castrale 1982).

Livestock grazing in sagebrush habitats may not be incompatible with sustaining a sage thrasher population. Although sage thrashers are found on grazed rangeland, the effects of long-term grazing by livestock are not known. The response by sage thrashers to grazing is mixed as studies have reported both positive and negative population responses to moderate grazing of big sage/bluebunch wheatgrass communities (Saab *et al.* 1995). Some evidence suggests that sage thrasher density may be lower in grazed habitats as the average distance between neighboring nests was found to be significantly lower in ungrazed versus grazed shrubsteppe habitats in south-central Idaho. Altman and Holmes (2000) suggest maintaining greater than 50 percent of annual vegetative growth of perennial bunchgrasses through the following growing season.

Grazing can increase sagebrush density, positively affecting thrasher abundance. Dense stands of sagebrush, however, are considered degraded range for livestock and may be treated to reduce or remove sagebrush. Grazing may also encourage the invasion of non-native grasses, which escalates the fire cycle and converts shrublands to annual grasslands. West (1988, 1996) estimates less than 1 percent of shrubsteppe habitat remain untouched by livestock, 20 percent is lightly grazed, 30 percent moderately grazed with native understory remaining, and 30 percent heavily grazed with understory replaced by invasive annuals. The effects of grazing in sagebrush habitats are complex, and depend on intensity, season, duration and extent of alteration to native vegetation.

Introduced vegetation such as cheatgrass readily invades disturbed sites, and has come to dominate the grass-forb communities of more than half the sagebrush region in the West (Rich 1996). Cheatgrass can create a more continuous grass understory than native bunchgrasses. Dense cheatgrass cover can possibly affect foraging ability for ground foragers, and more readily carries fire than native bunchgrasses. Crested wheatgrass and other non-native annuals have also altered the grass-forb community in many areas of sagebrush shrubsteppe.

Fire, specifically wildfire, is a threat to sagebrush communities as cheatgrass has altered the natural fire regime on millions of acres in the western range, increasing the frequency, intensity, and size of range fires. Fire kills sagebrush and where non-native grasses dominate, the landscape can be converted to annual grassland as the fire cycle escalates (Paige and Ritter 1998).

Predation can be a major factor in breeding success of sagebrush birds. Sage thrashers are preyed upon by loggerhead shrikes (Reynolds 1979). Sage thrashers coexist with brown-headed cowbirds at various points throughout their range and have been observed to reject cowbird eggs by ejecting eggs from the nest. As a result, brood parasitism is not significant (Rich and Rothstein 1985).

5.2.2.2.3 Current Distribution

Sage thrashers are a migratory species in the State of Washington; birds are present only during the breeding season. Confirmed breeding evidence has been recorded in Douglas, Grant, Lincoln, Adams, Yakima, and Kittitas Counties. Core habitats also occur in Okanogan, Chelan, Whitman, Franklin, Walla Walla, Benton, Klickitat, and Asotin Counties (Smith *et al.* 1997), (Figure 39). Estimates of sage thrasher density in eastern Washington during 1988-89 was 0.5 birds/acre (Dobler *et al.* 1996).

5.2.2.2.4 Population Trend Status

The sage thrasher is considered a 'state candidate' species by WDFW. In Canada, sage thrashers are on the British Columbia Environment Red List (review for endangered and threatened status). They are considered a priority species by the Oregon-Washington Chapter of Partners in Flight and are on the Audubon Society Watch List for Washington State. Sage thrashers are listed as a species of high management concern by the Interior Columbia River Basin Ecosystem Management Project (Saab and Rich 1997).

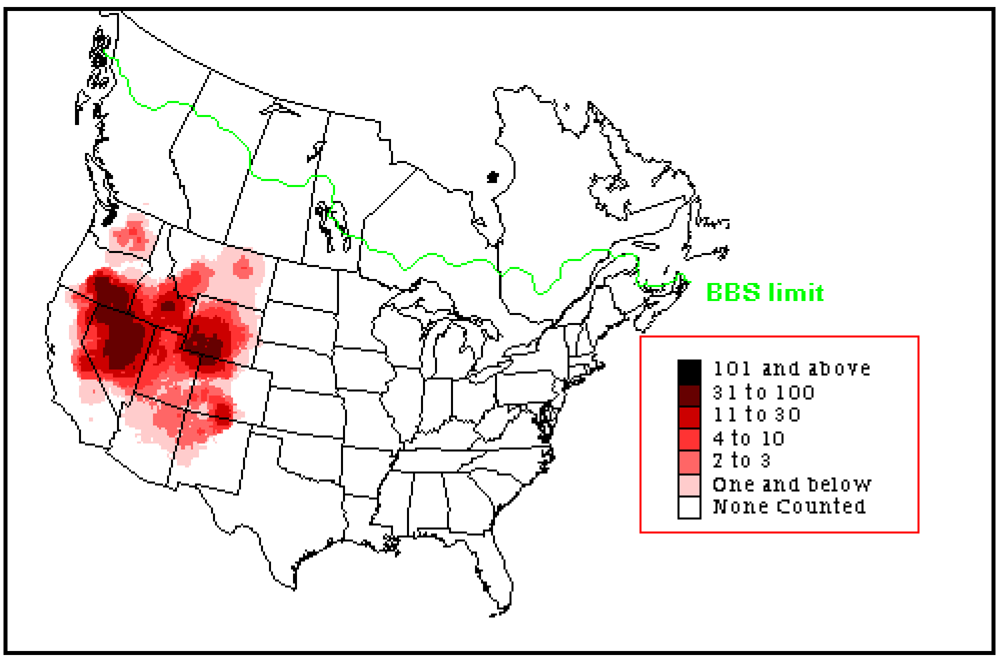


Figure 39. Sage thrasher breeding season abundance from BBS data (Sauer *et al.* 2003).

North American BBS data (1966-1996) show a non-significant sage thrasher survey-wide increase (n = 268 survey routes) (Figure 40). There have been increasing trends in all areas except Idaho (-1.0 average decline per year, non-significant, n = 29) and the Intermountain Grassland physiographic region (-4.0 average decline per year, significant, n = 26) for 1966-1996. BBS data indicate a significant decline in Intermountain Grassland for 1980-1996 (-8.8 average per year decrease, n = 22). Significant long-term increases in sage thrashers are evident in Colorado (4.4 percent average per year, n = 24) and Oregon (2.6 percent average per year, n = 28), 1966-1996. The sample sizes are small or trends are not significant in other states. The BBS data (1966-1996) for the Columbia Plateau are illustrated in Figure 41.

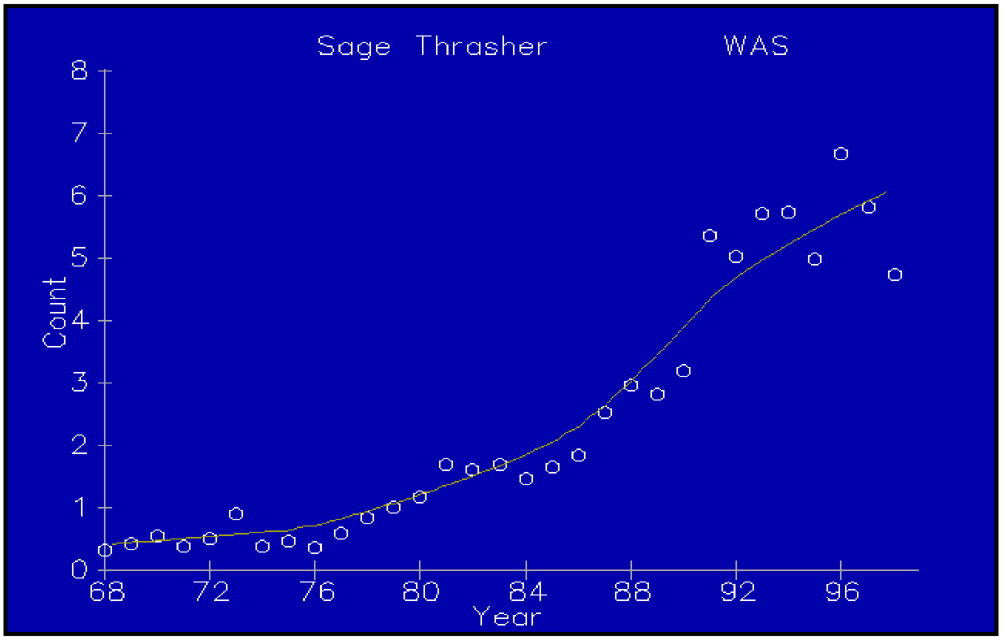


Figure 40. Sage thrasher trend results (from BBS data), Washington (Sauer *et al.* 2003).

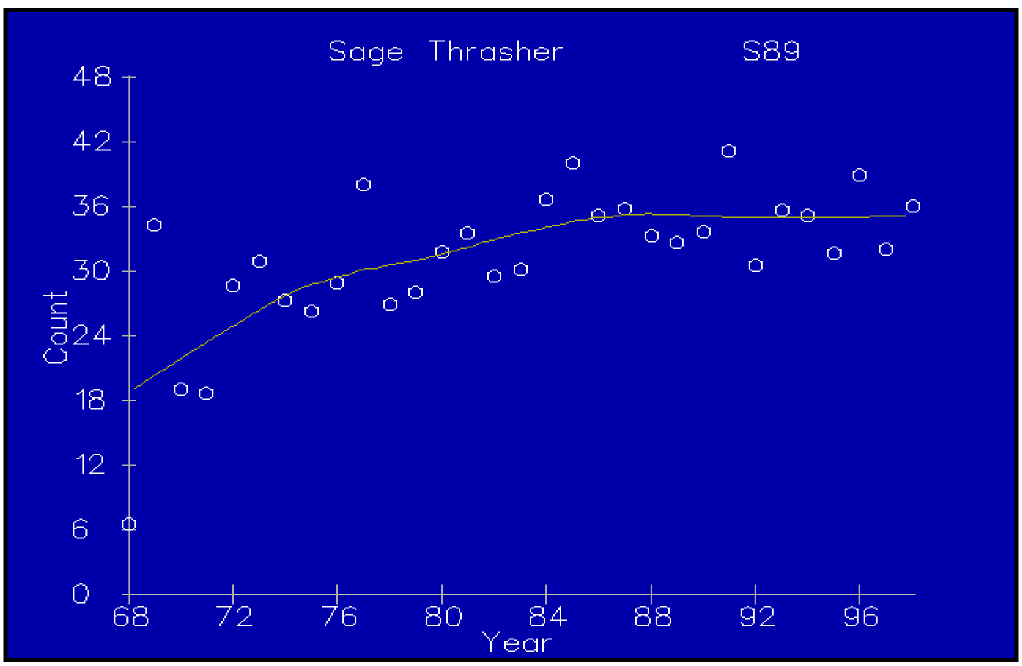


Figure 41. Sage thrasher trend results for the Columbia Plateau (from BBS data) (Sauer *et al.* 2003).

5.2.2.2.5 Structure Condition Associations

The sage thrasher is closely associated (C) and dependent upon eight out of the twelve structural conditions described in Table 29 during breeding (B). Northwest Habitat Institute data (2003) clearly demonstrate the thrasher's dependence on low to medium heght, mature/old shrubs and a general association (A) with sagebrush stands composed of seedlings and /or young plants.

Table 29. Sage thrasher structural conditions and association relationships (NHI 2003).

Common Name	Focal Habitat	Structural Condition (SC)	SC Activity	SC Assoc.
Sage Thrasher	Shrubsteppe	Low Shrub-Closed Shrub Overstory-Mature	B	C
		Low Shrub-Closed Shrub Overstory-Old	B	C
		Low Shrub-Closed Shrub Overstory-Seedling/Young	B	A
		Low Shrub-Open Shrub Overstory-Mature	B	C
		Low Shrub-Open Shrub Overstory-Old	B	C
		Low Shrub-Open Shrub Overstory-Seedling/Young	B	A
		Medium Shrub-Closed Shrub Overstory-Mature	B	C
		Medium Shrub-Closed Shrub Overstory-Old	B	C
		Medium Shrub-Closed Shrub Overstory-Seedling/Young	B	A
		Medium Shrub-Open Shrub Overstory-Mature	B	C
		Medium Shrub-Open Shrub Overstory-Old	B	C
		Medium Shrub-Open Shrub Overstory-Seedling/Young	B	A

5.2.2.3 Brewer's Sparrow

5.2.2.3.1 General Habitat Requirements

Brewer's sparrow is a sagebrush obligate species that prefers abundant sagebrush cover (Altman and Holmes 2000). Vander Haegen *et al.* (2000) determined that Brewer's sparrows were more abundant in areas of loamy soil than areas of sandy or shallow soil, and on rangelands in good or fair condition than those in poor condition. Knopf *et al.* (1990) reported that Brewer's sparrows are strongly associated throughout their range with high sagebrush vigor.

Brewer's sparrow is positively correlated with shrub cover, above-average vegetation height, bare ground, and horizontal habitat heterogeneity (patchiness). Brewer's sparrows prefer areas dominated by shrubs rather than grass. They prefer sites with high shrub cover and large patch size (Knick and Rotenberry 1995). In southwestern Idaho, the probability of habitat occupancy by Brewer's sparrows increased with increasing percent shrub cover and shrub patch size; shrub cover was the most important determinant of occupancy (Knick and Rotenberry 1995). Brewer's sparrow abundance in Washington increased significantly on sites where sagebrush cover approached the historic 10 percent level (Dobler *et al.* 1996).

In contrast, Brewer's sparrows are negatively correlated with grass cover, spiny hopsage, and budsage (Larson and Bock 1984; Rotenberry and Wiens 1980; Wiens 1985; Wiens and Rotenberry 1981). In eastern Washington, abundance of Brewer's sparrows was negatively associated with increasing annual grass cover; higher densities occurred in areas where annual grass cover (i.e., cheatgrass) was less than 20 percent (Dobler 1994). Removal of sagebrush cover to less than 10 percent has a negative impact on populations (Altman and Holmes 2000).

Recommended habitat objectives include the following: patches of sagebrush cover 10-30 percent, mean sagebrush height greater than 24 inches, high foliage density of sagebrush, average cover of native herbaceous plants greater than 10 percent, bare ground greater than 20 percent (Altman and Holmes 2000) (Table_20).

5.2.2.2.2 Limiting Factors

Habitat loss and fragmentation, livestock grazing, introduced vegetation, fire, and predators are the primary factors affecting Brewer's sparrows. Direct habitat loss due to conversion of shrublands to agriculture coupled with sagebrush removal programs and development have significantly reduced available habitat and contributed towards habitat fragmentation of remaining shrublands. Within the entire interior Columbia Basin, over 48 percent of watersheds show moderately or strongly declining trends in source habitats for this species (Wisdom *et al.* in press) (from Altman and Holmes 2000).

Livestock grazing can trigger a cascade of ecological changes, the most dramatic of which is the invasion of non-native grasses escalating the fire cycle and converting sagebrush shrublands to annual grasslands. Historical heavy livestock grazing altered much of the sagebrush range, changing plant composition and densities. West (1988, 1996) estimates less than 1 percent of shrubsteppe habitats remain untouched by livestock, 20 percent is lightly grazed, 30 percent moderately grazed with native understory remaining, and 30 percent heavily grazed with understory replaced by invasive annuals. The effects of grazing in sagebrush habitats are complex, depending on intensity, season, duration and extent of alteration to native vegetation. Rangeland in poor condition is less likely to support Brewer's sparrows than rangeland in good and fair condition.

Introduced vegetation such as cheatgrass readily invades disturbed sites, and has come to dominate the grass-forb community of more than half the sagebrush region in the West, replacing native bunchgrasses (Rich 1996). Cheatgrass has altered the natural fire regime in the western range, increasing the frequency, intensity, and size of range fires.

Fire kills sagebrush and where non-native grasses dominate, the landscape can be converted to grasslands dominated by introduced vegetation as the fire cycle escalates, removing preferred habitat (Paige and Ritter 1998). Crested wheatgrass and other non-native annuals have also fundamentally altered the grass-forb community in many areas of sagebrush shrubsteppe, altering shrubland habitats.

Predators (of eggs and nestlings) include gopher snake (*Pituophis melanoleucus*), Townsend's ground squirrel (*Spermohpilus townsendii*); other suspected predators include loggerhead shrike (*Lanius ludovicianus*), common raven (*Corvus corax*), black-billed magpie (*Pica pica*), long-tailed weasel (*Mustela frenata*), least chipmunk (*Eutamias minimus*), western rattlesnake (*Crotalus viridis*), and other snake species. Nest predation is the most significant cause of nest failure.

The American kestrel (*Falco sparverius*), prairie falcon (*Falco mexicanus*), coachwhip (*Masticophis flagellum*) have been observed preying on adult sparrows (Rotenberry *et al.* 1999). Wiens and Rotenberry (1981) observed significant negative correlation between loggerhead shrike and Brewer's sparrow density.

5.2.2.3.3 Current Distribution

Undoubtedly, the Brewer's sparrow was widely distributed throughout the lowlands of southeast Washington when it consisted of vast expanses of shrubsteppe habitat. Large scale conversion of shrubsteppe habitat to agriculture has resulted in populations becoming localized in the last vestiges of available habitat (Smith *et al.* 1997). Washington is near the northwestern limit of breeding range for Brewer's sparrows (Figure 42). Birds occur primarily in Okanogan, Douglas, Grant, Lincoln, Kittitas, and Adams Counties (Smith *et al.* 1997).

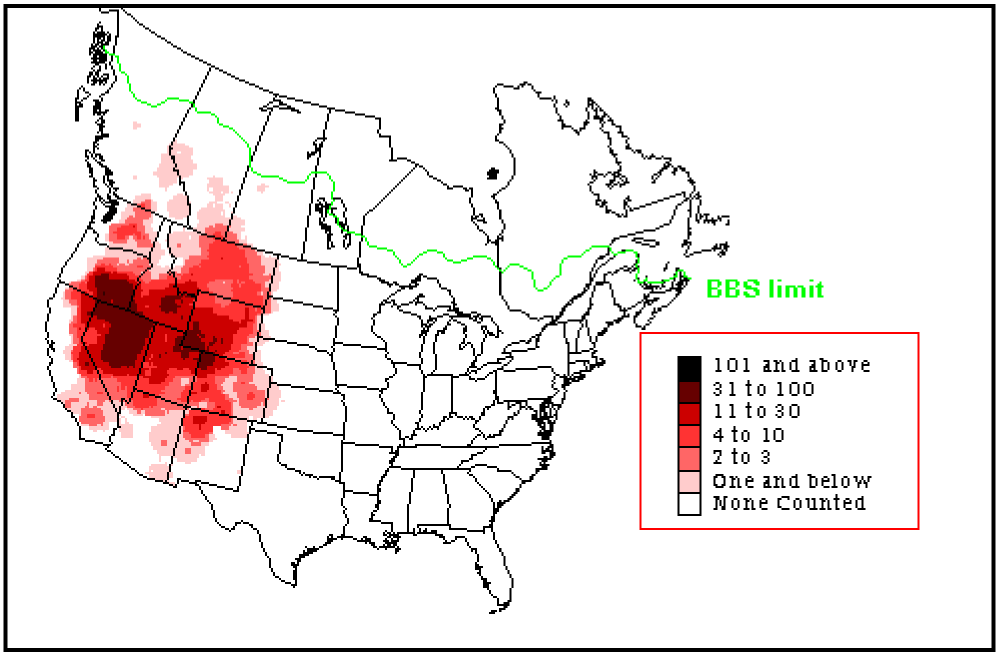


Figure 42. Brewer's sparrow breeding range and abundance (Sauer *et al.* 2003).

5.2.2.3.4 Population Trend Status

Brewer's sparrow is often the most abundant bird species in appropriate sagebrush habitats. However, widespread long-term declines and threats to shrubsteppe breeding habitats have placed it on the Partners in Flight Watch List of conservation priority species (Muehter 1998). Saab and Rich (1997) categorize it as a species of high management concern in the Columbia River Basin.

Historically, the Brewer's sparrow may have been the most abundant bird in the Intermountain West (Paige and Ritter 1998) but BBS trend estimates indicate a range-wide population decline during the last twenty-five years (Peterjohn *et al.* 1995). Brewer's sparrows are not currently listed as threatened or endangered on any state or federal list. Oregon-Washington Partners in Flight consider the Brewer's sparrow a focal species for conservation strategies for the Columbia Plateau (Altman and Holmes 2000).

Breeding Bird Survey data for 1966 -1996 show significant and strong survey-wide declines averaging -3.7 percent per year (n = 397 survey routes) (Figure 43). The BBS data (1966-1996) for the Columbia Plateau are illustrated in (Figure 44). Significant declines in Brewer's sparrow are evident in California, Colorado, Montana, Nevada, Oregon, and Wyoming, with the steepest significant decline evident in Idaho (-6.0 percent average per year; n = 39). These negative trends appear to be consistent throughout the 30-year survey period. Only Utah shows an apparently stable population. Sample sizes for Washington are too small for an accurate estimate.

Note that although positively correlated with presence of sage thrashers (*Oreoscoptes montanus*), probably due to similarities in habitat relations (Wiens and Rotenberry 1981), thrashers are not exhibiting the same steep and widespread declines evident in BBS data (Sauer *et al.* 1997).

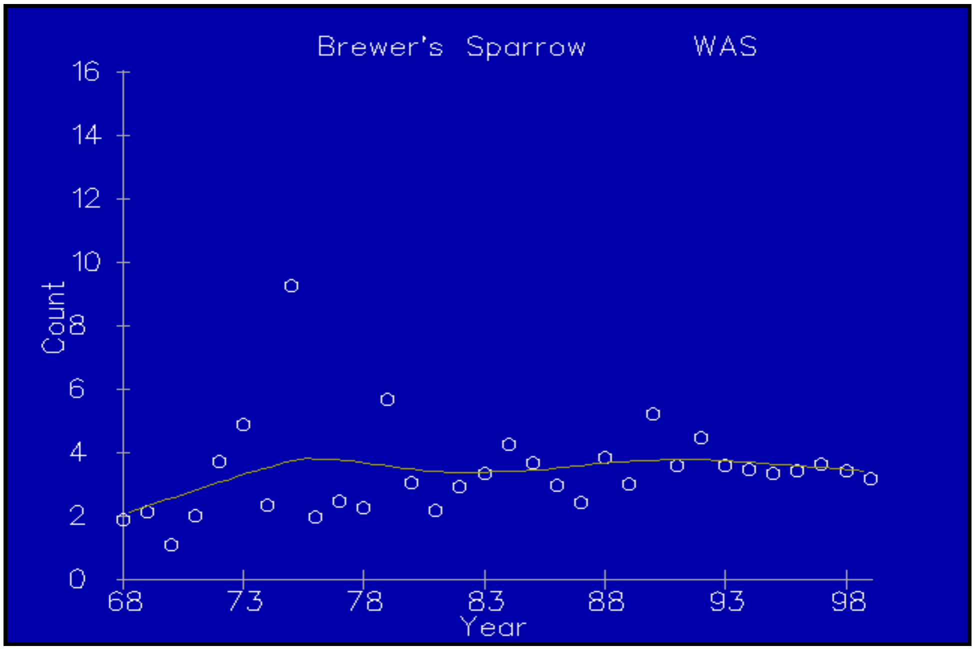


Figure 43. Brewer's sparrow trend results from BBS data, Washington (Sauer *et al.* 2003).

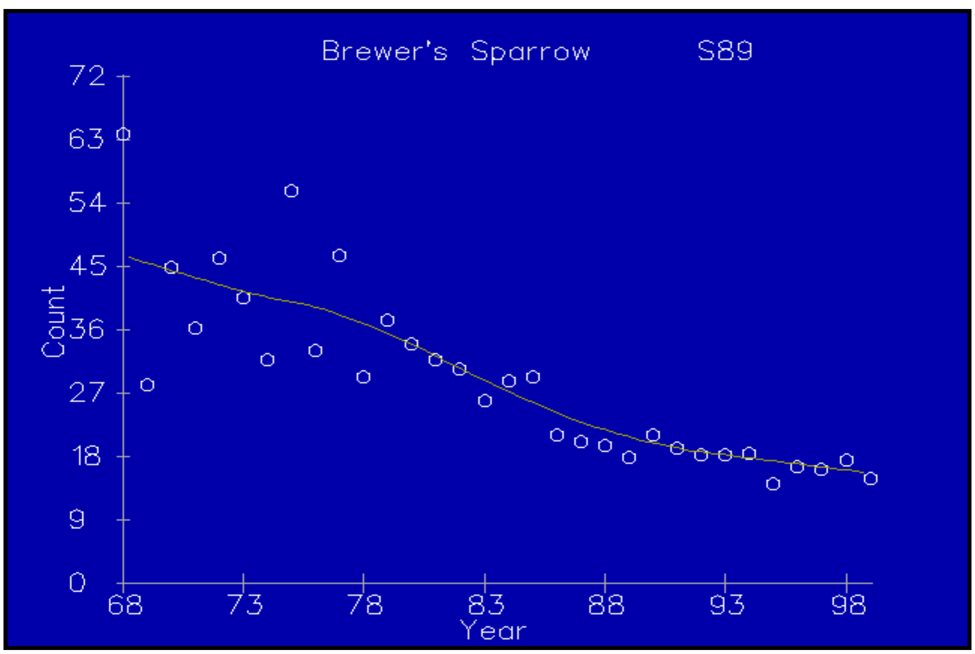


Figure 44. Brewer's sparrow trend results from BBS data, Columbia Plateau (Sauer *et al.* 2003).

5.2.2.3.5 Structural Condition Associations

Brewer's sparrows are closely associated (C) with and dependent upon four of the twelve structural conditions identified in NHI data (2003) during breeding (B) periods. Similar to sage thrasher, this species appears to be dependent upon medium height, mature/old age shrub structure regardless of canopy closure. Brewer's sparrows are also generally associated (A), but less dependent on a wide range of shrub structural and age conditions (Table 30).

Table 30. Brewer's sparrow structural conditions and association relationships (NHI 2003).

Common Name	Focal Habitat	Structural Condition (SC)	SC Activity	SC Assoc.
Brewer's Sparrow	Shrubsteppe	Low Shrub-Closed Shrub Overstory-Mature	B	A
		Low Shrub-Closed Shrub Overstory-Old	B	A
		Low Shrub-Closed Shrub Overstory-Seedling/Young	B	A
		Low Shrub-Open Shrub Overstory-Mature	B	A
		Low Shrub-Open Shrub Overstory-Old	B	A
		Low Shrub-Open Shrub Overstory-Seedling/Young	B	A
		Medium Shrub-Closed Shrub Overstory-Mature	B	C
		Medium Shrub-Closed Shrub Overstory-Old	B	C
		Medium Shrub-Closed Shrub Overstory-Seedling/Young	B	A
		Medium Shrub-Open Shrub Overstory-Mature	B	C
		Medium Shrub-Open Shrub Overstory-Old	B	C
		Medium Shrub-Open Shrub Overstory-Seedling/Young	B	A

5.2.2.4 Mule Deer

5.2.2.4.1 General Habitat Requirements

Mule deer occupy a variety of habitat types across eastern Washington. Consequently, habitat requirements vary with vegetative and landscape components contained within each herd range. Forested habitats provide mule deer with forage as well as snow intercept, thermal, and escape cover. Mule deer occupying mountain-foothill habitats live within a broad range of elevations, climates, and topography which includes a wide range of vegetation; many of the deer using these habitats are migratory. Mule deer are found in the deep canyon complexes along the major rivers and in the channeled scablands of eastern Washington; these areas are dominated by native bunch grasses or shrubsteppe vegetation. Mule deer also occupy agricultural areas which once where shrubsteppe.

5.2.2.4.2 Limiting Factors

Mule deer and their habitats are being impacted in a negative way by dam construction, urban and suburban developement, road and highway construction, over-grazing by livestock, inappropriate logging operations, competition by other ungulates, drought, fire, over-harvest by hunters, predation, disease and parasites.

Weather conditions can play a major role in the productivity and abundance of mule deer. Drought conditions can have a severe impact on mule deer because forage does not replenish itself on summer or winter range, and nutritional quality is low. Drought conditions during the summer and fall can result in low fecundity in does, and poor physical condition going into the winter months. Severe winter weather can cause result in high mortality depending on severity. Severe weather can result in mortality of all age classes, but the young, old, and mature bucks usually sustain the highest mortality. If mule deer are subjected to drought conditions in the summer and fall, followed by a severe winter, the result can be high mortality rates and low productivity the following year.

Habitat conditions in the Ecoprovince have deteriorated in some areas and improved dramatically in others. The conversion of shrubsteppe and grassland habitat to agricultural croplands has resulted in the loss of thousands of acres of mule deer habitat. However, this has been mitigated to some degree by the implementation of the CRP. Noxious weeds have invaded many areas resulting in a tremendous loss of good habitat for mule deer.

Fire suppression has resulted in a decline of habitat conditions in the mountains and foothills of the Cascade Mountains. Browse species need to be regenerated by fire in order to maintain availability and nutritional value to big game. Lack of fire has allowed many browse species to grow out of reach for mule deer (Leege 1968; 1969; Young and Robinette 1939).

The reservoirs created by dams on the Columbia River inundated prime riparian habitat that supported many species of wildlife, including mule deer. This riparian zone provided high quality habitat (forage/cover), especially during the winter months. The loss of this important habitat and the impact it has had on the mule deer population along the breaks of the Columbia River may never be fully understood.

5.2.2.4.3 Current Distribution

Mule deer are distributed throughout the Ecoprovince. Mule deer are harvested annually in every game management unit within the Ecoprovince. Populations fluctuate annually in response to a variety of factors, including climate, habitat change, and harvest. Crucial winter ranges are the limiting habitat west of the Columbia River where populations are predominantly migratory, and are primarily shrub-steppe habitats. These habitats are in decline in both quality and quantity; the first primarily due to invasive exotic weeds influenced by effects of livestock grazing and fire suppression, and the latter due to conversion for agriculture and development, and inundation by hydroelectric projects (B. Patterson, WDFW, personal communication 2003).

5.2.2.4.4 Population Trend Status

Information for this section is unavailable.

5.2.2.4.5 Structural Condition Associations

Mule deer are generally associated (A) with most, if not all, structural conditions found in shrubsteppe habitats. This generalist species utilizes both grass/forbs and shrub habitats during breeding (B) (Table_31).

Table 31 Mule deer structural conditions and association relationships (NHI 2003).

Common Name	Focal Habitat	Structural Condition (SC)	SC Activity	SC Assoc.
Mule Deer	Shrubsteppe	Grass/Forb-Closed	B	A
		Grass/Forb-Open	B	A
		Low Shrub-Closed Shrub Overstory-Mature	B	A
		Low Shrub-Closed Shrub Overstory-Old	B	A
		Low Shrub-Closed Shrub Overstory-Seedling/Young	B	A
		Low Shrub-Open Shrub Overstory-Mature	B	A
		Low Shrub-Open Shrub Overstory-Old	B	A
		Low Shrub-Open Shrub Overstory-Seedling/Young	B	A
		Medium Shrub-Closed Shrub Overstory-Mature	B	A
		Medium Shrub-Closed Shrub Overstory-Old	B	A
		Medium Shrub-Closed Shrub Overstory-Seedling/Young	B	A
		Medium Shrub-Open Shrub Overstory-Mature	B	A
		Medium Shrub-Open Shrub Overstory-Old	B	A
		Medium Shrub-Open Shrub Overstory-Seedling/Young	B	A
		Tall Shrub-Closed Shrub Overstory-Mature	B	A
		Tall Shrub-Closed Shrub Overstory-Old	B	A
		Tall Shrub-Closed Shrub Overstory-Seedling/Young	B	A
		Tall Shrub-Open Shrub Overstory-Mature	B	A
		Tall Shrub-Open Shrub Overstory-Old	B	A
		Tall Shrub-Open Shrub Overstory-Seedling/Young	B	A

5.2.2.5 Grasshopper Sparrow

5.2.2.5.1 General Habitat Requirements

Grasshopper sparrows prefer grasslands of intermediate height and are often associated with clumped vegetation interspersed with patches of bare ground (Bent 1968; Blankespoor 1980; Vickery 1996). Other habitat requirements include moderately deep litter and sparse coverage of woody vegetation (Smith 1963; Bent 1968; Wiens 1969, 1970; Kahl *et al.* 1985; Arnold and Higgins 1986). In east central Oregon, grasshopper sparrows occupied relatively undisturbed native bunchgrass communities dominated by *Agropyron spicatum* and/or *Festuca idahoensis*, particularly north-facing slopes on the Boardman Bombing Range, Columbia Basin (Holmes and Geupel 1998). Vander Haegen *et al.* (2000) found no significant relationship with vegetation type, but did find one with the percent cover of perennial grasses.

In portions of Colorado, Kansas, Montana, Nebraska, Oklahoma, South Dakota, Texas, Wisconsin, and Wyoming, abundance of grasshopper sparrows was positively correlated with percent grass cover, percent litter cover, total number of vertical vegetation hits, effective vegetation height, and litter depth; abundance was negatively correlated with percent bare ground, amount of variation in litter depth, amount of variation in forb or shrub height, and the amount of variation in forb and shrub heights (Rotenberry and Wiens 1980).

Grasshopper sparrows occasionally inhabit cropland, such as corn and oats, but at a fraction of the densities found in grassland habitats (Smith 1963; Smith 1968; Ducey and Miller 1980; Basore *et al.* 1986; Faanes and Lingle 1995; Best *et al.* 1997).

5.2.2.5.2 Limiting Factors

The principal post-settlement conservation issues affecting grasshopper sparrow populations include habitat loss and fragmentation resulting from conversion to agriculture, habitat degradation and alteration from livestock grazing, invasion of exotic vegetation, and alteration of historic fire regimes. Fragmentation resulting from agricultural development or large fires fueled by cheatgrass can have several negative effects on landbirds. These include insufficient patch size for area-dependent species, and increases in edges and adjacent hostile landscapes, which can result in reduced productivity through increased nest predation, nest parasitism, and reduced pairing success of males. Additionally, habitat fragmentation has likely altered the dynamics of dispersal and immigration necessary for maintenance of some populations at a regional scale. In a recent analysis of neotropical migratory birds within the Interior Columbia Basin, most species identified as being of "high management concern" were shrubsteppe species (Saab and Rich 1997), which includes the grasshopper sparrow.

Making this loss of habitat even more severe is that the grasshopper sparrow like other grassland species shows a sensitivity to grassland patch size (Herkert 1994; Samson 1980; Vickery 1994; Bock *et al.* 1999). Herkert (1991) found that grasshopper sparrows in Illinois were not present in grassland patches smaller than 74 acres despite the fact that their published average territory size is only about 0.75 acres. Minimum requirement size in the Northwest is unknown.

Grazing can trigger a cascade of ecological changes, the most dramatic of which is the invasion of non-native grasses escalating the fire cycle and converting sagebrush shrublands to annual grasslands. Historical heavy livestock grazing altered much of the sagebrush range, changing plant composition and densities. West (1988, 1996) estimates less than 1 percent of shrubsteppe habitats remain untouched by livestock, 20 percent is lightly grazed, 30 percent moderately grazed with native understory remaining, and 30 percent heavily grazed with understory replaced by invasive annuals. The effects of grazing in sagebrush habitats are complex, depending on intensity, season, duration and extent of alteration to native vegetation. Extensive and intensive grazing in North America has had negative impacts on this species (Bock and Webb 1984).

The grasshopper sparrow has been found to respond positively to light or moderate grazing in tallgrass prairie (Risser *et al.* 1981). However, it responds negatively to grazing in shortgrass, semidesert, and mixed grass areas (Bock *et al.* 1984).

The degree of degradation of terrestrial ecosystems is often diagnosed by the presence and extent of alien plant species (Andreas and Lichvar 1995); frequently their presence is related to soil disturbance and overgrazing. Increasingly, however, aggressive aliens are becoming established even in ostensibly undisturbed bunchgrass vegetation, wherever their seed can reach.

Cheatgrass has altered the natural fire regime in the western range, increasing the frequency, intensity, and size of range fires. Fire kills sagebrush and where non-native grasses dominate, the landscape can be converted to annual grassland as the fire cycle escalates, removing preferred habitat (Paige and Ritter 1998).

Studies on the effects of burns on grassland birds in North American grasslands have shown similar results as grazing studies: namely, bird response is highly variable. Confounding factors include timing of burn, intensity of burn, previous land history, type of pre-burn vegetation, presence of fire-tolerant exotic vegetation (that may take advantage of the post-burn circumstances and spread even more quickly) and grassland bird species present in the area. It should be emphasized that much of the variation in response to grassland fires lies at the level of species, but that even at this level results are often difficult to generalize. For instance, mourning doves (*Zenaidura macroura*) have been found to experience positive (Bock and Bock 1992; Johnson 1997) and negative (Zimmerman 1997) effects by fire in different studies. Similarly, grasshopper sparrows have been found to experience positive (Johnson 1997), negative (Bock and Bock 1992; Zimmerman 1997; Vickery *et al.* 1999), and no significant (Rohrbaugh 1999) effects of fire. Species associated with short and/or open grassy areas will most likely experience short-term benefits from fires. Species that prefer taller and denser grasslands most likely will demonstrate a negative response to fire (CPIF 2000).

Mowing and haying affects grassland birds directly and indirectly. It may reduce height and cover of herbaceous vegetation, destroy active nests, kill nestlings and fledglings, cause nest abandonment, and increase nest exposure and predation levels (Bollinger *et al.* 1990). Studies on grasshopper sparrow have indicated higher densities and nest success in areas not mowed until after July 15 (Shugaart and James 1973; Warner 1992). Grasshopper sparrows are vulnerable to early mowing of fields, while light grazing, infrequent and post-season burning or mowing can be beneficial (Vickery 1996).

Grasshopper sparrows may be multiply-parasitized (Elliott 1976, 1978; Davis and Sealy 2000). In Kansas, cowbird parasitism cost grasshopper sparrows about 2 young/parasitized nest, and there was a low likelihood of nest abandonment occurring due to cowbird parasitism (Elliott 1976, 1978).

5.2.2.5.3 Current Distribution

Grasshopper sparrows are found from North to South America, Ecuador, and in the West Indies (Vickery 1996; AOU 1957). They are common breeders throughout much of the continental United States, ranging from southern Canada south to Florida, Texas, and California. Additional populations are locally distributed from Mexico to Colombia and in the West Indies (Delany *et al.* 1985; Delany 1996; Vickery 1996).

The subspecies breeding in eastern Washington is *Ammodramus savannarum perpallidus* (Coues) which breeds from northwest California, where it is uncommon, into eastern Washington, northeast and southwest Oregon, where it is rare and local, into southeast British Columbia, where it is considered endangered, east into Nevada, Utah, Colorado, Oklahoma, Texas, and possibly to Illinois and Indiana (Vickery 1996).

sparrows have a spotty distribution at best across eastern Washington. Over the years they have been found in various locales, including CRP. They appear to utilize CRP on a consistent basis in southeast Washington (M. Denny, WDFW, personal communication, 2003) (Figure_45).

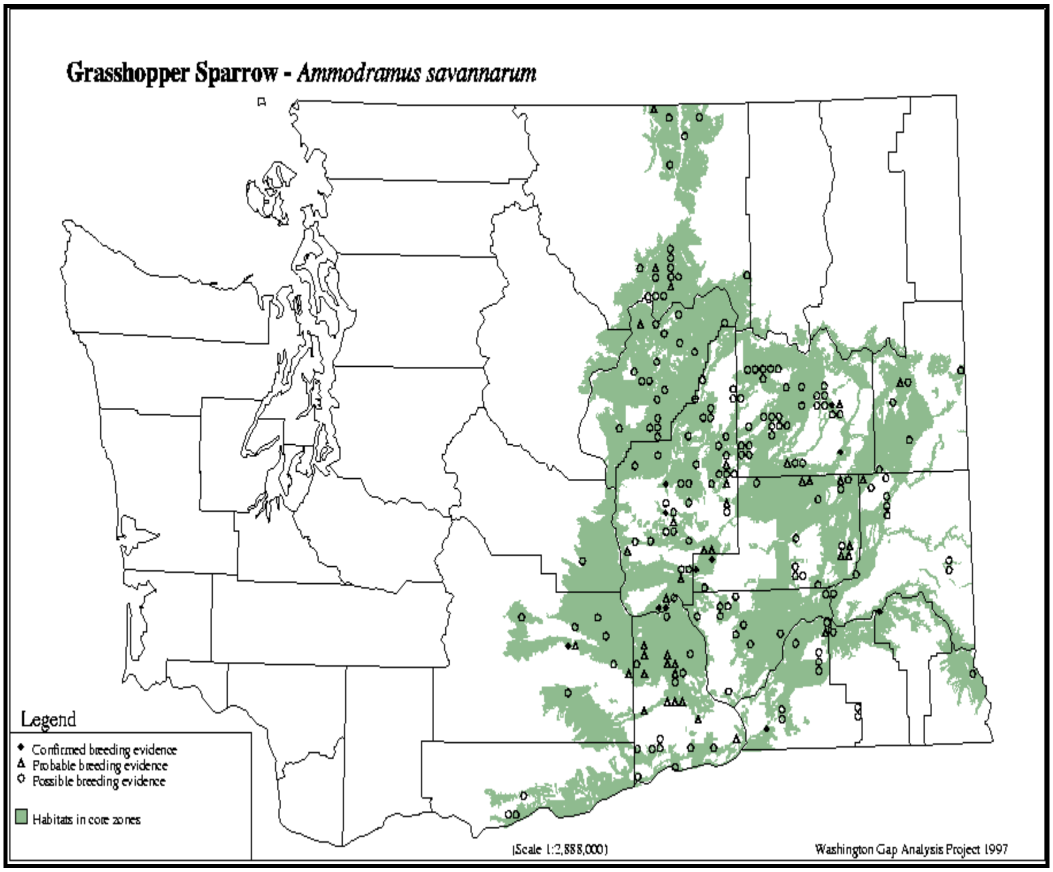


Figure 45. Grasshopper sparrow current distribution, Washington (Smith *et al.* 1997).

5.2.2.5.4 Population Trend Status

Throughout the United States, grasshopper sparrows have experienced population declines throughout most of their breeding range (Brauning 1992; Brewer *et al.* 1991; Garrett and Dunn 1981). In 1996, Vickery (1996) reported that grasshopper sparrow populations have declined by 69 percent across the U.S. since the late 1960s.

Approximately 15 million acres of shrubsteppe have been converted to wheat fields, row crops, and orchards in the interior Columbia Basin (Quigley and Arbelbide 1997). In Washington, over 50 percent of historic shrubsteppe has been converted to agriculture (Dobler *et al.* 1996).

Accordingly, BBS data show long term declines from 1980 through 2002 of -3.0, -1.6 and -10.7 for Washington, Oregon and Idaho, respectively (Table_32). The entire Intermountain Grassland area shows large decrease of -12.4 over this same time period.

Washington, Oregon and the entire Intermountain Grassland area show an increasing negative trend when looking at the more recent time period, 1996-2002, indicating the populations have increase even more over this time period (Sauer *et al.* 2003).

Table 32. Grasshpper sparrow population trends from BBS data, 1980-2002 (Sauer *et al.* 2003).

State/Region	1996-2002	1980-2002
Washington	-4.9	-3.0
Idaho	-7.4	-10.7
Oregon	-4.4	-1.6
Intermountain Grassland	-13.0	-12.4

5.2.2.5.5 Structural Condition Associations

The grasshopper sparrow is closely associated (C) with and dependent upon grass/forb structural conditions and generally associated (A) with open canopy shrublands (Table 33). This species prefers steppe (grassland) habitats and is an excellent indicator species to document shrub encroachment (grasshopper sparrow abundance is negatively correlated with dense shrub cover) and steppe habitat quality.

Table 33 Grasshopper sparrow structural conditions and association relationships (NHI 2003).

Common Name	Focal Habitat	Structural Condition (SC)	SC Activity	SC Assoc.
Grasshopper Sparrow	Shrubsteppe	Grass/Forb-Closed	B	C
		Grass/Forb-Open	B	C
		Low Shrub-Open Shrub Overstory-Mature	B	A
		Low Shrub-Open Shrub Overstory-Old	B	A
		Low Shrub-Open Shrub Overstory-Seedling/Young	B	A
		Medium Shrub-Open Shrub Overstory-Mature	B	A
		Medium Shrub-Open Shrub Overstory-Old	B	A
		Medium Shrub-Open Shrub Overstory-Seedling/Young	B	A

5.2.2.6 Sharp-tailed Grouse

5.2.2.6.1 General Habitat Requirements

The Columbian sharp-tailed grouse is one of six subspecies of sharp-tailed grouse and the only one found in Washington. Native habitats important for CSTG include grass-dominated nesting habitat and deciduous shrub-dominated wintering habitat, both of which are critical for sharp-tailed grouse (Giesen and Connelly 1993; Connelly *et al.* 1998).

Residual grasses and forbs are necessary for concealment and protection of nests and broods during spring and summer (Hart *et al.* 1952; Parker 1970; Oedekoven 1985; Marks and Marks 1988; Meints 1991; Giesen and Connelly 1993). Preferred nest sites are on the ground in relatively dense cover provided by clumps of shrubs, grasses, and/or forbs (Hillman and Jackson 1973). Fields enrolled in agricultural set-aside programs are often preferred. Giesen (1987) reported density of shrubs less than 3 feet tall were 5 times higher at nest sites than at random sites or sites 33 feet from the nest. Meints (1991) found that mean grass height at successful nests averaged less than 1 foot, while 7 inches was the average at unsuccessful nests. Hoffman (2001) recommended that the minimum height for good quality nesting and brood-rearing habitat is 8 inches, with 1 foot being preferred. Bunchgrasses, especially those with a high percentage of leaves to stems like bluebunch wheatgrass, is preferred by nesting sharp-tailed grouse over sod-forming grasses such as smooth brome.

Columbian sharp-tailed grouse are able to tolerate considerable variation in the proportion of grasses and shrubs that comprise suitable nesting habitat, but the most important factor is that a certain height and density of vegetation is required. Canopy coverage and visual obstruction are greater at nest sites than at independent sites (Kobriger 1980; Marks and Marks 1987; Meints 1991).

After hatching, hens with broods move to areas where succulent vegetation and insects can be found (Sisson 1970; Gregg 1987; Marks and Marks 1987; Klott and Lindzey 1990). In late summer, riparian areas and mountain shrub communities are preferred (Giesen 1987).

Food items in the spring and summer include wild sunflower (*Helianthus* spp.), chokecherry, sagebrush, serviceberry, salsify (*Tragopogon* spp.), dandelion (*Taraxacum* spp.), bluegrass, and brome (Hart *et al.* 1952; Jones 1966; Parker 1970). Although juveniles and adults consume insects, chicks eat the greatest quantity during the first few weeks of life (Parker 1970; Johnsgard 1973). In winter, sharptails commonly forage on persistent fruits and buds of chokecherry, serviceberry, hawthorn, snowberry, aspen, birch, willow, and wild rose (Giesen and Connelly 1993; Schneider 1994).

5.2.2.6.2 Limiting Factors

The primary factors affecting the continued existence of sharp-tailed grouse in Washington relate to habitat loss and alteration and the precarious nature of small, geographically isolated subpopulations. Three of the major factors that contributed to the decline of sharp-tailed grouse and their habitat in Washington are still threats today: conversion to agriculture, conversion to pastureland for livestock, and overgrazing. The removal of shrubs as part of agricultural practices reduces the quantity and quality of winter habitat, and the degradation of shrub and meadow steppe habitat as a result of livestock management reduces the quality of breeding habitat. The remaining subpopulations are small and isolated from one another, which increases the risk of extirpation.

Population isolation is potentially a major factor influencing the continued existence of sharptailed grouse in Washington. As grouse populations naturally fluctuate due to environmental conditions, the lower the population level, the greater the risk of extirpation. The isolation of populations may have important ramifications for their genetic quality and recruitment (Lacy 1987). It may require human transport of individuals to counteract loss of fitness due to genetic drift.

It is not clear if the Washington populations are declining due to their isolation or because of a combination of other factors. Initial evidence (M. Schroeder, WDFW, personal communication, 2003) indicates that most movements of radio-marked birds are insufficient to allow interchange of individuals among populations in north-central Washington. Although current estimates of the total population range up to 1,000 individuals, it is divided among 8 small isolated subpopulations. Four of these populations are estimated to contain fewer than 25 birds. These populations are under immediate threat of extirpation (Reed *et al.* 1986). Near-term extirpation risks due to population size are present for two of three other populations remaining outside the Colville Indian Reservation (Gilpin 1987), as less than 100 individuals are estimated at each site (M. Schroeder, WDFW, personal communication, 2003). These populations are likely much less tolerant of environmental changes, such as habitat degradation and weather extremes, than populations in Lincoln County and the Colville Indian Reservation. Predation is more of a concern for these very small populations than it would be for larger populations in good habitat.

A wide variety of genetic problems can occur with small populations, and these genetic problems can interact with demographic and habitat problems and lead to extinction (Gilpin and Soule 1986). Overall threats to sharp-tailed grouse are greater with individuals spread through small subpopulations than one larger population.

Sharptails in Douglas and Okanogan Counties, and to a lesser degree in Lincoln County, are now restricted to high-elevation areas, specifically those areas that have both shrubs and grasses (Schroeder 1996). High winter mortality resulting from declining quantity and quality of winter habitat is likely the most significant factor causing the decline in the sharptail population in Washington (Schroeder 1996). Protecting and enhancing high quality habitat where sharptails continue to concentrate, and restoring key low-elevation winter sites is vital to conservation of sharp-tailed grouse in Washington.

Habitat quality overall is improving for sharp-tailed grouse in Lincoln County where WDFW and the BLM are actively managing habitat for sharp-tailed grouse. Continuation of the CRP is also important to improve habitat quality in Lincoln and Douglas Counties. Washington Department of Fish and Wildlife acquisition of lands in Okanogan County near Tunk Valley, Chesaw and Conconully should also result in improving habitats. Private and tribal lands with sharp-tailed grouse that are grazed change in habitat quality with the intensity of grazing. Trends on these grazed lands are not predictable.

Increases in grazing pressure on currently occupied sharp-tailed grouse habitat is a principal threat to the continued existence of populations. In general, when grazing by livestock reduces the grass and forb component, sharp-tailed grouse are excluded (Hart *et al.* 1950; Brown 1966b; Parker 1970; Zeigler 1979). Loss of deciduous cover is especially severe near riparian areas that attract livestock in summer because of water and shade; this cover provides critical foraging areas and escape cover for sharptails throughout the year (Zeigler 1979; Marks and Marks 1987a). Trampling, browsing, and rubbing decrease the annual grass and forbs, deciduous trees, and shrubs needed for food and shelter in winter (Parker 1970; Kessler and Bosch 1982; Marks and Marks 1987a). Mattise (1978) found overgrazing very detrimental in nesting and brood-rearing habitat.

In Montana, Brown (1968) reported that the reduction in habitat due to intensive livestock grazing resulted in the elimination of sharptails in particular areas. Sharptails were observed shifting use to ungrazed areas following livestock use of traditional sites (Brown 1968). Marks and Marks (1988) also found sharptails in western Idaho selecting home ranges that were least modified by livestock grazing.

The effects of grazing on sharp-tailed grouse reported vary and appear to depend primarily on intensity, duration of grazing, kind of livestock, site characteristics, precipitation levels, and past and present land-use practices. Grazing systems currently used in range management include seasonal, deferred, and rotation grazing (Stoddard *et al.* 1975). Hart *et al.* (1950) found light to moderate grazing benefitting landowners and sharptails on the foothills and benchlands of Utah. Weddell (1992) concluded that rest rotation and deferred grazing were less detrimental to sharptailed grouse than season-long grazing, and suggested the disadvantages of increasing grazing under any of these systems outweigh the advantages for sharp-tailed grouse. Even light to moderate grazing can be detrimental in areas with a history of overgrazing, because it may prevent recovery of the native vegetation.

Kessler and Bosch (1982) surveyed sharp-tailed grouse management practices and concluded that grazing and the resulting habitat loss are the most serious threats to sharp-tailed grouse survival. Their survey of states and provinces with past or present Columbian sharp-tailed grouse populations found respondents regarded low intensity grazing as beneficial and high intensity grazing to be negative in its effects on sharptails (Kessler and Bosch 1982). Twenty percent more respondents found moderate grazing negative in its effects and twice as many preferred deferred and rest rotation over continuous grazing. Five of the seven states or provinces with Columbian sharp-tailed grouse listed overgrazing as a major issue/problem related to maintaining this species and its habitat (Braun 1991).

Grazing is a continuing threat to sharp-tailed grouse because of unpredictable changes in land ownership, grazing economics, and the needs of private landowners. Grazing pressure is increasing in several important sharptail areas in Washington (M. Schroeder, WDFW, personal communication, 2003).

The removal of CRP habitat in Lincoln, Douglas, and Okanogan Counties could cause further declines in sharp-tailed grouse numbers. Contracts for approximately 785,795 acres expired in 1997. Washington farmers submitted applications for new contracts on 590,582 acres and nearly 484,326 acres were accepted. Conservation Reserve Program lands placed back into grain production could cause further declines in the number of sharp-tailed grouse, depending upon how sharp-tailed grouse use these areas. Conservation Reserve Program land and other habitat enhancement areas must be near existing sharptail populations to be beneficial (Meints *et al.* 1992). Although WDFW is assisting landowners in applying for CRP funding, the long-term status of these areas is uncertain.

The loss of deciduous trees and shrubs by chemical control was associated with declining sharptail populations in Washington (Zeigler 1979) and Utah (Hart *et al.* 1950). Chemical treatment of vegetation in sharp-tailed grouse habitat is detrimental due to the direct loss of vegetation (McArdle 1977; Blaisdell *et al.* 1982; Oedekoven 1985; Klott 1987). Kessler and Bosch (1982) found most biologists regarded chemical brush control as a negative management practice for sharptails. However, in Michigan, herbicidal treatment was used to open dense areas and provide more adequate sharp-tailed grouse habitat (Van Etten 1960). In Washington, continued use of herbicides to control sagebrush and other vegetation may cause additional reductions in sharp-tailed grouse habitat.

Fire is a continual threat to sharp-tailed grouse populations. Fire has become a major tool for altering large blocks of sagebrush rangelands. In Lincoln County, three large prescribed fires and one chemical control of sagebrush in the 1980s in areas containing active leks, were believed to be directly responsible for the decline of both sharp-tailed and sage grouse populations (Merker 1988). McArdle (1977) found less use by sharptails in burned areas compared to other vegetation manipulations. Likewise, Hart *et al.* (1950) reported Columbian sharptails abandoning a lek site following a fire which also caused accelerated erosion, loss of nests, and loss of winter food and cover.

Under some circumstances, burning can help improve sharp-tailed grouse habitat. Burning dense sagebrush and thickly wooded areas was found to improve sharp-tailed grouse habitat in Utah (Hart *et al.* 1950), North Dakota (Kirsh *et al.* 1973), Colorado (Rogers 1969), and Wyoming (Oedekoven 1985). In Manitoba and British Columbia, a large movement of sharptailed grouse occurred from a high-use lek site to a burned area following a fire that eliminated all residual grass and forbs but did not greatly affect shrub or tree cover. Modern fire suppression policies have allowed conifers to invade bunchgrass-prairie habitats in some areas to the detriment of sharp-tailed grouse populations. In these situations, prescribed burning may be effective in maintaining suitable habitats (Giesen and Connelly 1993). In Washington, prescribed fire is not recommended in shrubsteppe but may be acceptable for creating habitat where conifers have invaded traditional shrubsteppe areas.

5.2.2.6.3 Current Distribution

Currently, Columbian sharptails occupy less than 10 percent of their historic range in Idaho, Montana, Utah, Wyoming, and Washington, and approximately 50 percent in Colorado, and 8 percent in British Columbia (Oedekoven 1985; Sullivan 1988; Ritcey 1995). Columbian sharp-tailed grouse are extirpated from California and possibly Oregon and Nevada (Wick 1955; Evanich 1983; Oedekoven 1985). Possible sightings in Nevada (Goose Creek south of Twin Falls, Idaho) and Oregon (Baker County) were recently reported (Braun 1991). Columbian sharptails are being reintroduced in Oregon (Starkey and Schnoes 1979; Crawford 1986).

The current range of Columbian sharp-tailed grouse in Washington consists of eight small, severely fragmented populations in Douglas, Lincoln, and Okanogan Counties (Figure 46). Sightings of sharptails were reported in Asotin County in the mid-1980s; however, the Idaho Department of Fish and Game transplanted sharptails in Idaho at that time, and some probably dispersed to Asotin County. Sharp-tailed grouse found outside Douglas, Lincoln, and Okanogan Counties are likely transient birds that periodically occupy pockets of remaining shrubsteppe.

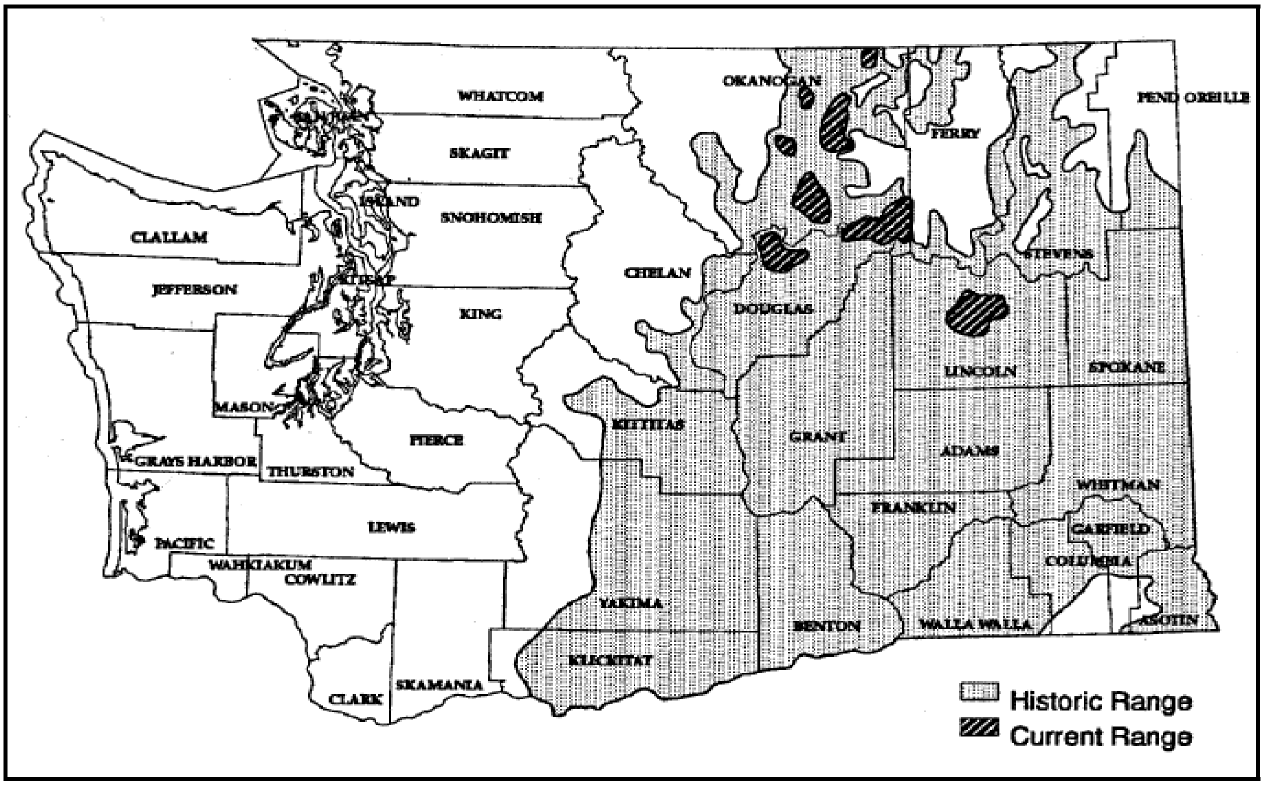


Figure 46. Historic and current range of shap-tailed grouse in Washington (Hays *et al.* 1998).

5.2.2.6.4 Population Trend Status

The 1997 breeding population of sharp-tailed grouse in Washington has been estimated through lek counts and a population model. During spring surveys, 358 grouse were counted on 44 leks in 3 counties (Table 34). A model based on scientific literature, input and survey data from WDFW biologists, and current research in Washington was used to estimate the size of the 1997 breeding population.

Table 34. Results of 1997 sharp-tailed grouse lek counts in Washington (Hays *et al.* 1998).

County	Birds	Leks	Birds/lek
Okanogan	169	17	9.9
Lincoln	88	10	8.8
Okanogan (off Colville Reservation)	59	9	6.5
Douglas	42	8	5.3
TOTAL	**358**	**44**	**8.1**

The model assumed all leks were known and surveyed, all males were on leks during counts, and the male to female sex ratio was 1:1. This model would underestimate actual population size if some leks were not located, if all males were not on leks during counts, if the sex ratio was not 1:1, and if surveys were flawed (e.g., bad weather, incomplete counts, etc.). The model would overestimate actual population size if lek counts included females, which are difficult to distinguish. The population estimate based on the model is 716 sharp-tailed grouse in Washington in 1997 (Table 35). Allowing for additional unsurveyed habitat, M. Schroeder (WDFW, personal communication, 2003) suggests as many as 1,000 sharp-tailed grouse may remain in Washington.

Table 35. Estimated size of the Washington sharp-tailed grouse breeding population in 1997 (Hays *et al.* 1998).

Sex	Population Estimate	Estimate Source
Male	358	Statewide lek counts
Female	358	1:1 sex ratio
TOTAL	**716**	**Males + Females**

The remaining sharp-tailed grouse in Washington are distributed in eight fragmented subpopulations. Of these, the subpopulation on the Colville Indian Reservation is the largest remaining in the state (Table 34). It is estimated to include about 352 grouse and is considered self-sustaining. Of the subpopulations outside of the Reservation, the largest population is in western Lincoln County (177 birds). The subpopulation south of Bridgeport in Douglas County contains about 31 birds. Outside the reservation, Okanogan County supports a total of only 138 birds. This includes four subpopulations that each support fewer than 25 grouse and they are likely unstable and near extirpation. Sharp-tailed grouse in each of the eight geographic areas (Figure 46) appear to be isolated (Schroeder 1996).

5.2.2.6.5 Structural Condition Associations

Sharp-tailed grouse are closely associated (C) and dependent upon steppe (grassland) habitats and open canopy shrublands (Table 36). This species is also generally associated (A) and present (P) within other shrubsteppe structural conditions during breeding (B).

5.2.2.6 Sage Grouse

5.2.2.6.1 General Habitat Requirements

Sage grouse inhabit shrubsteppe and meadow steppe, and as their name implies they are closely associated with sagebrush. Shrubsteppe is a descriptive term for plant communities consisting of one or more layers of perennial grass with a conspicuous, but discontinuous, layer of shrubs above (Daubenmire 1970). Elevations range from 100 to 4,000 feet.

Table 36. Sharp-tailed grouse structural conditions and association relationships (NHI 2003).

Common Name	Focal Habitat	Structural Condition (SC)	SC Activity	SC Assoc.
Sharp-tailed Grouse	Shrubsteppe	Grass/Forb-Closed	B	C
		Grass/Forb-Open	B	C
		Low Shrub-Open Shrub Overstory-Mature	B	C
		Low Shrub-Open Shrub Overstory-Old	B	A
		Low Shrub-Open Shrub Overstory-Seedling/Young	B	C
		Medium Shrub-Open Shrub Overstory-Mature	B	A
		Medium Shrub-Open Shrub Overstory-Old	B	P
		Medium Shrub-Open Shrub Overstory-Seedling/Young	B	C

Average precipitation ranges from 4.7 in at the Columbia River up to 21.6 in where steppe transitions to forest at the northeast part of the Columbia Basin (Daubenmire 1970, Rickard *et al.* 1988). Forest vegetation is generally absent. Shrubsteppe communities in Washington typically contain bunchgrasses and shrubs such as big sagebrush, three-tipped sagebrush (*A. tripartita*), and bitterbrush (*Purshia tridentata*), and a variety of forbs. Meadow steppe communities are dense at ground level, supporting many grasses and forbs with broad leaves and have few shrubs. Meadow steppe is barely dry enough to exclude trees and generally has meadow characteristics (Franklin and Dyrness 1973; Daubenmire 1970). Sage grouse populations are found in areas of the *Artemisia tridentata - Agropyron spicatum* and the *Artemisia tripartita - Festuca idahoensis* vegetative units as described by Daubenmire (1970).

Sage grouse have adapted to seasonal use of altered habitats, but that use generally depends on the proximity to native steppe habitat (Schroeder *et al.* 1999). Low rolling hills and adjacent valleys provide the best topography for sage grouse (Call and Maser 1985). Sage grouse prefer slopes less than 30 percent (Call and Maser 1985). In Colorado, they preferred south-facing slopes year round (Rogers 1964). On the Yakima Training Center (YTC), habitat that contained successful nests was more likely to be on northeast aspects than on south or southwest aspects (Cadwell *et al.* 1997). Habitat consists of sagebrush/bunchgrass stands having medium to high canopy cover (10-35 percent) of sagebrush in a variety of height classes (Table 37) and a diverse grass and forb understory (Peterson 1970, Wallestad 1971, Eng and Schladweiler 1972). In Washington, sage grouse on the YTC were found at elevations of 1,650 to 2,970 feet and on slopes less than 16°F (Cadwell *et al.* 1997).

5.2.2.6.2 Limiting Factors

The primary threat to remaining sage grouse populations is habitat loss and degradation resulting from large-scale fires; the potential reduction of lands in the CRP; and conversion of shrubsteppe to agriculture on WDNR-owned lands to produce income for state trust funds. The two remaining sage grouse populations at the YTC and in Douglas and Grant Counties are too small to be considered secure. Fire prevention and management of training activities are critical to maintaining sage grouse at the YTC and continuation of the CRP and protection of remnant patches of native habitat are critical for sage grouse in Douglas County. Genetic data suggest the two populations are isolated from each other and losing genetic diversity. Both

Table 37. Vegetation characteristics of productive sage grouse habitats (modified from Connelly *et al.* 2000b).

	Breeding		**Brood-rearing**		**Winter**[a]	
	Height (cm)	**Canopy (%)**	**Height (cm)**	**Canopy (%)**	**Height (cm)**	**Canopy (%)**
Sagebrush	30-80[b]	15-25	40-80	10-25	25-35	10-30
Grass-forb	>18[c]	>25[d]	Variable	>15	--	--

[a] Above snow
[b] For more mesic sites, the height is 40-80 cm.
[c] Measured as droop height; the highest naturally growing portion of the plant.
[d] For arid sites, the canopy is ≥ 15%.

populations have many leks with low numbers of males. Small reductions in habitat quality may have significant effects on the continued use of leks. Without continued and expanded conservation effort to address the remaining threats, the sage grouse population in Washington is likely to continue to decline.

Population isolation is potentially a significant factor influencing the continued existence of sage grouse in Washington. As grouse populations naturally fluctuate due to environmental conditions, the smaller the population, the greater the risk of extirpation. The potential for compounded effects of habitat change are great when populations have dropped to low levels. For example, dispersal by juvenile sage grouse is typically advantageous in widespread and connected populations. However, it may become detrimental in isolated populations if juveniles that disperse widely are a net loss to the population and there is no compensating immigration. Both the YTC and Douglas County sage grouse subpopulations in Washington have fluctuated to estimated lows of 100-150 females during the 1990s. Many authors indicate that long-term survival (greater than 100 years) of isolated populations may require many more individuals (Lande and Barrowclough 1987; Dawson *et al.* 1987; Grumbine 1990).

Nelle *et al.* (2000) examined vegetation cover, forb abundance, and invertebrate abundance on 20 different-aged burns in mountain big sagebrush on the Upper Snake River Plain in southeastern Idaho. They found no benefits for sage grouse from burning nesting and brood-rearing habitat. They further concluded that burning had long-term negative impacts on nesting habitat because sagebrush required more than 20 years for canopy cover to become sufficient for nesting. Byrne (2002) investigated burns and habitat use in southeast Oregon and reported that unburned areas were generally selected and burned areas were generally avoided by female sage grouse during the breeding season. Burns in Wyoming big sagebrush appeared to have no value to female sage grouse. Wambolt *et al.* (2002) reviewed the impact of fire on big sagebrush ecosystems and noted recovery usually takes several decades. They concluded that there was “no empirical evidence supporting the notion that fire has positive effects on sage grouse over the short or long term.”

Livestock grazing has been suggested as a potential factor in both historical (Edminster 1954), and recent declines in sage grouse numbers throughout their range (Braun 1998; Connelly and Braun 1997; Pedersen *et al.* 2003). An earlier range-wide decline coincided with the maximum livestock use of range resources between 1900 and 1915 (Patterson 1952). Yocom (1956) believed overgrazing during the era when cattle, sheep, and horses were much more abundant in Washington may have had a depressive effect on sage grouse population levels, although he noted that the plowing and burning of shrubsteppe had a greater effect. The historical decline from 1870-1930 also occurred during the period when hunting regulations were becoming established. Despite the pervasive influence of livestock grazing in sage grouse range, there have been no experimental studies of the impact on sage grouse populations.

Cessation of livestock grazing would not necessarily result in recovery of vegetation and subsequent benefit to sage grouse. Laycock (1994) reviewed studies that showed that once a site has a reduced understory and sagebrush dominates, the site may remain in that condition for a very long time. He indicates that simple relaxation or removal of grazing often is not sufficient to move a site out of that new stable state (Laycock 1991, 1994; West 1999).

Livestock grazing is compatible with sage grouse where the habitat characteristics needed for breeding and wintering can be consistently maintained (Connelly *et al.* 2000b; Wambolt *et al.* 2002; Rowland and Wisdom 2002). Whether this is possible on any particular site depends on many factors including the grazing history of the site, site condition, livestock involved, the season, intensity, frequency and duration of grazing.

Although predation is the most important proximate cause of mortality for sage grouse, the rate of predation is ultimately dependent on the quality of habitat (Schroeder and Baydack 2001). Habitat that provides good shrub and grass cover for nesting and wintering allows grouse to increase despite predation, but losses to predation may be greater where habitat is fragmented (VanderHagen *et al.* 2002) and may be significant for small populations. Where studies indicate that juvenile survival is a problem, management of habitat to increase juvenile survival may be critical to restoring sage grouse populations. Predator control programs to benefit bird populations have been shown to be locally effective at improving nest success in ducks (Greenwood and Sovada 1996), and are commonly used to benefit grouse in Europe. However, there is no information on the long term impacts of predator control on the behavior, genetics, and abundance of sage grouse (Schroeder and Baydack 2001). In the only experimental study of predator control for the benefit of sage grouse, Batterson and Morse (1948) reported higher nesting success in an area where ravens had been controlled. Cote and Sutherland (1997) analyzed past studies of predator control to protect birds and concluded that though predator control may reduce nest predation and increase the post-breeding population, it does not reliably result in an increase of the breeding population in subsequent seasons. Connelly *et al.* (2000b) concluded that nest-success rates (greater than 40 percent) in most locations suggest that nest predation is not a widespread problem. They state that though expensive and often ineffective, predator control programs may provide temporary help where habitat is recovering or where seasonal habitats have been greatly reduced. They recommend that predator management should only be implemented if nest success and hen survival data support the action. If corvids are identified as the dominant nest predator and nest success is less than 25 percent (Connelly *et al.* 2000b), an efficient method of control that could be considered is the use of the avicide DRC-1339 applied to hard-boiled eggs in artificial nests. This would only affect the birds actually depredating nests. Any predator control programs that are implemented should be evaluated for benefits to the breeding population.

Potential disturbances to sage grouse include off-road recreational vehicles, farming activities, military training, bird dog field trials, birdwatchers or photographers, falconry, and hunting. The only current recreational use focused on sage grouse directly is viewing. Uncontrolled viewing could disrupt breeding populations and should be monitored and restricted if necessary. During the breeding season, repeated disturbance at a lek has the potential to reduce mating opportunities and cause decreased production. When humans approach the display site, grouse often flush and may or may not return again that day (Call 1979). Viewing at a distance from automobiles does not appear to disrupt courtship activity; but grouse flush when people leave cars to get a closer look. All the Douglas County leks are on private property, but some are visible from county roads. The location of at least one lek is known by the birding community, and disturbance has on occasion been a problem at that site.

Insecticides applied to agricultural fields and shrubsteppe communities may be detrimental to sage grouse. Approximately 35,000 mi^2 of western rangelands were sprayed for grasshopper control from 1985 to 1990 (Johnson and Boyce 1990). Areas sprayed were commonly used by nesting sage grouse. Insects such as ants, beetles, and grasshoppers are a key item in the diet of chicks (Rasmussen and Griner 1938; Patterson 1952; Klebenow and Gray 1968; Peterson 1970; Johnson and Boyce 1990), and chicks more than 3 weeks old show reduced growth rates when insects are removed from their diet (Johnson and Boyce 1990). Blus *et al.* (1989) reported mortalities of sage grouse after application of organophosphorus insecticides (dimethoate and methamidophos) on fields in southeastern Idaho. Herbicides are also used to control weeds, such as knapweeds and cheatgrass.

5.2.2.6.3 Current Distribution

Sage grouse occur only in western North America. Historically, greater sage grouse were distributed throughout much of the western United States in 13 states and along the southern border of three western Canadian provinces (Patterson 1952; Braun 1993) (Figure_47).

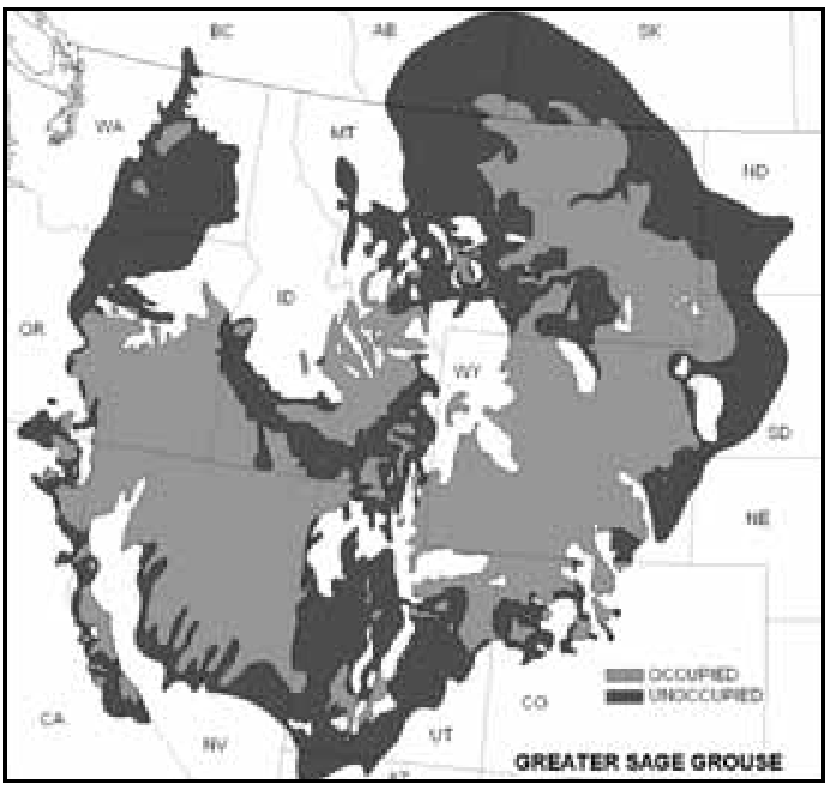


Figure 47. Historic and currently occupied range of the greater sage grouse (Stinson *et al.* 2003).

Gunnison sage grouse were found in south western Colorado, southeastern Utah, northern New Mexico and in western Oklahoma and Kansas (Young *et al.* 2000). Sage grouse range followed the distribution of sagebrush north to British Columbia, south to Arizona, east into Nebraska, and west to California (Aldrich 1963; Guiquet 1970). Lewis and Clark first reported sage grouse at the head of the Missouri River and on the plains of the Columbia; they were particularly abundant at the mouth of the Snake River (Coues 1893). Historical reports describe large numbers of sage grouse throughout their range (Escalante 1776; Coues 1893; Huntington 1897; Burnett 1905; Wilhelm 1970). Sage grouse populations declined throughout North America from 1900 to 1940 primarily due to habitat loss, extreme overgrazing, drought, and excessive hunting mortality (Patterson 1952; Jewett *et al.* 1953). Currently, greater sage grouse occur in 11 states and 2 provinces ranging from southeastern Alberta and southwestern Saskatchewan, south to northwestern Colorado, and west to eastern California and central Oregon and Washington. Within these outer margins, sage grouse occur in southern Idaho, northern Nevada, Utah, Wyoming, central and eastern Montana, and extreme western North and South Dakota (Schroeder *et al.* 1999). Greater sage grouse have been extirpated from Arizona, Nebraska, and British Columbia (Braun 1998); Gunnison sage grouse have been extirpated from New Mexico, Kansas, and Oklahoma (Young *et al.* 2000).

Sage grouse were distributed throughout central and eastern Oregon, except for Wallowa County, in sagebrush dominated areas until the early 1900s (Gabrielson and Jewett 1940). By 1920, sage grouse populations had decreased and were considered scarce except for areas in southeastern Oregon (Gabrielson and Jewett 1940; Meyers 1946). Sage grouse distribution in Oregon declined by approximately 50 percent from 1900 to 1940 (Crawford and Lutz 1985). By 1955, the northern parts of the state, including Jefferson, Wasco, Sherman, Morrow, and Umatilla Counties, and sizeable portions of Lake County in south-central and Grant County in northeastern Oregon were devoid of sage grouse (Masson and Mace 1962; Drut 1994). Further declines in sage grouse distribution and abundance likely continued to the mid-1980s (Crawford and Lutz 1985). In 1992 there were estimated to be 28,000 - 66,000 breeding birds in Oregon (Willis *et al.* 1993).

The estimated historical distribution of sage grouse in Washington spanned 35,800 mi^2. Sage grouse inhabited the shrubsteppe and meadow steppe of the Columbia Basin region of eastern Washington. There are now 2 relatively isolated sage grouse populations remaining in Washington. Their range has been reduced about 92 percent to 2,900 mi^2 (Schroeder *et al.* 2000). One population is found in Douglas and Grant Counties, predominantly on private land. The other population is found on the YTC. These sage grouse populations are isolated from one another, as well as surrounding populations in Idaho and Oregon.

5.2.2.6.4 Population Trend Status

Meriwether Lewis reported sage grouse "in great abundance" in 1806 in an area that would become Benton and Klickitat Counties (Zwickel and Schroeder 2003). Sage grouse numbers in Washington declined from the late 1800s to the early 1900s because of habitat conversion, overgrazing, and weak hunting regulations (Yocom 1956). Sage grouse historically ranged from the Columbia River in Klickitat County, north to Oroville, west to the foothills of the Cascades, and east to the Spokane River (Figure 48). As early as 1860, sage grouse had declined and were rarely seen in some areas that had formerly contained numerous birds. In 1897, the hunting season for sage grouse extended from 15 August – 1 December, with a bag limit of 10 birds/day. By the early 1900s, sage grouse had been extirpated from Spokane, Columbia, and Walla Walla Counties and perhaps other counties that historically contained small populations. In 1922 the sage grouse season was closed in all counties except Benton and Franklin Counties, where the season was limited to 2-6 September with daily bag of 3. The season was closed in all counties in 1923, and remained closed statewide until 1950. Sage grouse numbers increased somewhat in some areas with the change from horse-drawn to mechanized farming,

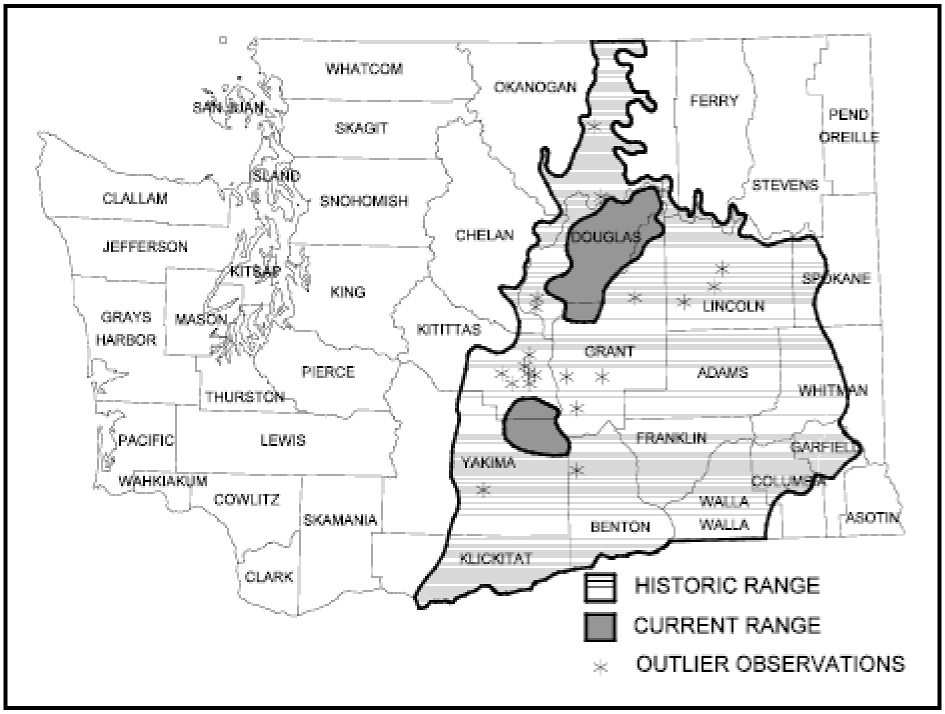


Figure 48. Historic and current sage grouse range in Washington (Stinson *et al.* 2003).

and protection from hunting from 1933-1949. Sage grouse were apparently abundant enough to be causing damage to alfalfa and potatoes in the Badger Pocket area of Kittitas County when the first hunting season since 1932 was opened in 1950 (Yocum 1956). The recovery was temporary, however, as more and more shrubsteppe was converted to agriculture within the Columbia Basin Irrigation Project.The sage grouse population on the Fitzner and Eberhardt Arid Lands Ecology Reserve (FEALE) unit of Hanford Reach National Monument, (formerly part of the Department of Energy's Hanford site), in Benton County was evidently extirpated, probably due to catastrophic fires in 1981 and 1984. No sage grouse populations have been found there in recent surveys, although individual birds are sighted on rare occasions. The breeding population in Lincoln County was essentially eliminated by 1985 because of habitat alteration. The Badger Pocket area, southeast of Ellensburg in Kittitas County, historically supported large numbers of sage grouse, but they were extirpated by 1987 due to conversion of shrubsteppe to agriculture in the 1970s and 1980s.

While habitat loss was probably the most important factor in the elimination of sage grouse from most of their range in Washington, over-harvest may have exacerbated the impacts of habitat fragmentation and accelerated local extirpations. New management guidelines state that where sage grouse populations are hunted, harvest rates should be 10 percent or less of the estimated fall population (Connelly *et al.* 2000b), although this recommended harvest rate was not based on research experiments. Past harvest rates in Washington greatly exceeded 10 percent of the estimated spring population in some years. For example, in 1954, an estimated 2,700 birds were killed in Kittitas County, when the statewide breeding population may have been around 9,000 birds; 3,300 hunters killed an estimated 2,065 birds in 1970 when the spring population may have been only about 3,800 birds (Hays *et al.* 1998). Excessive harvest occurred in part because it was assumed that hunting mortality of less than 30 percent of the population was compensatory (Autenrieth *et al.* 1982). Also, harvest was assumed to be more or less self-limiting by what Leopold (1933) called the "law of diminishing returns" meaning that hunters stop hunting when game becomes scarce. Despite the season closure in 1988, the sage grouse population stayed at low levels or continued to decline (Figure 49), probably due to the dramatic reduction in habitat, deterioration and fragmentation of the remaining habitat, and isolation and small size of the remaining populations. Sage grouse have survived in Washington largely because portions of the land in Douglas County are poorly suited to agriculture, and in part because U.S. Army ownership of the YTC prevented agricultural conversion and most other development.

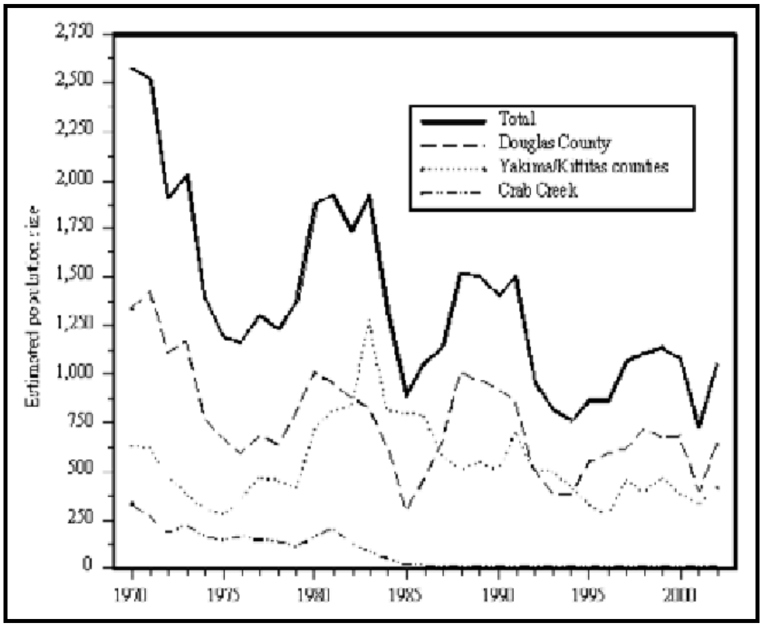


Figure 49. Estimated breeding population of sage grouse in Washington, 1970-2002 (Stinson *et al.* 2003).

The statewide breeding population of sage grouse in Washington in 2003 was conservatively estimated to be approximately 1,017 birds in two populations: about 632 in the Douglas-Grant Counties population and 385 in Kittitas-Yakima Counties population on the YTC (Figure 50). These 2 populations are separated by 30-36 miles. The statewide breeding population declined from about 1,080 in 2000 to 730 birds in 2001, but seemed to rebound to 1,040 in 2002 (Schroeder, unpub. data). These estimates are probably underestimates. The population declined an average of 0.7 percent/year (SE = 3.5 percent) from 1970-2001 (Schroeder 2002). Schroeder *et al.* (2000) estimated a decline of 77 percent between 1960 and 1999, but indicated that the estimate would be closer to 95 percent if an additional 16 leks for which there was no early count data were assumed to have been of average size in 1960 and were included in the estimate. The Yakima-Kittitas population estimate ranged from 166-421 during 1989-2002 and averaged 306 birds (U.S. Army 2002). Although the Yakima-Kittitas population has fluctuated over the years, the average estimate is higher for the most recent half of the period (326 for 1996-2002; 285 for 1989-95). The average annual percent change (+6.84 percent) indicates a slight increase overall since 1989 (U.S. Army 2002). Based on occasional sightings, a few scattered sage grouse may occur on the periphery of the current range but are not believed to play a significant role in the dynamics of the populations. Most of the lek complexes (49 of 68; 72.1 percent) that were active at least 1 year from 1960 - 2001, are now vacant (Figure 50).

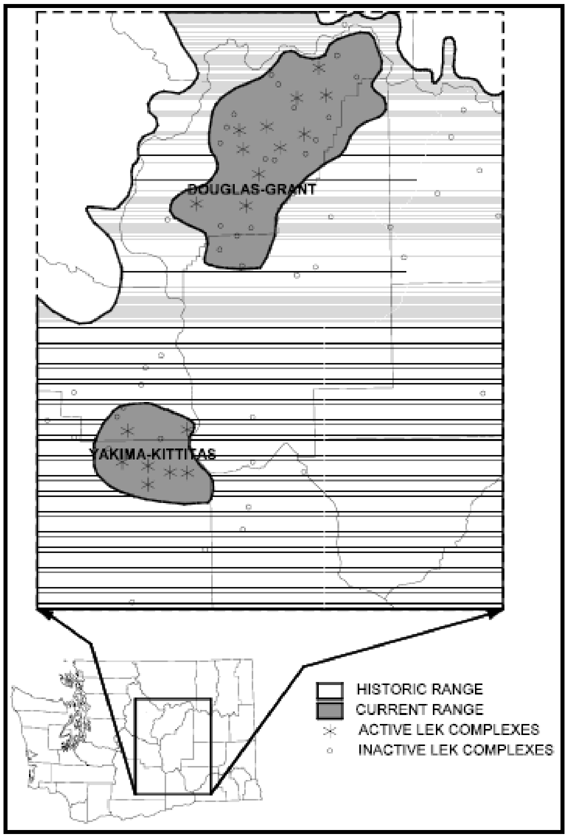


Figure 50. Distribution of active and inactive lek complexes within current and historic sage grouse range in Washington (Stinson *et al.* 2003).

Just over half (26 leks) of these vacant leks are outside the current range, while the remainder (23) reflect a decline in grouse density within the current range (Schroeder *et al.* 2001). In the 20th century, the range of sage grouse in Washington has declined by approximately 92 percent.

The two remaining populations in Washington are too small to be considered viable, so the persistence of sage grouse in Washington is likely to depend on recovery efforts. Small populations are affected by loss of genetic variability, inbreeding, and predation pressure, and are at risk to random events such as extreme weather or fires. The effective population size of sage grouse populations are smaller than the number of individuals because a small portion of the adult males do most of the breeding. This means that genetically, and demographically, these populations are more similar to populations of a smaller size. Sage grouse numbers are somewhat cyclic, putting small populations at greater risk. Populations of a few thousand individuals may be needed for long term viability (i.e. 100 years).

5.2.2.6.5 Structural Condition Associations

Sagegrouse, a shrubsteppe obligate species, are closely associated (C) and dependent upon grass/forb and shrub structural conditions (Table_38). This species' winter diet is almost exclusively sagebrush while insects and forbs are utilized throughout the spring and summer.

Table 38. Sage grouse structural conditions and association relationships (NHI 2003).

Common Name	Focal Habitat	Structural Condition (SC)	SC Activity	SC Assoc.
Sage Grouse	Shrubsteppe	Grass/Forb-Closed	B	C
		Grass/Forb-Open	B	C
		Low Shrub-Open Shrub Overstory-Mature	B	C
		Low Shrub-Open Shrub Overstory-Old	B	A
		Low Shrub-Open Shrub Overstory-Seedling/Young	B	C
		Medium Shrub-Open Shrub Overstory-Mature	B	C
		Medium Shrub-Open Shrub Overstory-Old	B	A
		Medium Shrub-Open Shrub Overstory-Seedling/Young	B	C

5.2.2.7 Shrubsteppe Focal Species Structural Condition Summary

Shrubsteppe structural conditions are summarized by association in Figure 51. The species assemblage selected to represent this habitat type are more closely associated (C) with structural conditions than focal species assemblages representing interior grassland, ponderosa pine, or riparian forest habitats. Moreover, the species assemblage is also generally associate (A) with numerous shrubsteppe structural conditions. This infers that shrubsteppe obligate species are present within the focal species assemblage and that the shrubsteppe habitat type is adequately represented relative to structural conditions. The presence of viable populations of sage sparrows, sage thrashers, Brewer's sparrows, and mule deer, coupled with the large number of close and general associations of structural conditions, would suggest that shrubsteppe habitats are functioning adequately. Local population data, however, on sage sparrows, sage thrashers, and Brewer's sparrows is lacking and is considered a data gap. As a result, habitat functionality cannot be determined. In contrast, the mule deer (a generalist species) population in Ecoprovince shrubsteppe habitats have peaked and may be starting to decline in some areas (P. Fowler, WDFW, personal communication, 2003), which suggests that habitat conditions are adequate for at least some shrubsteppe associated species.

Structural conditions summarized in Figure 51 and associated tables can also be used to define the range of recommended shrubsteppe structural conditions, prioritize protection strategies, and guide wildlife managers in identifying important structural condition considerations when making species specific shrubsteppe management decisions. Land managers are also encouraged to review the key environmental correlates (fine filter) associated with structural conditions (course filter) in the NHI database (2003) to gain additional insights into habitat functionality and quality.

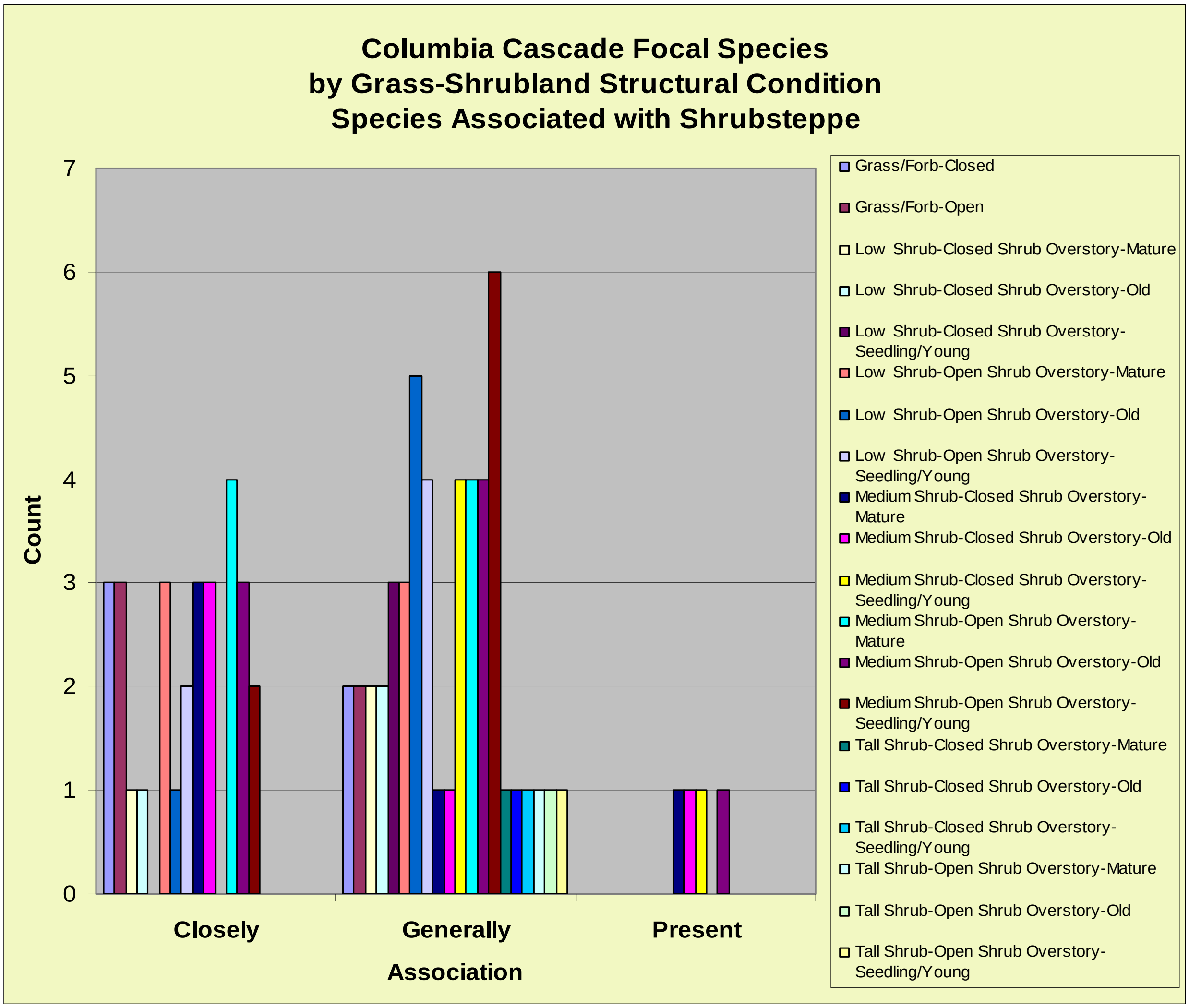


Figure 51. Shrubsteppe focal species structural condition associations (NHI 2003).

5.2.2.8 Shrubsteppe Key Ecological Functions

Key ecological functions performed by shrubsteppe focal species are limitied to those carried out by mule deer (Table 38) (NHI 2003). Similarly, KEFs performed by non-focal species and functional redundancy within the Ecoprovince are illustrated in Figure 52. The overall low functional redundancy (three or less species) associated with KEF 3.9 is not negative, because snags and trees are not an inherent component of the shrubsteppe habitat type found within the Ecoprovince. Similarly, the complete lack of functional redundancy for KEF 3.5 is not an issue in shrubsteppe habitats because this KEF is associated with forest cover types. Functional redundancy results in conjunction with structural condition associations clearly support the conclusion that shrubsteppe habitats within the Ecoprovince are functional at this juncture.

Table 39. Key ecological functions performed by shrubsteppe focal species (NHI 2003).

KEF	KEF Description	Common Name	Number of Species
5.1	Physically affects (improves) soil structure, aeration (typically by digging)	Pygmy rabbit	1
3.9	Primary cavity excavator in snags or live trees	None	0
3.6	Primary creation of structures (possibly used by other organisms)	None	0
3.5	Creates feeding, roosting, denning, or nesting opportunities for other organisms	None	0
1.1.1.9	Fungivore (fungus feeder)	Mule Deer	1
1.1.1.4	Grazer (grass, forb eater)	Mule Deer	1
1.1.1.3	Browser (leaf, stem eater)	Mule Deer	1

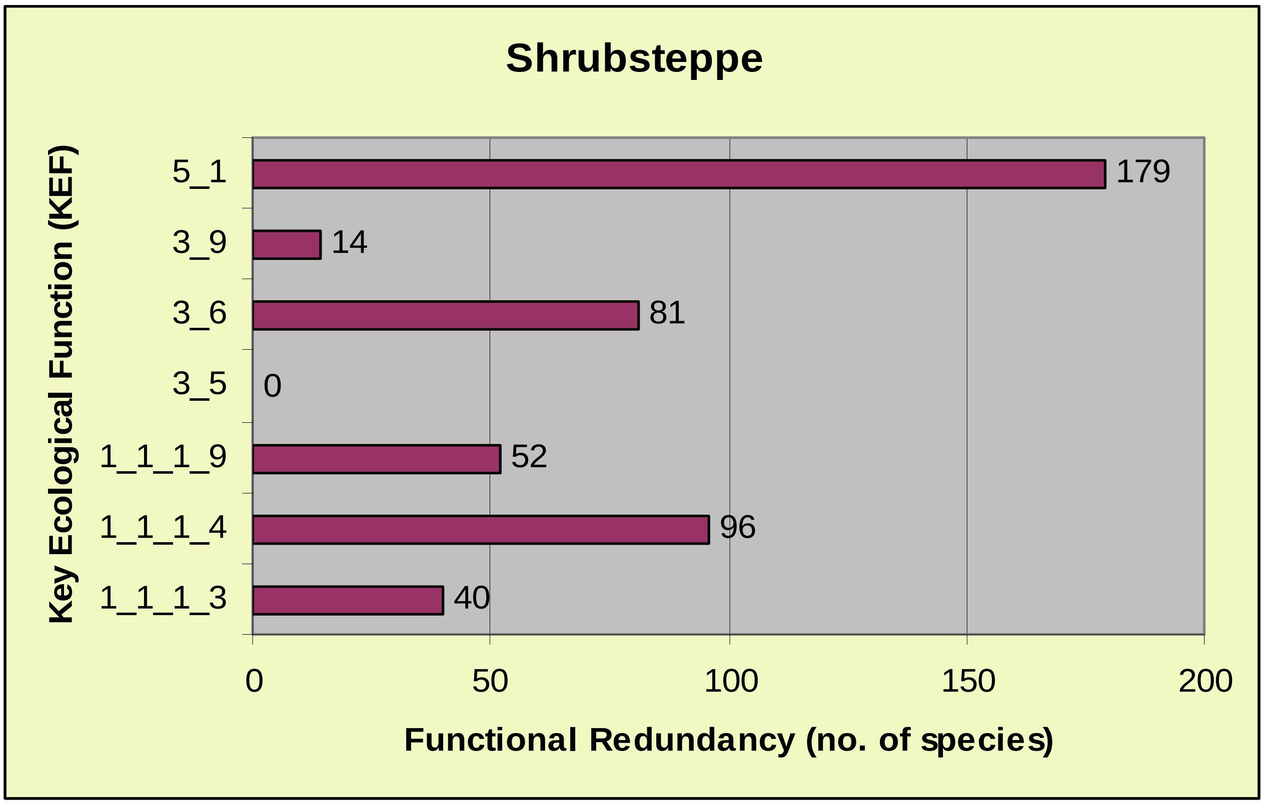


Figure 52. Functional redundancy in shrubsteppe habitat (NHI 2003).

5.2.3 Eastside (Interior) Riparian Wetlands Focal Species Information

5.2.3.1 Red-eyed Vireo

5.2.3.1.1 General Habitat Requirements

Partners in Flight established biological objectives for this species in the lowlands of western Oregon and western Washington. These include providing habitats that meet the following definition: mean canopy tree height greater than 50 feet, mean canopy closure greater than 60 percent, young (recruitment) sapling trees greater than 10 percent cover in the understory, riparian woodland greater than 64 feet wide (Altman 2001). Red-eyed vireos are closely associated with riparian woodlands and black cottonwood stands and may use mixed deciduous stands.

The patchy distribution in Washington for this species correlates with the distribution of large black cottonwood groves, which are usually limited to riparian areas. The red-eyed vireo is one of the most abundant species in northeastern United States, but is much less common in Washington due to limited habitat.

5.2.3.1.2 Limiting Factors

Habitat loss due to hydrological diversions and control of natural flooding regimes has resulted in an overall reduction of riparian habitat for red-eyed vireos through the conversion of riparian habitats and inundation from impoundments.

Like other neotropical migratory birds, red-eyed vireos suffer from habitat degradation resulting from the loss of vertical stratification in riparian vegetation, lack of recruitment of young cottonwoods, ash (*Fraxinus latifolia*), willows (*Salix spp*.), and other subcanopy species.

Streambank stabilization narrows stream channels and reduces the flood zone and extent of riparian vegetation. The invasion of exotic species such as canarygrass (*Phalaris spp*.) and blackberry (*Rubus spp*.) also contributes to a reduction in available habitat for the red-eyed vireo. Habitat loss can also be attributed to overgrazing, which can reduce understory cover. Reductions in riparian corridor widths may decrease suitability of riparian habitat and may increase encroachment of nest predators and nest parasites to the interior of the stand.

Hostile landscapes, particularly those in proximity to agricultural and residential areas, may have high density of nest parasites, such as brown-headed cowbirds and domestic predators (cats), and can be subject to high levels of human disturbance. Recreational disturbances, particularly during nesting season, and particularly in high-use recreation areas may have an impact on red-eyed vireos.

Increased use of pesticide and herbicides associated with agricultural practices may reduce the insect food base for red-eyed vireos.

5.2.3.1.3 Current Distribution

The North American breeding range of the red-eyed vireo extends from British Columbia to Nova Scotia, north through parts of the Northwest Territories, and throughout most of the lower United States (Figure_53). They migrate to the tropics for the winter.

The patchy distribution in Washington for this species correlates with the distribution of large black cottonwood groves, which are usually limited to riparian areas. The red-eyed vireo is one of the most abundant species in the northeastern United States, but is much less common in Washington due to limited habitat. Red-eyed vireo breeding and summer distribution is illustrated in Figure_54 and Figure_55.

5.2.3.1.4 Population Trend Status

The red-eyed vireo is secure, particularly in the eastern United States. Within the state of Washington, the red-eyed vireo is locally common, more widespread in northeastern and southeastern Washington and not a conservation concern (Altman 1999).

Red-eyed vireos are currently protected throughout their breeding range by the Migratory Bird Treaty Act (1918) in the United States, the Migratory Bird Convention Act (1916) in Canada, and the Convention for the Protection of Migratory Birds and Game Mammals (1936) in Mexico.

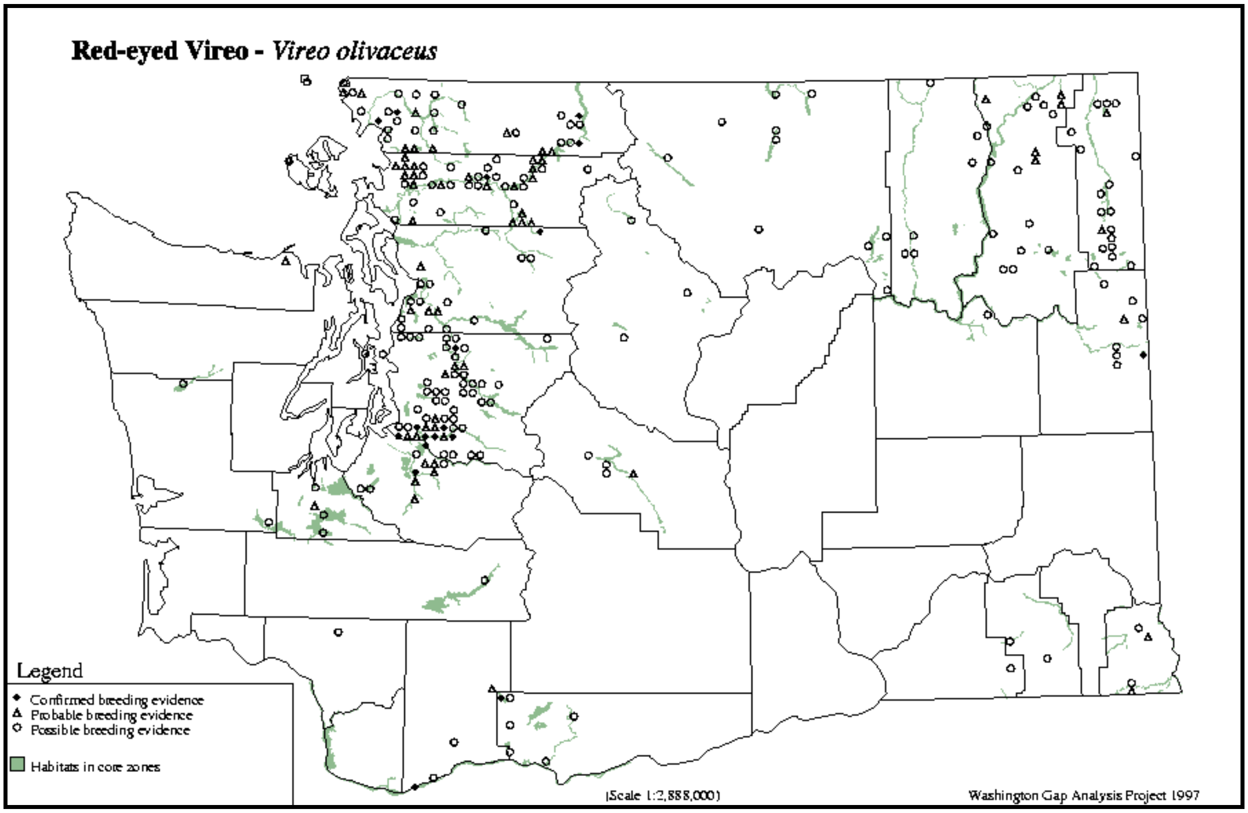


Figure 53. Breeding bird atlas data (1987-1995) and species distribution for red-eyed vireo (Washington GAP Analysis Project 1997).

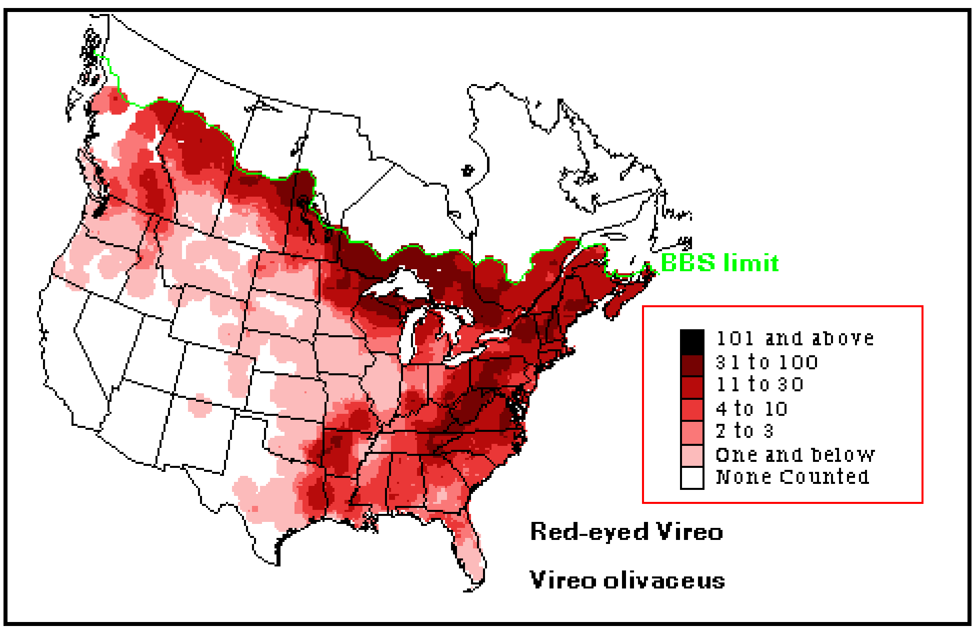


Figure 54. Red-eyed vireo breeding distribution (Sauer *et al.* 2003).

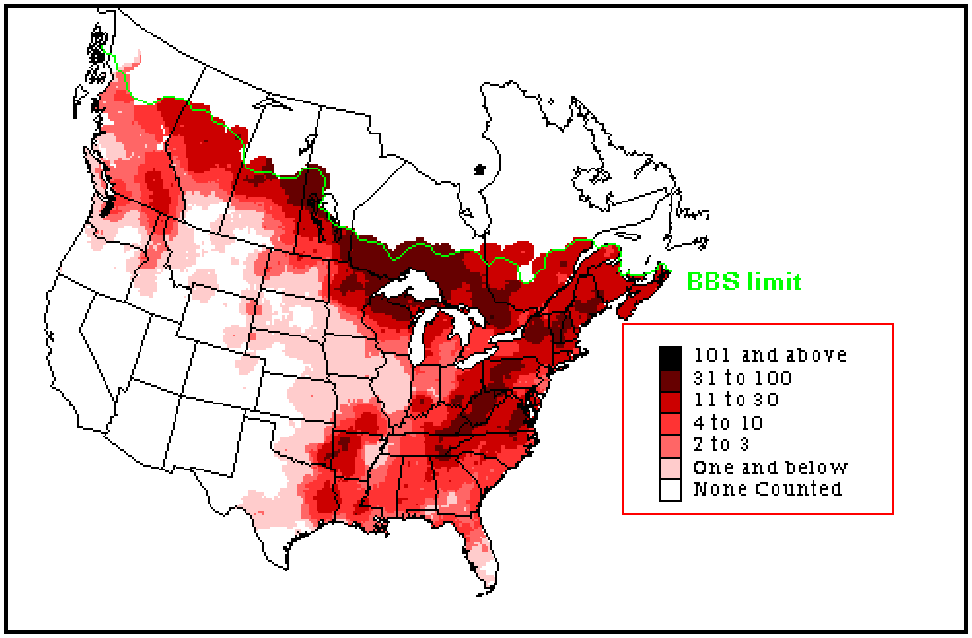


Figure 55. Red-eyed vireo summer distribution (Sauer *et al.* 2003).

In Washington, BBS data show a significant population increase of 4.9 percent per year from 1982 to 1991 (Peterjohn 1991) (Figure_56). However, long-term, this has been a population decline in Washington of 2.6 percent per year, although the change is not statistically significant largely because of scanty data (Sauer *et al.* 2003). Because the BBS dates back only about 30 years, population declines in Washington resulting from habitat loss dating prior to the survey would not be accounted for by that effort.

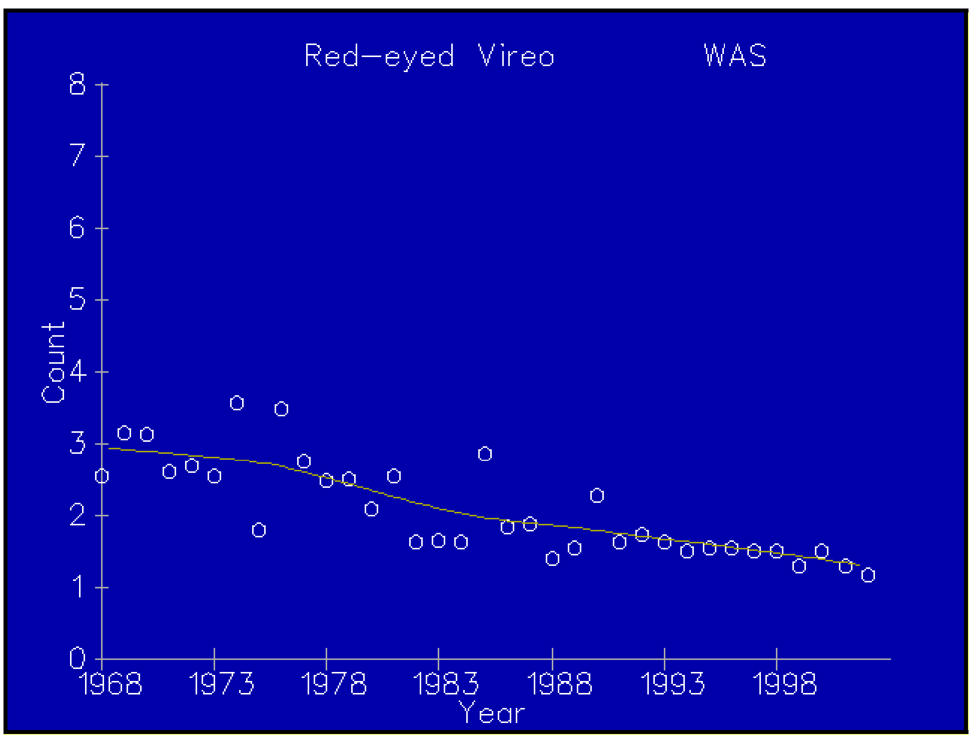


Figure 56. Red-eyed vireo trend results from BBS data, Washington (Sauer *et al.* 2003).

5.2.3.1.5 Structural Condition Associations

Red-eyed vireo are closely associated (C) and dependent upon large, multi-story, open to closed canopy cottonwood trees (Table 40). The large to giant tree class is critical to this species during breeding (B) season.This species is also generally associated (A) with small and medium, single/multi-story, open to closed canopy tree structure and occasionally present (P) in small tree open canopy sites. Although dependent upon large class trees, this species clearly utilizes multiple tree structural conditions.

Table 40. Red-eyed vireo structural conditions and association relationships (NHI 2003).

Common Name	Focal Habitat	Structural Condition (SC)	SC Activity	SC Assoc.
Red-eyed Vireo	Riparian Wetlands	Giant Tree-Multi-Story	B	C
		Large Tree-Multi-Story-Closed	B	C
		Large Tree-Multi-Story-Moderate	B	C
		Large Tree-Multi-Story-Open	B	C
		Large Tree-Single Story-Closed	B	C
		Large Tree-Single Story-Moderate	B	A
		Large Tree-Single Story-Open	B	A
		Medium Tree-Multi-Story-Closed	B	C
		Medium Tree-Multi-Story-Moderate	B	A
		Medium Tree-Multi-Story-Open	B	A
		Medium Tree-Single Story-Closed	B	A
		Medium Tree-Single Story-Moderate	B	A
		Small Tree-Multi-Story-Closed	B	A
		Small Tree-Multi-Story-Moderate	B	A
		Small Tree-Multi-Story-Open	B	P
		Small Tree-Single Story-Closed	B	A
		Small Tree-Single Story-Moderate	B	A

5.2.3.2 American Beaver

5.2.3.2.1 General Habitat Requirements

Suitable beaver habitat in all wetland cover types (e.g., herbaceous wetland, riparian wetland, and deciduous forested wetland) must have a permanent source of surface water with little or no fluctuation (Slough and Sadleir 1977). Lakes and reservoirs that have extreme annual or seasonal fluctuations in the water level will be unsuitable habitat for beaver. Similarly, intermittent streams, or streams that have major fluctuations in discharge, or a stream channel gradient of 15 percent or more will have little year-round value as beaver habitat. Assuming that there is an adequate food source available, small lakes less than 20 acres in surface area are assumed to provide suitable habitat for beavers. Large lakes and reservoirs greater than 20 acres in surface area must have irregular shorelines in order to provide optimum habitat for beaver.

Beavers are generalized herbivores and prefer herbaceous vegetation such as duck potato (*Sagittaria spp.),* duckweed (*Lemna spp.),* pondweed (*Potamogeton spp.),* and water weed (*Elodea* spp.) over woody vegetation during all seasons of the year, if it is available (Jenkins 1981). The leaves, twigs, and bark of woody plants are eaten, as well as many species of aquatic and terrestrial herbaceous vegetation.

Beaver show strong preferences for particular woody plant species and size classes (Jenkins 1975; Collins 1976a; Jenkins 1979). Denney (1952) reported that beavers preferred, in order of preference, aspen, willow, cottonwood, and alder. Woody stems cut by beavers are usually less than 3 to 4 inches DBH (Bradt 1947; Hodgdon and Hunt 1953; Longley and Moyle 1963; Nixon and Ely 1969). Jenkins (1980) reported a decrease in mean stem size cut and greater selectivity for size and species with increasing distance from the water's edge. Food preferences may vary seasonally, or from year to year, as a result of variation in the nutritional value of food sources (Jenkins 1979). Specific habitat attributes are shown in Table_20.

5.2.3.2.2 Limiting Factors

Beavers readily adapt to living in urban areas near humans and are limited primarily by the availability of permanent water with limited fluctuations and accessibility of food.

Riparian habitat along many water ways has been removed in order to plant agricultural crops, thus removing important habitat and food sources for beaver.

Beavers create dams that restrict fish passage, and are removed in order to restore fish passage.

5.2.3.2.3 Current Distribution

The beaver is found throughout most of North America except in the Arctic tundra, peninsular Florida, and the Southwestern deserts (Figure_57) (Allen 1983; VanGelden 1982; Zeveloff 1988).

Figure 57. Geographic distribution of American beaver (Castor canadensis) (Linzey and Brecht 2002).

5.2.3.2.4 Population Trend Status

Trend and population data are not available for the Ecoprovince.

5.2.3.2.5 Structural Condition Associations

Beaver are generally associated (A) with multi-structural tree conditions and present (P) in grass/forbs sites with a tree overstory (Table 41). Not closely associated with any specific structural condition, this "generalist" species requires permanent water, but otherwise utilizes a wide range of riparian wetland habitat structural conditions.

Table 41. Beaver structural conditions and association relationships (NHI 2003).

Common Name	Focal Habitat	Structural Condition (SC)	SC Activity	SC Assoc.
American Beaver	Riparian Wetlands	Giant Tree-Multi-Story	F/R-HE	P
		Grass/Forb-Closed	F/R-HE	P
		Grass/Forb-Open	F/R-HE	P
		Large Tree-Multi-Story-Closed	F/R-HE	A
		Large Tree-Multi-Story-Moderate	F/R-HE	A
		Large Tree-Multi-Story-Open	F/R-HE	A
		Large Tree-Single Story-Closed	F/R-HE	A
		Large Tree-Single Story-Moderate	F/R-HE	A
		Large Tree-Single Story-Open	F/R-HE	A
		Medium Tree-Multi-Story-Closed	F/R-HE	A
		Medium Tree-Multi-Story-Open	F/R-HE	A
		Medium Tree-Single Story-Closed	F/R-HE	A
		Medium Tree-Single Story-Moderate	F/R-HE	A
		Medium Tree-Single Story-Open	F/R-HE	A
		Sapling/Pole-Closed	F/R-HE	A
		Sapling/Pole-Moderate	F/R-HE	A
		Sapling/Pole-Open	F/R-HE	A
		Shrub/Seedling-Closed	F/R-HE	A
		Shrub/Seedling-Open	F/R-HE	A
		Small Tree-Multi-Story-Closed	F/R-HE	A
		Small Tree-Multi-Story-Moderate	F/R-HE	A
		Small Tree-Multi-Story-Open	F/R-HE	A
		Small Tree-Single Story-Closed	F/R-HE	A
		Small Tree-Single Story-Moderate	F/R-HE	A
		Small Tree-Single Story-Open	F/R-HE	A
		Low Shrub-Closed Shrub Overstory-Mature	F/R-HE	P
		Low Shrub-Closed Shrub Overstory-Old	F/R-HE	P
		Low Shrub-Closed Shrub Overstory-Seedling/Young	F/R-HE	P
		Low Shrub-Open Shrub Overstory-Mature	F/R-HE	P
		Low Shrub-Open Shrub Overstory-Old	F/R-HE	P

Common Name	Focal Habitat	Structural Condition (SC)	SC Activity	SC Assoc.
		Low Shrub-Open Shrub Overstory-Seedling/Young	F/R-HE	P
		Medium Shrub-Closed Shrub Overstory-Mature	F/R-HE	P
		Medium Shrub-Closed Shrub Overstory-Old	F/R-HE	P
		Medium Shrub-Closed Shrub Overstory-Seedling/Young	F/R-HE	P
		Medium Shrub-Open Shrub Overstory-Mature	F/R-HE	P
		Medium Shrub-Open Shrub Overstory-Old	F/R-HE	P
		Medium Shrub-Open Shrub Overstory-Seedling/Young	F/R-HE	P
		Tall Shrub-Closed Shrub Overstory-Mature	F/R-HE	P
		Tall Shrub-Closed Shrub Overstory-Old	F/R-HE	P
		Tall Shrub-Closed Shrub Overstory-Seedling/Young	F/R-HE	P
		Tall Shrub-Open Shrub Overstory-Mature	F/R-HE	P
		Tall Shrub-Open Shrub Overstory-Old	F/R-HE	P
		Tall Shrub-Open Shrub Overstory-Seedling/Young	F/R-HE	P

5.2.3.3 Yellow-breasted Chat

5.2.3.3.1 General Habitat Requirements

Yellow-breasted chats are found in second growth, shrubby old pastures, thickets, bushy areas, scrub, woodland undergrowth, and fence rows, including low wet places near streams, pond edges, or swamps, thickets with few tall trees, early successional stages of forest regeneration, and in sites close to human habitation. In winter, yellow-breasted chats establish territories in young second-growth forest and scrub (Dennis 1958; Thompson and Nolan 1973; Morse 1989).

5.2.3.3.2 Limiting Factors

Threats the yellow-breasted chats include habitat loss due to successional changes and clearing of land for agricultural or residential development. These birds are frequently parasitized by the brown-headed cowbird (*Molothrus ater*), but whether this has a significant impact on reproductive success is not well known.

5.2.3.3.3 Current Distribution

Yellow-breasted chat breeding range includes southern British Columbia across southern Canada and the northern U.S. to southern Ontario and central New York, south to southern Baja California, to Sinaloa on Pacific slope, to Zacatecas in interior over plateau, to southern Tamaulipas on Atlantic slope, and to Gulf Coast and northern Florida (AOU 1998).

Yellow-breasted chat non-breeding range includes southern Baja California, southern Sinaloa, southern Texas, southern Louisiana, and southern Florida south (rarely north to Oregon, Great Lakes, New York, and New England) to western Panama (AOU 1998).

5.2.3.3.4 Population Trend Status

North American BBS data indicate a significant population decline in eastern North America, 1966-1988; and a significant increase in western North America, 1978-1988 (Sauer and Droege 1992); in North America overall, from 1966-1989, there was a nonsignificant decline averaging 0.8 percent per year from 1966-1989 (Droege and Sauer 1990), a nonsignificant 9% decline from 1966 to 1993, and a barely significant increase of 8% from 1984 to 1993 (Price *et al.* 1995). Yellow-breasted chats may have declined in south-central and southeastern New York between the early 1900s and mid-1980s (Eaton, in Andrle and Carroll 1988). Numbers have steadily declined in some areas of Ohio, though the range has not changed much since the 1930s (Peterjohn and Rice 1991). Yellow-breasted chat has declined in Indiana and Illinois since the mid-1960s. Yellow-breasted chat has declined along the lower Colorado River with loss of native habitat (Hunter *et al.* 1988). Canada: thought to be slowly declining due to habitat destruction in British Columbia; populations in Alberta and Saskatchewan apear to be stable; population has declined at Point Pelee National Park in Ontario, which contains a considerable proportion of the province's small population; no longer breeds at Rondeau Provincial Park (Ontario); population on Pelee Island (Ontario) appears to be stable (Cadman and Page 1994). Washington trends are illustrated in Figure_58. Yellow-breasted chat breeding season abundance (from BBS data) is illustrated in Figure_59 and winter season abundance (from CBC data) is illustrated in Figure_60.

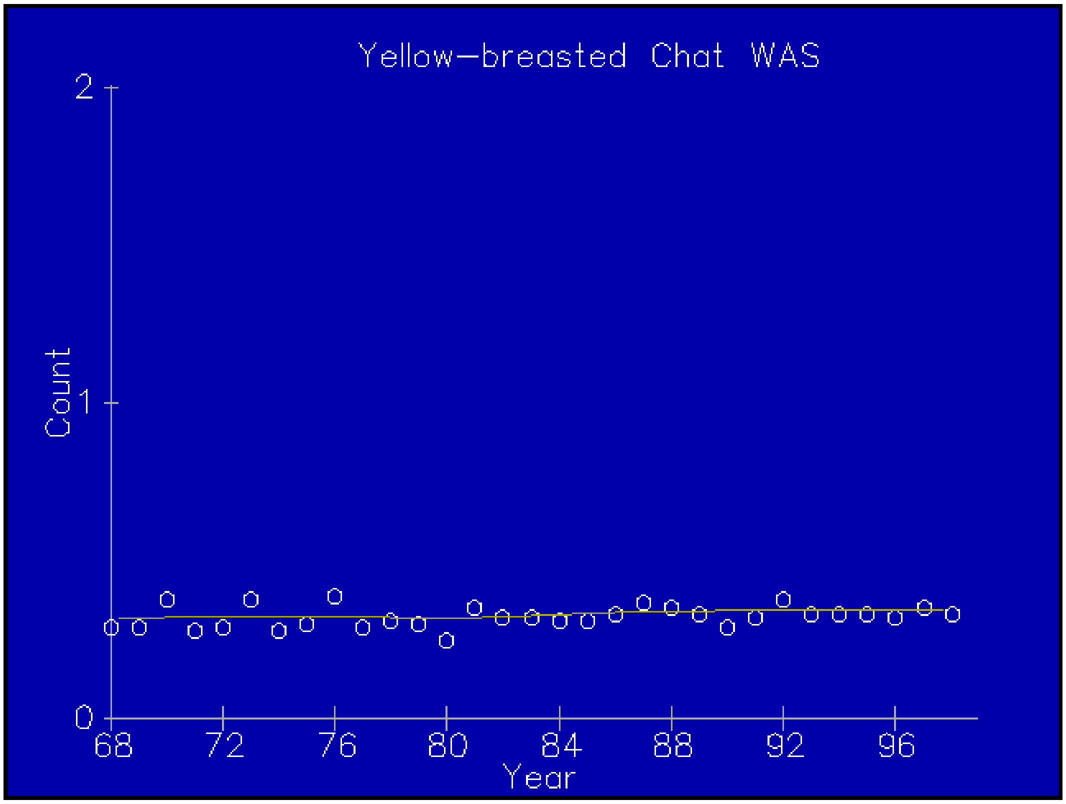


Figure 58. Yellow-breasted chat population trend results from BBS data (Sauer *et al*. 2003).

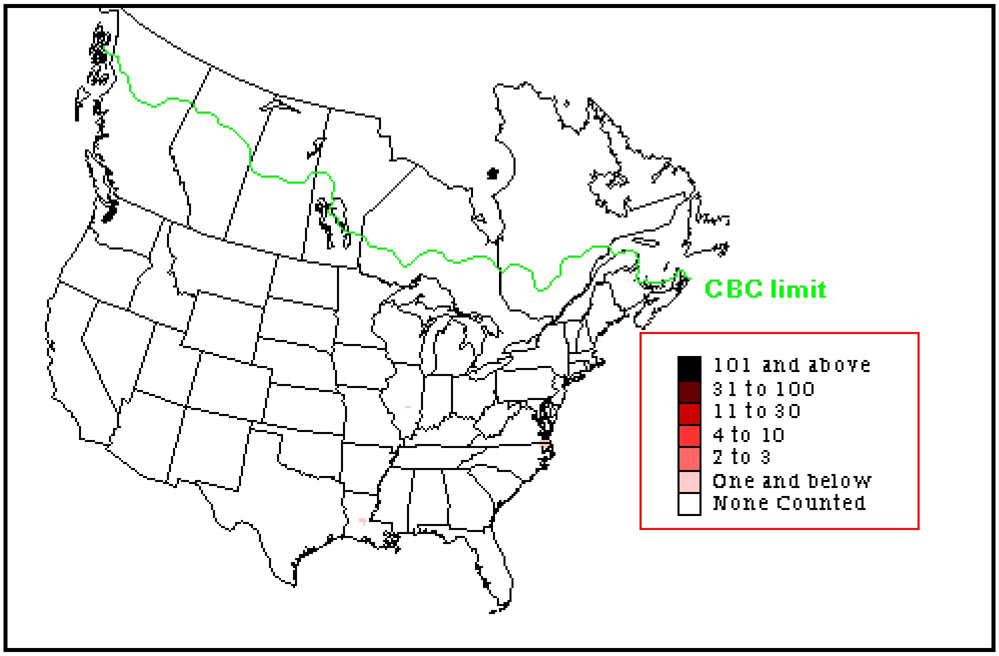


Figure 59. Yellow-breasted chat breeding season abundance from BBS data (Sauer *et al.* 2003).

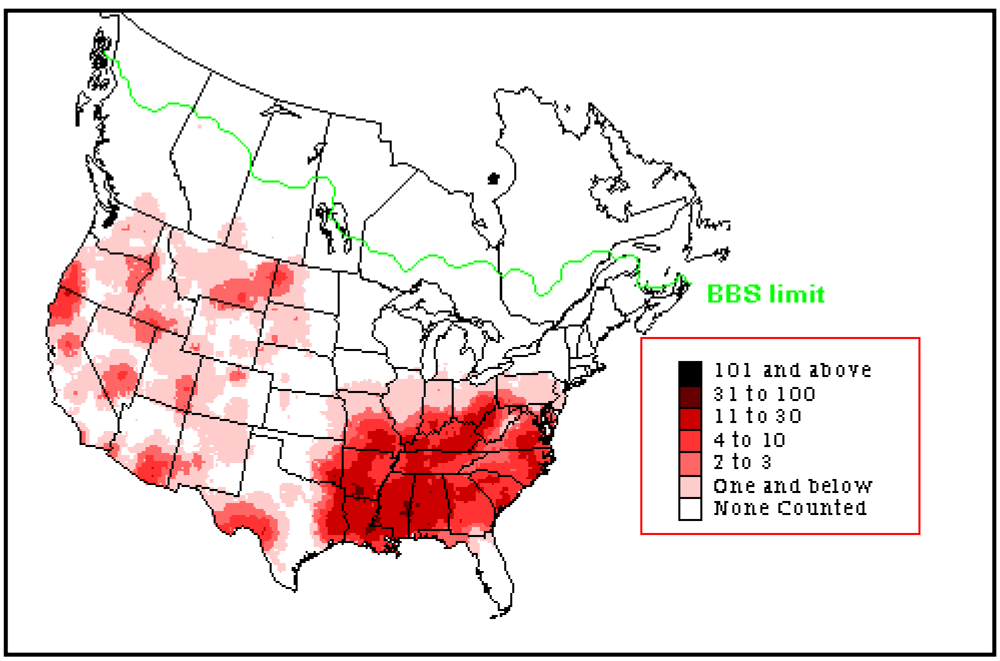


Figure 60. Yellow-breasted chat winter season abundance from CBC data (Sauer *et al*. 2003).

5.2.3.3.5 Structural Condition Associations

Yellow-breasted chat are dependent upon and closely associated (C) with tall shrub open to closed canopy conditions and sapling/pole tree structural conditions that mimic tall shrub structural attributes. Chats are also generally associated (A) with and utilize other shrub/tree structural conditions (Table_42).

Table 42. Yellow-breasted chat structural conditions and association relationships (NHI 2003).

Common Name	Focal Habitat	Structural Condition (SC)	SC Activity	SC Assoc.
Yellow-breasted Chat	Riparian Wetlands	Sapling/Pole-Moderate	B	A
		Sapling/Pole-Open	B	C
		Shrub/Seedling-Closed	B	A
		Shrub/Seedling-Open	B	C
		Small Tree-Single Story-Open	B	A
		Tall Shrub-Closed Shrub Overstory-Mature	B	C
		Tall Shrub-Closed Shrub Overstory-Old	B	C
		Tall Shrub-Closed Shrub Overstory-Seedling/Young	F	A
		Tall Shrub-Open Shrub Overstory-Mature	B	C
		Tall Shrub-Open Shrub Overstory-Old	B	C
		Tall Shrub-Open Shrub Overstory-Seedling/Young	F	A

5.2.3.4 Lewis' Woodpecker

5.2.3.4.1 General Habitat Requirements

Habitats used by Lewis' woodpeckers are characterized by their openness (Bock 1970). Open forests allow sufficient visibility and movement for the Lewis' woodpecker to flycatch effectively and also allow the development of a shrubby understory that supports terrestrial insects. Vertical interspersion of vegetative strata is important in evergreen forests and in burns in meeting habitat requirements for breeding and, to a lesser degree, for winter habitat. Although logged or burned habitats may provide suitable habitat for 10 to 30 years following the disturbance, the habitat will be unsuitable if it does not contain a shrub stratum (as a result, for example, of overgrazing or intensive forest management). However, the presence of a shrubby understory is apparently of less importance in riparian areas, farmstead fence rows, and oak woodlands. Although the reasons for such a difference in the importance of shrubs is unclear, it may be due to different feeding strategies in coniferous and burned habitats compared to riparian and oak habitats.

The Lewis' woodpecker is restricted, as a breeding species, to areas below the upper montane life zone. Park-like ponderosa pine stands provide the major breeding habitat of the Lewis; woodpecker throughout its range (Bock 1970). The combination of an open canopy, a brushy understory, and an abundance of insects describes breeding habitat for the Lewis' woodpecker in ponderosa pine forests. Logged or burned coniferous forests that are structurally similar to park-like pine stands also provide suitable breeding habitat. At lower elevations, breeding habitat is provided by riparian cottonwood groves, fence rows in agricultural areas, and oak woodlands. Suitalbe conditions for breeding in these habitats are provided by the same structural features important in ponderosa pine forests, except that shrub cover is apparently not a critical habitat feature. Areas dominated by agricultural lands may be used by Lewis' woodpeckers if sufficient nest trees are available in fence rows, along roads, or around buildings (Bock *et al.* 1971). Pinyon-juniper woodlands are infrequently occupied, possible because such woodlands typically occur on dry sites that may not support sufficient insect prey (Bock 1970).

Lewis' woodpeckers are cavity nesters but are not well suited for excavating their own cavities except in dead or dying trees (Bock 1970). The height of nest cavities summarized by Bock (1970) ranged from 5 to 170 feet, although Thomas *et al.* (1979a) considered the minimum snag height to be 30 feet. Suitable snags have a minimum diameter at breast height of 12 inches (Thomas *et al.* 1979a). An average density of one suitable snag per acre is required to support maximum breeding densities of Lewis' woodpeckers in the Blue Mountains of Washington and Oregon (Thomas *et al.* 1979a). The proportion of the maximum population that can be supported is considered to be positively correlated with snag density; for example, in otherwise equal habitat, an area with an average density of only 0.5 snags/acre will support only 50 percent of the maximum breeding population.

It is assumed that canopy conditions will be optimal if tree canopy closure is less than 30 percent and will be unsuitable if canopy closure exceeds 75 percent. Optimal understory conditions are assumed to exist if shrub crown cover exceeds 50 percent. Both understory and canopy conditions must be optimal in order to have optimal conditions in ponderosa pine stands. If tree canopy closure exceeds 75 percent or if no shrubs occur in the understory, then it is assumed that the habitat will not be useable by the Lewis' woodpecker. The same habitat features may be used to describe foraging habitat during the breeding season in deciduous cover types, although a dense shrub stratum is apparently unnecessary. In deciduous cover types, the presence of shrubs is considered to add to the food value, but will not be limiting to food suitability.

Cavity nesters generally face a shortage of nesting sites where trees occur in clumps (Jackman 1975). In areas of high demand for sites, Lewis' woodpeckers may nest within a short distance of each other. Currier (1928) reported three holes that were occupied by Lewis' woodpeckers in each of two trees less than 0.25 miles apart. Managed forests generally have fewer available nesting sites than do natural forests, because snags and diseased and damaged trees are usually removed (Jackman 1975). Lewis' woodpeckers exhibit a strong pair bond and high nest fidelity, returning to nest in the same cavity in consecutive years (Bock 1970).

5.2.3.4.2 Limiting Factors

Although preferred habitat types for breeding and wintering remain structurally similar from year to year, the presence of Lewis' woodpeckers in any given preferred habitat depends heavily on the food supply, either insects or mast (Bock 1970). Because the habitat needs of Lewis' woodpeckers are more specialized in winter than during the breeding season, destruction of winter range represents a greater potential threat to the species than loss of breeding habitat.

Lewis' woodpecker habitat may be adversely affected by grazing as it eliminates brushy undergrowth (Jackman 1975). Forest management practices that provide snags, a brushy understory, and slash provide suitable Lewis' woodpecker habitat.

Lewis' woodpecker is vulnerable to processes that result in loss of large snags (nesting sites) or degradation of foraging habitat. Such habitat alteration evidently is the reason for the declines that have occurred in coastal areas of British Columbia and Washington. Drought and overgrazing pose continued threats to riparian habitats in arid regions (Ehrlich *et al.* 1992). Fire suppression encourages the replacement of ponderosa pine forests by Douglas-fir, and leads to denser, closed-canopy forest stands. Lewis' woodpeckers will decline with fire suppression in ponderosa pine/Douglas fir stands compared to regular fire intervals of 10-30 years (Saab and Dudley 1998). Lewis' woodpeckers may be most sensitive to destruction of specialized winter habitat (Sousa 1983). Sousa (1983) also suggested that European starlings (*Sturnus vulgaris*) may usurp nesting habitat. Lewis' woodpecker does not appear to be sensitive to direct human disturbance (USFS 1994).

5.2.3.4.3 Current Distribution

Lewis' woodpeckers are found throughout the Columbia Basin as far north as Revelstoke and Golden, British Columbia. The Lewis' woodpecker breeds in the southern interior from the Similkameen Valley east to the East Kootenay Trench and north to Revelstoke and near Williams Lake. The core breeding range is in the Okanagan Valley and Thompson Basin. Occasionally, small numbers breed beyond the normal limits of its range. Lewis' woodpecker formerly bred in southeastern Vancouver Island and the lower Fraser Valley (Cannings *et al.* In prep.).

Lewis' woodpecker breeds in North America from interior British Columbia and southwestern Alberta south to Arizona and New Mexico, and from coastal California east to Colorado. Virtually the entire Canadian population occurs in British Columbia. The birds winter from interior British Columbia (casually) south through the western states to northern Mexico, but mainly in the southwestern United States (Cannings *et al.* in prep.).

5.2.3.4.4 Population Trend Status

Historical source habitats for Lewis' woodpecker occurred in most watersheds of the Ecoprovince (Wisdom *et al.* in press). Within this core of historical habitat, declines in source habitats have been strongly reduced from historical levels, including 97 percent in the Columbia Plateau and 95 percent in the Owyhee Uplands. Within the entire interior Columbia Basin, overall decline in source habitats for this species was the greatest among 91 species of vertebrates analyzed (Wisdom *et al.* in press).

Lewis' woodpecker populations tend to be scattered and irregular and are considered rare, uncommon, or irregularly common throughout their range; local abundance may be cyclical or irregular (Tobalske 1997). In the past century, populations have apparently declined in British Columbia by more than 50 percent and decreased in Oregon, California, and Utah (DeSante and George 1994). Based on North American BBS data, numbers may have declined more than 60 percent overall between the 1960s and mid-1990s (Tobalske 1997). Breeding Bird Survey data indicate a significant decline in the United States for the period 1966-1996 (-3.3 percent average annual decrease; P = 0.01; N = 62 survey routes) and a nonsignificant declining trend between 1980 and 1996 (-1.7 percent; P = 0.22; N = 53). Thirty-year trends were negative but not statistically significant survey-wide. For the Western BBS Region and California, trends were positive but not statistically significant for these analysis areas from 1980 to 1996. Mapped trends for 1966-1996 show steep declines throughout the range. Overall, however, BBS sample sizes are relatively low for robust trend analysis (Sauer *et al.* 1997). Declines have occurred in coastal areas of British Columbia and Washington. Lewis' woodpecker trend data for Washington are illustrated in Figure_61.

Christmas Bird Count (CBC) data show nonsignificant declining trends survey-wide and in California, Colorado, and Oregon, and a nonsignificant increase in Arizona, for the period form 1959 to 1988 (Figure_62) (Sauer *et al.* 1996). Ehrlich *et al.* (1992) suggest that populations appear to have stabilized recently, but those in riparian habitats in arid regions continue to be vulnerable to drought, overgrazing, and other habitat degradations.

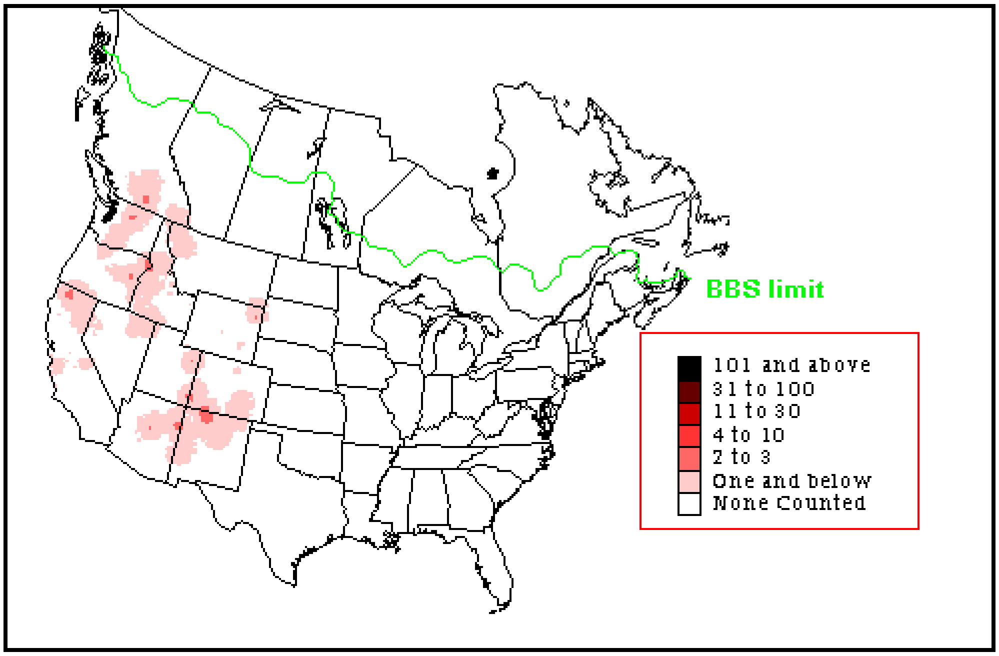


Figure 61. Lewis' woodpecker breeding season abundance (from BBS data) (Sauer *et al.* 1997).

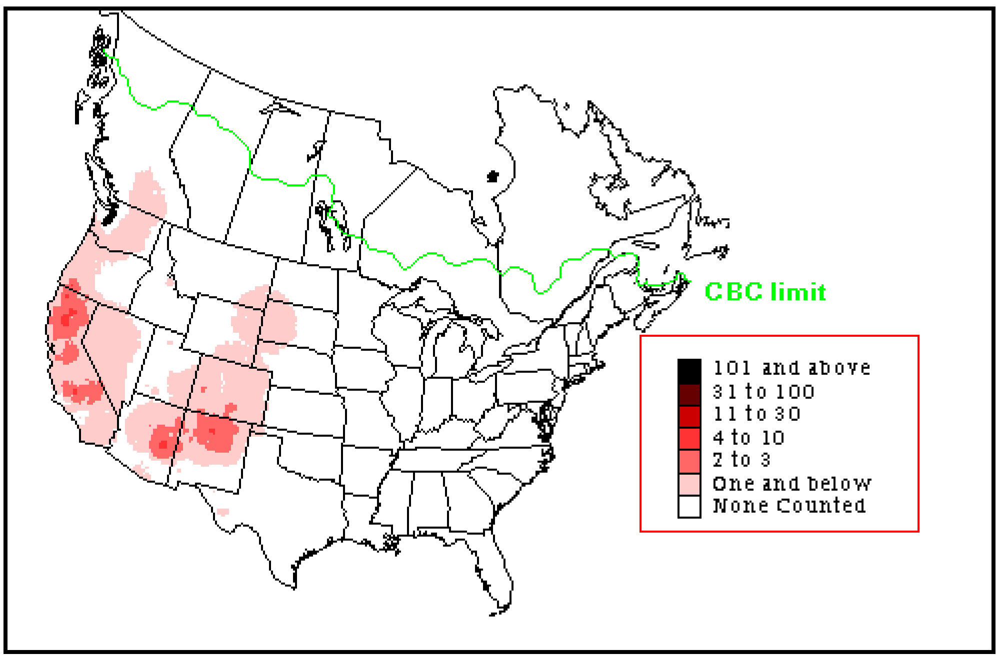


Figure 62. Winter season abundance from CBC data (Sauer *et al.* 1996).

5.2.3.4.5 Structural Condition Associations

Northwest Habitat Institute data (2003) suggest that Lewis' woodpecker utilize and are generally associated (A) with a wide range of structural conditions for feeding and reproduction (F/R). The data further infers that this is more of a "generalist" species and is not dependent upon or closely associated (C) with any specific structural condition. Lewis' woodpecker are also present (P) in numerous other structural conditions (Table 43).

Table 43. Lewis' woodpecker structural condition and association relationships (NHI 2003).

Common Name	Focal Habitat	Structural Condition (SC)	SC Activity	SC Assoc.
Lewis' Woodpecker	Riparian Wetlands	Giant Tree-Multi-Story	F/R-HE	A
		Grass/Forb-Closed	F/R-HE	A
		Grass/Forb-Open	F/R-HE	A
		Large Tree-Multi-Story-Moderate	F/R-HE	A
		Large Tree-Multi-Story-Open	F/R-HE	A
		Large Tree-Single Story-Moderate	F/R-HE	A
		Large Tree-Single Story-Open	F/R-HE	A
		Medium Tree-Multi-Story-Moderate	F/R-HE	A
		Medium Tree-Multi-Story-Open	F/R-HE	A
		Medium Tree-Single Story-Moderate	F/R-HE	A
		Medium Tree-Single Story-Open	F/R-HE	A
		Shrub/Seedling-Closed	F/R-HE	A
		Shrub/Seedling-Open	F/R-HE	A
		Small Tree-Multi-Story-Moderate	F/R-HE	P
		Small Tree-Multi-Story-Open	F/R-HE	P
		Small Tree-Single Story-Moderate	F/R-HE	P
		Small Tree-Single Story-Open	F/R-HE	P
		Grass/Forb-Closed	F/R-HE	P
		Grass/Forb-Open	F/R-HE	P
		Medium Shrub-Closed Shrub Overstory-Mature	F/R-HE	P
		Medium Shrub-Closed Shrub Overstory-Old	F/R-HE	P
		Medium Shrub-Closed Shrub Overstory-Seedling/Young	F/R-HE	P
		Medium Shrub-Open Shrub Overstory-Mature	F/R-HE	P
		Medium Shrub-Open Shrub Overstory-Old	F/R-HE	P
		Medium Shrub-Open Shrub Overstory-Seedling/Young	F/R-HE	P
		Tall Shrub-Open Shrub Overstory-Mature	F/R-HE	P
		Tall Shrub-Open Shrub Overstory-Old	F/R-HE	P
		Tall Shrub-Open Shrub Overstory-Seedling/Young	F/R-HE	P

5.2.3.5 Willow Flycatcher

5.2.3.5.1 General Habitat Requirements

Willow flycatchers are restricted to riparian habitats with dense patches of shrubs interspersed with openings (Altman and Holmes 2000). In southeastern Oregon, birds were most abundant in riparian habitats where the willow vegetation measured greater than 8,490 yd^3/2.5 acres and less abundant in areas where willow was less than 2,049 yd^3/2.5 acres (Sanders and Edge 1998 in Altman and Holmes 2000).

The following habitat features of riparian areas in the Columbia Plateau are recommended: patch size greater than 12 yd^2 of dense native shrubs interspersed with openings of herbaceous vegetation; 40-80 percent shrub layer cover; shrub layer height greater than 39 inches high; and tree cover less than 30 percent (Altman and Holmes 2000). Suitable habitat patches should be greater than 20 acres within a matrix of habitat where less than 10 percent is agricultural land that is subject to moderate-heavy grazing as such areas support higher brown-headed cowbird densities.

Nests are usually constructed in dense shrubs low to the ground, between 20 and 39 inches above ground (Sedgwick 2000). One study in eastern Washington found birds nesting in ninebark (*Physocarpus malvaceous*) brush habitat, willow, hawthorn, and chokecherry (Frakes and Johnson 1982). In southeastern Washington, nests have been located in rose, hawthorn, cow parsnip, and chokecherry (Sedgwick 2000).

5.2.3.5.2 Limiting Factors

Flycatchers are vulnerable to a variety of human influences such as damming, dredging, channelization, urbanization, and de-watering of streams as in many cases they will not nest in the absence of flowing water (Sedgwick 2000). Channeling of riparian areas is discouraged as this reduces the riparian floodplain and the associated shrub habitat.

Belsky *et al.* (1999) summarized available literature concerning the major effect of livestock grazing on riparian systems in arid rangelands in the western United States and concluded, "*Livestock grazing was found to negatively affect water quality and seasonal quantity, steam channel morphology, hydrology, riparian zone soils, instream and streambank vegetation, and aquatic and riparian wildlife*." For willow flycatchers, excessive or improper livestock grazing can reduce the recruitment of shrub vegetation in riparian areas used by willow flycatchers (Altman and Holmes 2000). Grazing results in negative impacts to willow flycatchers, including soil compaction and gullying (resulting in a drying of wet meadows), grazing of willow vegetation, and changes in vegetation height. In some cases cattle activity may disturb or trample nests constructed low in the vegetation (Sedgwick 2000).

Willow flycatchers are particularly vulnerable to nest parasitism by brown-headed cowbirds resulting in reduced productivity, even in suitable areas. Concentration of livestock in riparian areas attracts cowbirds to these sites potentially impacting willow flycatchers (Altman and Holmes 2000). In Oregon, willow flycatchers were more abundant in rarely grazed/undisturbed willow habitats than grazed habitats. Additionally, dramatic increases in flycatcher densities followed reduction in cattle-grazing and elimination of willow cutting and spraying (Sedgwick 2000).

5.2.3.5.3 Current Distribution

Willow flycatchers are common on the west side of the state in wetlands, shrubby areas, and clearcuts. In the central Columbia Basin, willow flycatchers are rare primarily because of hotter, drier conditions than what is typically found west of the Cascades. Shrubsteppe habitats are generally considered peripheral breeding range, but birds may be found in areas of low density development, forest patches, and wetlands (Smith *et al.* 1997). Breeding Bird Survey data for Washington (Figure_63 and Figure_64) illustrate breeding and summer distribution of willow flycatchers. The BBS data also show a significant population decrease from 1966-1996 (Sauer *et al.* 2003).

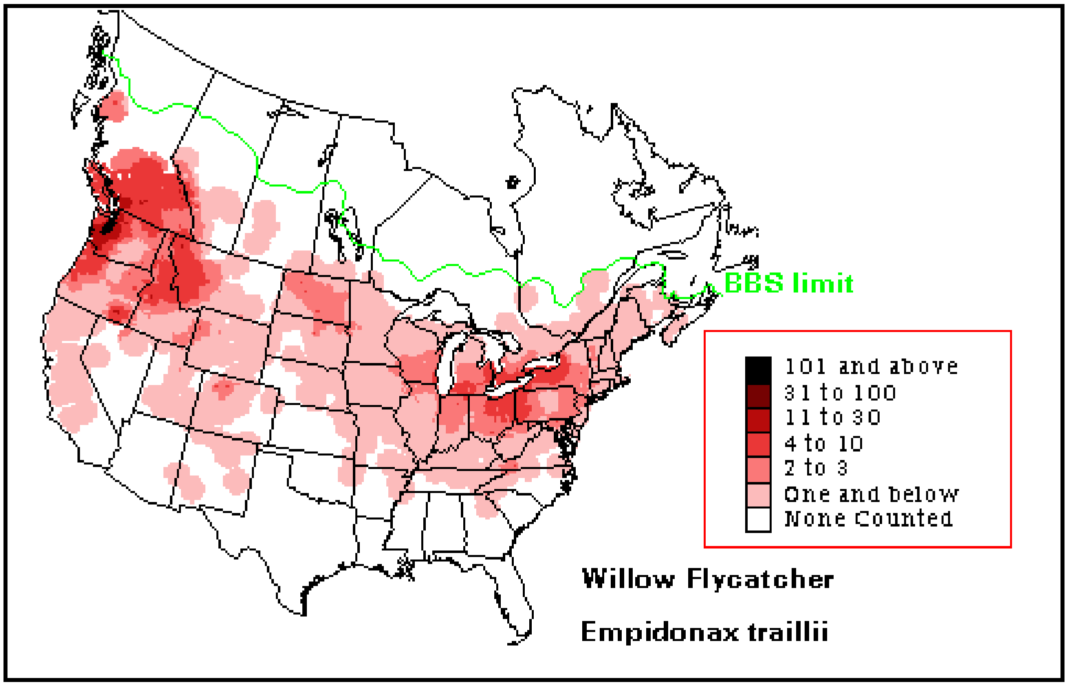


Figure 63. Willow flycatcher breeding distribution from BBS data (Sauer *et al.* 2003).

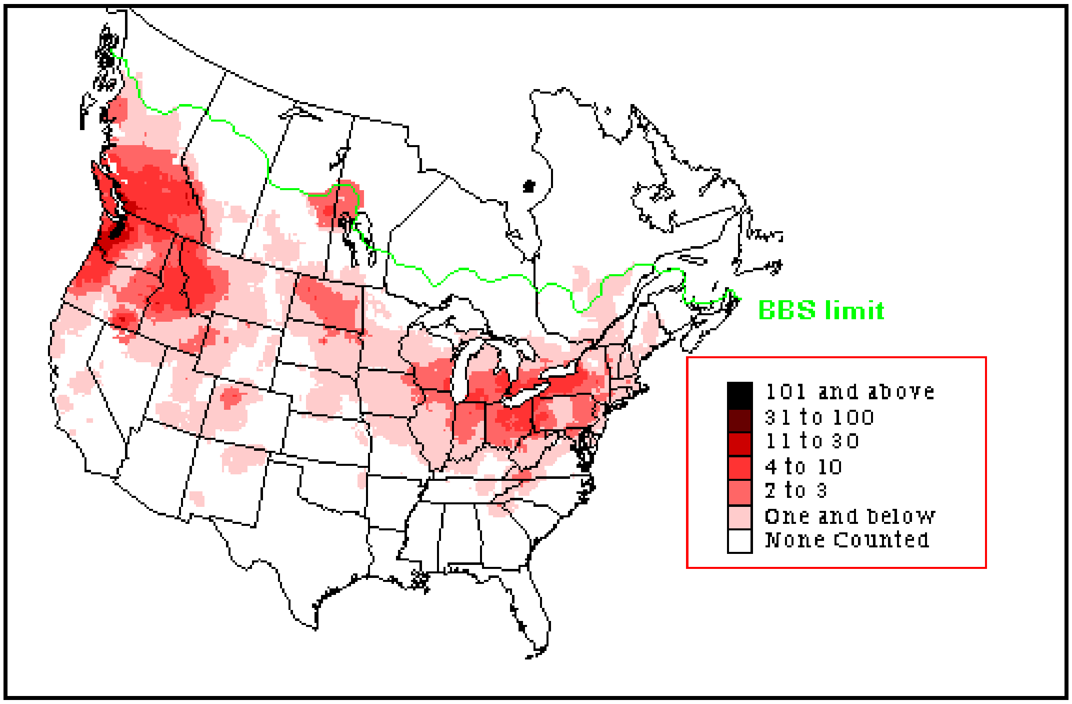


Figure 64. Willow flycatcher summer distribution from BBS data (Sauer *et al.* 2003).

Douglas County
Willow flycatchers are rare to uncommon but breeding and migrating birds have been found in suitable willow and riparian habitats. Documented areas where willow flycatchers have been sighted in the county include West Foster Creek, Central Ferry Canyon (both observations in June, M. Schroeder personal communication), McCartney Creek, Douglas Creek, and Alstown (observations in June and July, D. Stevens personal communication).

5.2.3.5.4 Population Trend Status

The southwestern subspecies, *E. t. extrimus*, was listed in 1995 as endangered by the USFWS. In Washington, the willow flycatcher is listed on the Audubon Society Watchlist. Breeding Bird Survey data indicate a continent wide decline in willow flycatcher numbers between 1966 and1996. Population trend data are illustrated in Figure_64. Habitat loss, degradation and overgrazing by livestock are cited as the major causes of this decline (Sedgwick 2000).

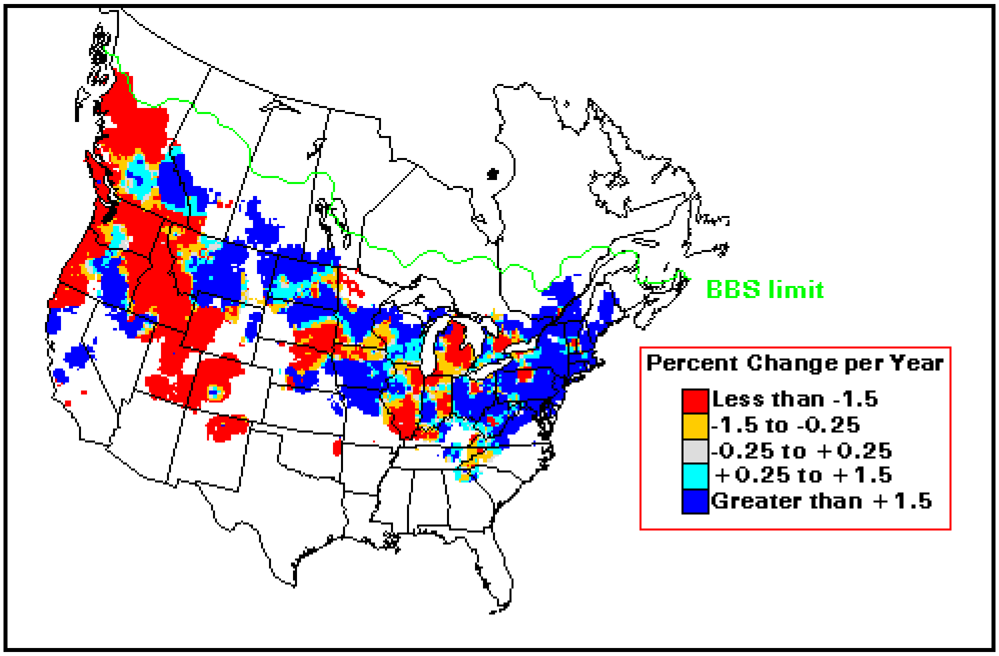


Figure 65. Willow flycatcher BBS population trend: 1966-1996 (Sauer *et al.* 2003).

5.2.3.5.5 Structural Condition Associations

The willow flycatcher is generally associated (A) with structural conditions that include sapling/small trees and tall shrubs, but is not dependent upon nor closely associated (C) with any specific structural condition (NHI 2003). It has also been present (P) in seedling shrub structural conditions (Table_44).

Table 44. Willow flycatcher structural condition and association relationships (NHI 2003).

Common Name	Focal Habitat	Structural Condition (SC)	SC Activity	SC Assoc.
Willow Flycatcher	Riparian Wetlands	Sapling/Pole-Closed	B	A
		Sapling/Pole-Moderate	B	A
		Sapling/Pole-Open	B	A
		Shrub/Seedling-Closed	B	P
		Shrub/Seedling-Open	B	P
		Small Tree-Multi-Story-Closed	B	A
		Small Tree-Multi-Story-Moderate	B	A
		Small Tree-Multi-Story-Open	B	A
		Small Tree-Single Story-Closed	B	A
		Small Tree-Single Story-Moderate	B	A
		Small Tree-Single Story-Open	B	A

Common Name	Focal Habitat	Structural Condition (SC)	SC Activity	SC Assoc.
		Tall Shrub-Closed Shrub Overstory-Mature	B	A
		Tall Shrub-Closed Shrub Overstory-Old	B	A
		Tall Shrub-Closed Shrub Overstory-Seedling/Young	B	A
		Tall Shrub-Open Shrub Overstory-Mature	B	A
		Tall Shrub-Open Shrub Overstory-Old	B	A
		Tall Shrub-Open Shrub Overstory-Seedling/Young	B	A

5.2.3.6 Eastside (Interior) Riparian Wetlands Structural Condition Summary

Riparian habitat structural conditions are summarized by association in Figure 66. The species selected to represent this habitat type are either generally associated (A) with structural conditions, or are present (P). The large number of structural conditions generally associated (A) with the chosen species assemblage ensures that most key structural components will be considered by wildlife managers during the planning phase. The lack of closely associated (C) structural attributes, however, suggests the need to closely examine how managing riparian habitats for the focal species assemblage will provide for the needs of riparian habitat obligate species. Future analysis should include the addition of riparian obligate species that are closely associated with structural conditions.

The structural conditions summarized in Figure 66 and associated tables can also be used to help define the range of recommended riparian habitat structural conditions, prioritize protection strategies, and guide wildlife managers in identifying important structural considerations when making specific management decisions. Land managers are also encouraged to review the KECs (fine filter) associated with structural conditions (course filter) in the NHI database (2003) to gain additional insights into habitat functionality and quality.

5.2.3.7 Eastside (Interior) Riparian Wetlands Key Ecological Functions

Key ecological functions performed by riparian wetland focal species are limitied to those carried out by beaver and great blue heron (Table 45) (NHI 2003). Key ecological functions performed by non-focal species and functional redundancy within the Ecoprovince are illustrated in Figure 67. The functional redundancy provided by non-focal species suggests that riparian habitats, at the Ecoprovince scale, can resist some change in its overall functional integrity (this may not be true at the local watershed or 6th - level HUC scale). In order to document potential changes in KEFs/functional redundancy, wildlife managers should monitor species response to habitat changes at the subbasin/project level and infer riparian obligate species population trends at the Ecoprovince scale.

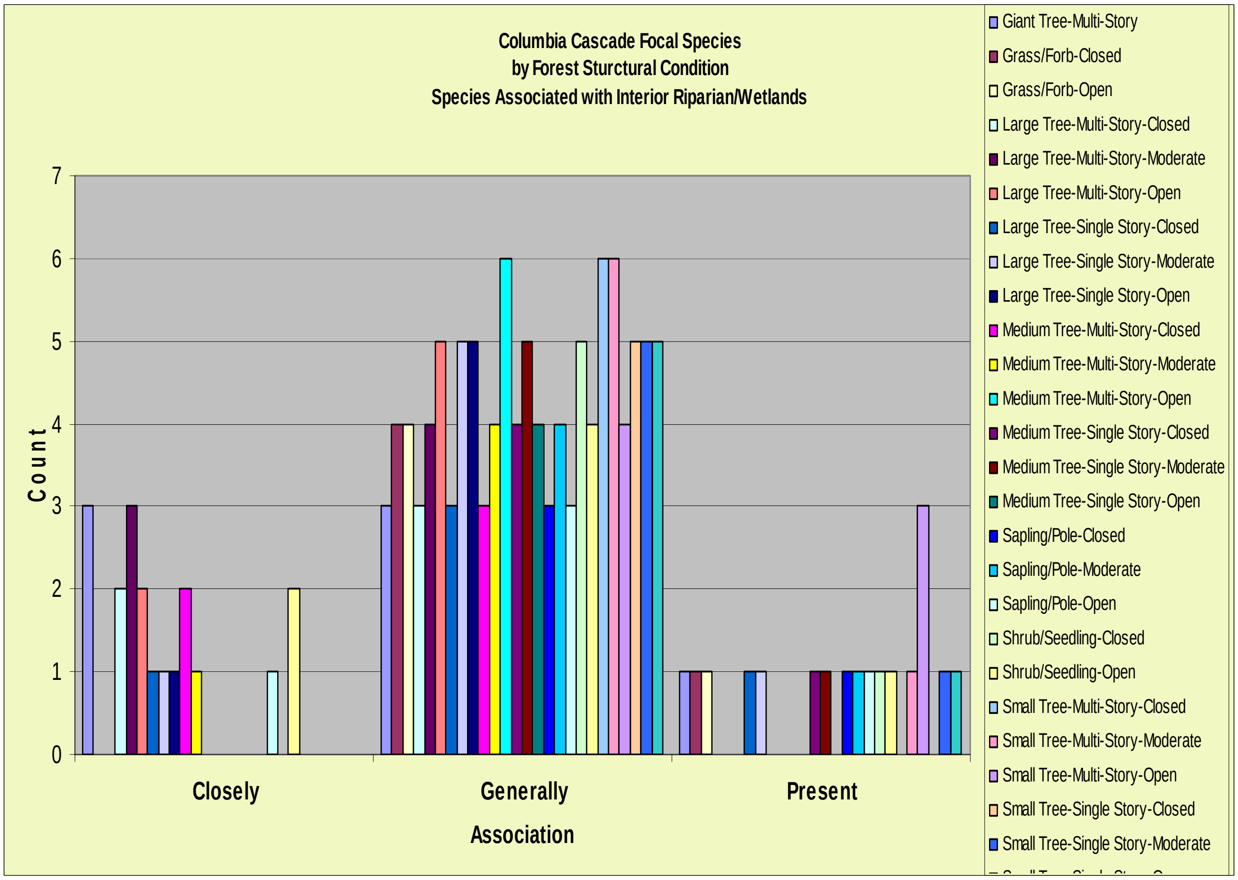


Figure 66. Riparian wetland focal species structural condition associations (NHI 2003).

Table 45. Key ecological functions performed by riparian wetlands focal species (NHI 2003).

KEF	KEF Description	Common Name	Number of Species
5.1	physically affects (improves) soil structure, aeration (typically by digging)	American beaver	1
3.9	primary cavity excavator in snags or live trees	White-headed woodpecker, Pygmy nuthatch	2
3.6	primary creation of structures (possibly used by other organisms)	American beaver	1
3.5	creates feeding, roosting, denning, or nesting opportunities for other organisms	None	0
1.1.1.9	fungivore (fungus feeder)	Mule deer	1
1.1.1.4	grazer (grass, forb eater)	Mule deer	1
1.1.1.3	browser (leaf, stem eater)	Mule deer, American beaver	2

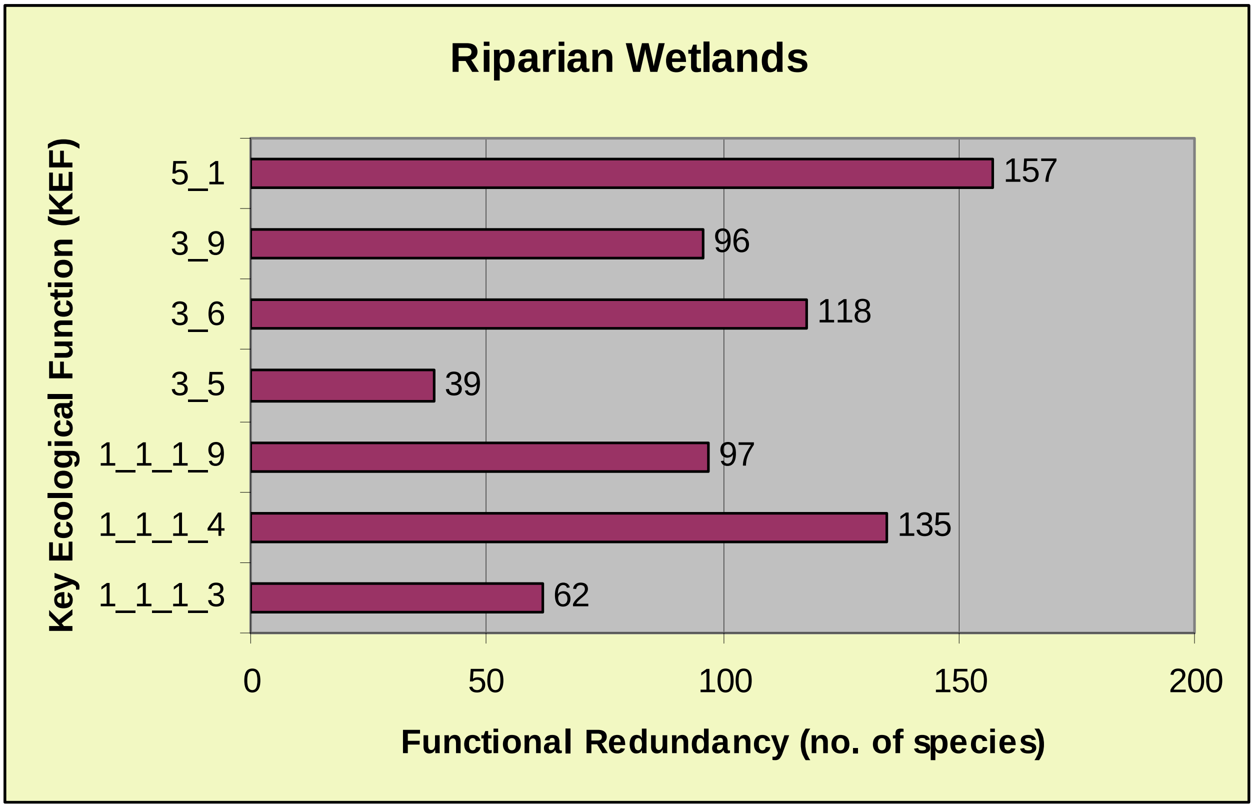


Figure 67. Functional redundancy in Ecoprovince riparian wetlands (NHI 2003).

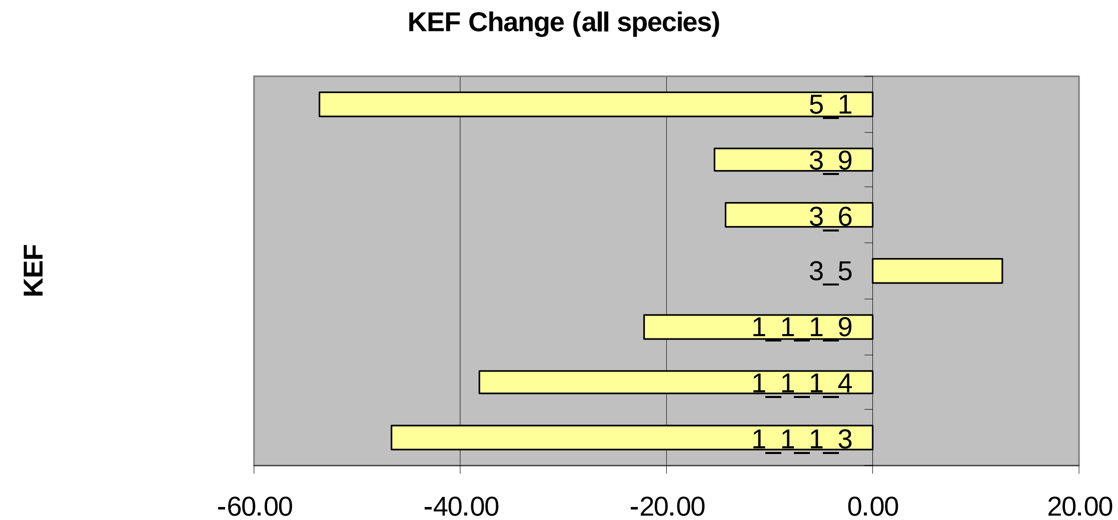
5.3 Key Ecological Functions

Eighty-five KEFs are identified in the NHI database (2003). In order to streamline the analysis process, NHI staff identified seven KEF categories that represent critical functions for most habitat types (Table_46). These KEFs were selected because there is less than 20 percent similarity of species composition among the categories. Collectively, these seven categories span the greatest species diversity. Functional redundancy, for the seven KEFs described in Table_46, for all Ecoprovince habitat types is displayed in Appendix_B.

Table 46. Descriptions of seven critical key ecological functions (NHI 2003).

KEF	KEF Description
5.1	physically affects (improves) soil structure, aeration (typically by digging)
3.9	primary cavity excavator in snags or live trees
3.6	primary creation of structures (possibly used by other organisms)
3.5	creates feeding, roosting, denning, or nesting opportunities for other organisms
1.1.1.9	fungivore (fungus feeder)
1.1.1.4	grazer (grass, forb eater)
1.1.1.3	browser (leaf, stem eater)

In summary, the number of Ecoprovince species performing KEF 3.5 has increased over historic periods by almost 13 percent. In contrast, the number of all other species performing the remaining six KEFs has decreased from just over 14 percent to nearly 54 percent (Figure_68). Clearly, there is a downward trend in functional redundancy for these seven KEFs. This same downward trend is repeated for most of the remaining 77 KEFs with the exception of species that perform KEFs associated with humans (for example, KEF 1.1.7: feeds on human garbage/refuse); functional redundancy in these KEFs has increased notably over historic periods (Appendix_B). Functional redundancy has decreased more than 50 percent in 13 KEFs.



	1_1_1_3	1_1_1_4	1_1_1_9	3_5	3_6	3_9	5_1
KEF Change	-46.73	-38.07	-22.14	12.57	-14.23	-15.38	-53.68

Figure 68. Percent change in functional redundancy for seven KEFs (NHI 2003).

Changes in the seven primary KEFs are illustrated in Appendix_G. Changes in Ecoprovince total functional diversity from circa 1850 to 1999 are displayed at the 6th - level HUC in Figure_69. There is little positive change (blue color shades). The vast majority of the Ecoprovince has experienced dramatic declines in total functional diversity (red color shades). The relative difference between the positive change represented by the blue HUCs and the negative change represented by the red HUCs is a factor of just over -9.

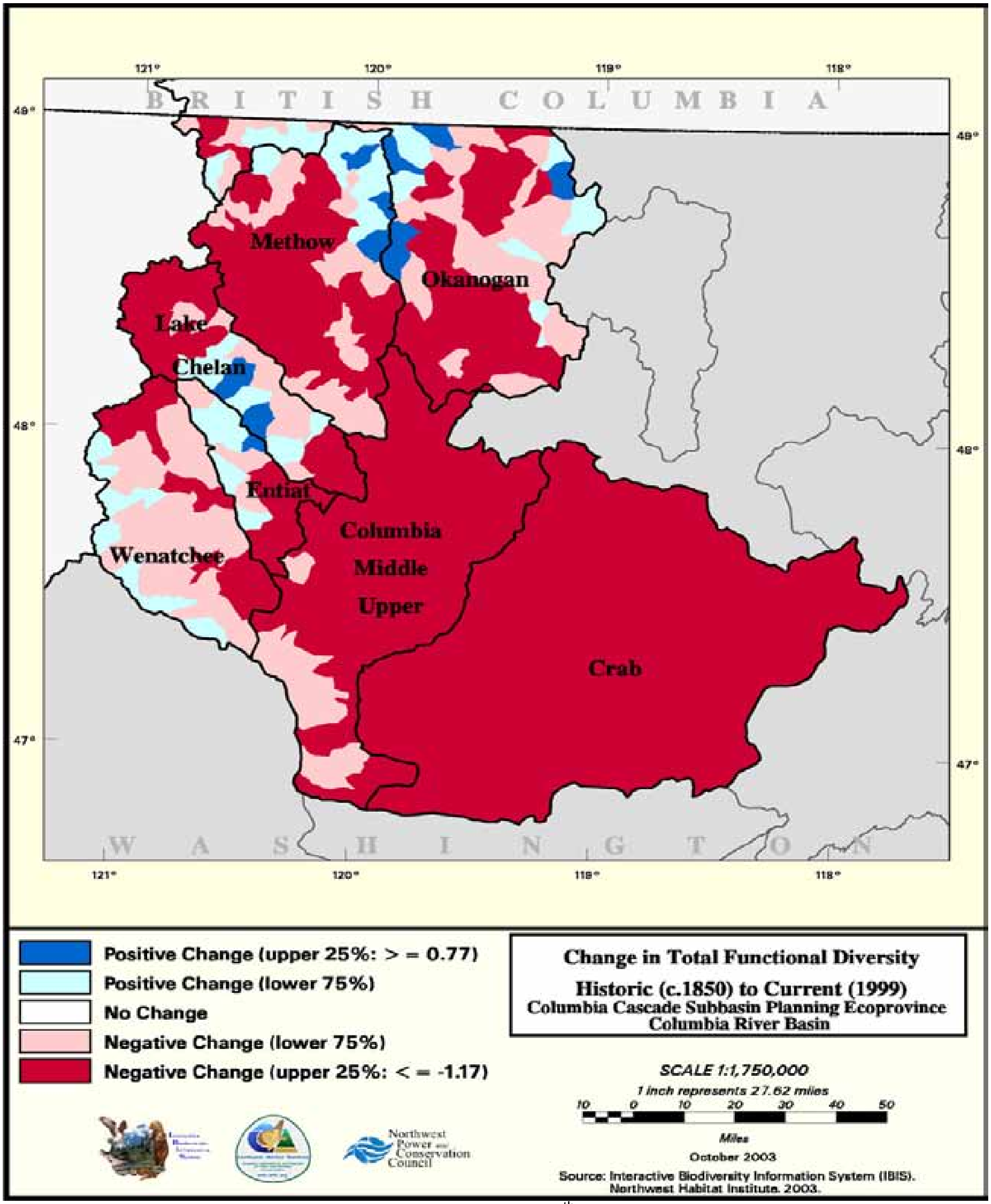


Figure 69. Changes in total functional diversity at the 6th - level HUC (NHI 2003).

5.4 Functional Specialists and Critical Functional Link Species

According to the NHI (2003), functional specialists are:

> "*species that have only one or a very few number of key ecological functions. An example is turkey vulture, which is a carrion-feeder functional specialist. Functional specialist species could be highly vulnerable to changes in their environment (such as loss of carrion causing declines or loss of carrion-feeder functional specialists) and thus might be good candidates for focal species. Few studies have been conducted to quantify the degree of their vulnerability. Note that functional specialists may not necessarily be (and often are not) also critical functional link species (functional keystone species), and vice versa.*"

Wildlife functional specialists are shown in Table_47. No Ecoprovince focal species are functional specialists.

Table 47. Wildlife functional specialists in the Columbia Cascade Ecoprovince, Washington (NHI 2003).

Common Name	Scientific Name	Number of KEFs
Sharptail Snake	*Contia tenuis*	1
Turkey Vulture	*Cathartes aura*	1
Common Nighthawk	*Chordeiles minor*	1
Common Poorwill	*Phalaenoptilus nuttallii*	1
Black Swift	*Cypseloides niger*	1
Dunn's Salamander	*Plethodon dunni*	2
Ringneck Snake	*Diadophis punctatus*	2
Harlequin Duck	*Histrionicus histrionicus*	2
Osprey	*Pandion haliaetus*	2
Gyrfalcon	*Falco rusticolus*	2
Snowy Owl	*Nyctea scandiaca*	2
Northern Pygmy-owl	*Glaucidium gnoma*	2
Boreal Owl	*Aegolius funereus*	2
Vaux's Swift	*Chaetura vauxi*	2
White-throated Swift	*Aeronautes saxatalis*	2
Olive-sided Flycatcher	*Contopus cooperi*	2
Western Wood-pewee	*Contopus sordidulus*	2
Brown Creeper	*Certhia americana*	2
Rock Wren	*Salpinctes obsoletus*	2
Canyon Wren	*Catherpes mexicanus*	2
Winter Wren	*Troglodytes troglodytes*	2
Northern Waterthrush	*Seiurus noveboracensis*	2
Masked Shrew	*Sorex cinereus*	2
Montane Shrew	*Sorex monticolus*	2
Long-eared Myotis	*Myotis evotis*	2
Western Pipistrelle	*Pipistrellus hesperus*	2
Spotted Bat	*Euderma maculatum*	2
Northern Bog Lemming	*Synaptomys borealis*	2
Wolverine	*Gulo gulo*	2
Lynx	*Lynx canadensis*	2

Similarly, critical functional link species are:

> "*those species that are the only ones that perform a specific ecological function in a community. Their removal would signal loss of that function in that community. Thus, critical functional link species are critical to maintaining the full functionality of a system. The function associated with a critical functional link species is termed a 'critical function.' Reduction or extirpation of populations of functional keystone species and critical functional links may have a ripple effect in their ecosystem, causing unexpected or undue changes in biodiversity, biotic processes, and the functional web of a community. A limitation of the concept is that little research has been done on the quantitative effects, on other species or ecosystems, or of the reduction or loss of critical functional link species.*"

Of the 10 critical functional link species within the Ecoprovince, beaver is the only one that is a focal species (Table_48).

Table 48. Critical function link species in the Columbia Cascade Ecoprovince, Washington (NHI 2003).

Habitat Name	Common Name
Shrubsteppe	Black-chinned Hummingbird
	Bushy-tailed Woodrat
	Mink
	Brown-headed Cowbird
	Rocky Mountain Elk
Riparian Wetlands	Great Blue Heron
	Bushy-tailed Woodrat
	Brown-headed Cowbird
	Double-crested Cormorant
	American Beaver
Ponderosa Pine	Snowshoe Hare
	Red Squirrel
	American Beaver
	Brown-headed Cowbird

5.5 Key Environmental Correlates

According to the NHI (2003), key environmental correlates (KECs) are:

> "*specific substrates, habitat elements, and attributes of species' environments that are not represented by overall (macro)habitats and vegetation structural conditions. Specific examples of KECs include snags, down wood, type of stream substrate, and many others. In the NHI database, KECs are denoted for each species using a standard classification system, which include the KECs for vegetation habitat elements, non-vegetation terrestrial elements, aquatic bodies and substrates, anthropogenic structures, and other categories. A limitation of the KEC information in the NHI database is that it is represented as simple categorical relations with species (e.g., a list of KECs pertinent to each species) rather than as quantified correlations (e.g., specific amounts, levels, or rates of each KEC and corresponding population densities or trends of each species); such data are essentially lacking in most cases.*"

All environmental scales, from broad floristic communities to fine-scale within stand features, are included in the definition of KECs. The word "*key*" refers to the high degree of influence (either positive or negative) the environmental correlates exert on the fitness of a given species (NHI 2003). Therefore, if a KEC is associated with a species, that KEC is important to the viability of that species.

Ecoprovince focal species are associated with 7-61 KECs (also known as habitat elements) (Table 49). Only aquatic related KECs are discussed further in this document to ensure that a link is made between terrestrial and aquatic habitats and species. Aquatic KECs associated with Ecoprovince focal species are shown in Table 50 while all aquatic KECs are listed in Appendix I.

Table 49. Ecoprovince focal species key environmental correlate counts (NHI 2003).

Common Name	Number of KECs
Grasshopper sparrow	7
Sharp-tailed grouse	26
Sage grouse	24
Pygmy rabbit	21
Mule deer	40
Willow flycatcher	15
Lewis' woodpecker	31
Red-eyed vireo	12
Yellow-breasted chat	15
American beaver	61
Pygmy nuthatch	19
Gray flycatcher	8
White-headed woodpecker	20
Flammulated owl	20

Aquatic key environmental correlates associated with terrestrial Ecoprovince focal species are shown in Table 50. Five Ecoprovince focal species are associated with aquatic KECs. American beaver has the highest number of aquatic KEC associations followed by mule deer, red-eyed vireo, yellow-breasted chat, and sharp-tailed grouse. Not all aquatic KECs are linked to salmonid bearing streams and/or free running water; they also include seeps, springs, and ephemeral ponds.

Table 50. Aquatic key environmental correlates associated with focal species (NHI 2003).

Common Name	KEC	KEC Description
Sharp-tailed grouse	4.2	rivers and streams
	4.2.13	seeps or springs
Red-eyed vireo	4.2	rivers & streams
	4.2.2	order and class
	4.2.2.3	lower perennial
Yellow-breasted chat	4.7	wetlands/marshes/wet meadows/bogs and swamps (Positive relationships only)
	4.7.1	riverine wetlands
American beaver	4.1	water characteristics
	4.1.2	water depth
	4.1.6	water velocity

Common Name	KEC	KEC Description
	4.1.8	free water (derived from any source)
	4.2	rivers & streams
	4.2.1	oxbows
	4.2.12	banks
	4.2.2	order and class
	4.2.2.1	intermittent
	4.2.2.2	upper perennial
	4.2.2.3	lower perennial
	4.2.3	zone
	4.2.3.1	open water
	4.2.3.3	shoreline
	4.2.6	coarse woody debris in streams and rivers
	4.2.7	pools
	4.3	ephemeral pools
	4.6	lakes/ponds/reservoirs
	4.6.1	zone
	4.6.1.1	open water
	4.6.1.3	shoreline
	4.6.4	size
	4.6.4.1	ponds (<2ha)
	4.7	wetlands/marshes/wet meadows/bogs and swamps (Positive relationships only)
	4.7.1	riverine wetlands
	4.7.2	context
	4.7.2.1	forest
	4.7.2.2	non-forest
Mule deer	4.1	water characteristics (specify whether negative or positive relationship in comments)
	4.1.8	free water (derived from any source)
	4.7	wetlands/marshes/wet meadows/bogs and swamps (Positive relationships only)
	4.7.2	context
	4.7.2.1	forest
	4.7.2.2	non-forest

The KEC descriptions and associated focal species in Table 50, clearly illustrate the close link between the needs of terrestrial Ecoprovince focal species, aquatic habitat elements, life requisites, and other factors influencing fish and other aquatic organisms. For example, sharp-tailed grouse may depend on hydrophytic shrubs and trees (e.g., water birch, aspen, and elderberry) growing within riparian wetland habitats for winter food (KEC 4.2). These same shrubs and trees also shade stream channels, lowering water temperatures important to salmonid survival.

Beaver physically influence aquatic habitats and KECs more than any other Ecoprovince focal species through dam building, feeding, and denning activities. Beaver manipulate water depth and velocities (KECs 4.1.2 and 4.1.6) and create pools (KEC 4.2.7) which influence water temperature, fish refugia, aquatic invertebrate populations, and water turbidity. Feeding activities alter vegetation structure and composition adjacent to and within riparian wetland habitats.

Beaver feed on aquatic vegetation, trees, and shrubs and use woody material to construct dams, which adds coarse woody debris to riverine systems (KEC 4.2.6). Adding course woody material to riparian wetland habitats through feeding activities and/or dam construction:

- alters water chemistry;
- creates pools that provide fish with deep water winter habitat/refugia, act as sediment traps, and provide habitat for aquatic invertebrates and other wildlife species such as aquatic fur bearers, ducks, and amphibians;
- may change stream course/sinuosity by redirecting the thalweg;
- adds to fish spawning gravel recruitment as new channels are scoured;
- increases fish productivity by adding nutrients from the decay of flooded vegetation (C. Donley, WDFW, personal communication, 2003);
- affects water temperatures both through the removal and establishment of dense woody riparian vegetation and the creation of deep pools;
- disperses riparian vegetation seed and rooting material from woody cuttings into the riverine system potentially resulting in establishment of riparian vegetation downstream;
- reduces stream incising by reducing water velocity; and
- increases the extent of wetland vegetation through capillary action of pooled water, which may also raise the water table on adjacent lands making conditions favorable for additional riparian vegetation.

Beaver dens in streambanks create holes that contribute toward stream channel movement, and they provide denning oportunities for secondary users such as otter. Beaver droppings in pooled water also benefit fish by increasing nutrient loads important to aquatic invertebrates that fish feed upon.

Mule deer are associated with riparian wetland habitats (KEC 4.1) and free standing water from any source (KEC 4.1.8) for at least part of their life cycle. Riparian wetland habitats provide refugia, water, food, and thermal cover for mule deer. Deer droppings fertilize riparian habitat, which improves soil nutrients for shrubs, trees, and herbaceous vegetation growth. Riparian vegetation shades the water column, which reduces water temperatures that impact fish populations, and provides habitat for terrestrial insects upon which both birds and fish depend.

5.6 Focal Species Salmonid Relationships

The willow flycatcher is the only focal species that has an indirect relationship with salmonids (Figure_51). Salmonid relationship data for all Ecoprovince wildlife species are listed in Appendix_E.

Table 51. Ecoprovince focal species salmonid relationships (NHI 2003).

Common Name	Relationship Description	Stages Description
willow flycatcher	Indirect relationship	Carcasses

5.7 Wildlife Species

The NHI data suggest there are an estimated 367 wildlife species that occur within the Ecoprovince (Table E-1). Of these, 16 species are non-native, and one [bighorn sheep (*Ovis canadensis*)] has been reintroduced. Forty-two wildlife species that occur in the Ecoprovince are listed federally or in the State of Washington as Threatened, Endangered, or a Candidate species (Table E-2). Ninety-eight bird species are listed as Washington State Partners in Flight priority and focal species (Table E-3). A total of 15 wildlife species were used to develop loss assessments for the initial mitigation due to the construction of Grand Coulee, Chief Joseph, and the Lower Snake River dams (Table_17). Fifty-seven wildlife species are managed by WDFW as game species (Table E-4). Table E-5 includes wildlife species associated with salmonids.

Although there is wildlife species redundancy between subbasins, there are some differences as well. Table_40 illustrates species richness throughout the Ecoprovince and includes associations with riparian wetland habitats and/or salmonids. Differences in species richness can partially be explained as variation in biological potential and quality of habitats, amount, type, and juxtaposition of remaining habitats, and robustness of data bases used to establish the species lists.

The Upper Middle Mainstem Columbia River subbasin is unique among other subbasins in the Ecoprovince in that 100 percent of the species that occur in the Ecoprovince occurs in this subbasin. Other distinctions in species richness can also be made. For example, the Crab subbasin contains the lowest percentage (86 percent) of species occurrence (n = 317) than any other subbasin in the Ecoprovince. Only 53 percent (n = 9) of amphibian species and 68 percent (n = 13) of reptiles that occur in the Ecoprovince occurs in the Okanogan subbasin.

Wildlife species with close associations to riparian wetland habitats range from 90 percent in the Wenatchee subbasin to 99 percent in the Upper Middle Mainstem Columbia River subbasin. This underscores the importance of riparian wetland habitat throughout the Ecoprovince. As in other areas within the greater Columbia Plateau, riparian wetland habitats are used disproportionately by wildlife species relative to the amount of habitat availability.

6.0 Assessment Synthesis

Assessment information is synthesized in Table_52 for each Ecoprovince focal habitat. Historic and current extent of focal habitats and species, percent change, protection status, factors affecting habitats, data quality assessment, working hypothesis statement, management strategies, and data and monitoring and evaluation needs are summarized for focal habitat types. Data quality confidence rankings (similar to precision) and level of certainty qualifiers (analogous to accuracy) are described as follows:

- No confidence/no level of certainty: 0
- Poor confidence/little certainty: 1
- Marginal confidence/some certainty: 2
- Medium confidence/medium certainty: 3
- High confidence/high certainty:

Table 52. Species richness and associations for subbasins in the Columbia Cascade Ecoprovince, Washington (NHI 2003).

Class	Subbasin														
	Entiat	% of Total	Lake Chelan	% of Total	Wenatchee	% of Total	Methow	% of Total	Okanogan	%of Total	Upper Middle Mainstem	% of Total	Crab	% of Total	Total (Ecoprovince)
Amphibians	11	65	11	65	16	94	11	65	9	53	17	100	9	53	**17**
Birds	218	93	221	94	215	92	221	94	222	95	234	100	214	91	**234**
Mammals	91	94	93	96	91	94	93	96	86	89	97	100	78	80	**97**
Reptiles	16	84	16	84	19	100	16	84	13	68	19	100	16	84	**19**
Total	**336**	**92**	**341**	**93**	**341**	**93**	**341**	**93**	**328**	**89**	**367**	**100**	**317**	**86**	**367**
Association															
Riparian Wetlands	72	92	73	94	70	90	73	94	73	94	77	99	73	94	**78**
Other Wetlands (Herbaceous and Montane Coniferous)	30	81	32	86	26	68	32	86	31	84	36	95	33	89	**38**
All Wetlands	102	89	105	91	96	83	105	91	104	90	113	97	106	92	**116**
Salmonids	77	93	75	90	76	93	75	90	71	86	81	98	72	87	**82**

ASSESSMENT SYNTHESIS
COLUMBIA CASCADE ECOPROVINCE

FOCAL HABITAT/SPECIES: Ponderosa pine/white-headed woodpecker, flammulated owl, gray flycatcher, pygmy nuthatch

VEGETATION ZONES: Ponderosa pine

FOCAL HABITAT DESCRIPTION/CHANGE:

Ecoprovince	Acres	Subbasin	% Change
Historic	1,118,602	Entiat	-55
Current	489,293	Lake Chelan	-26
Difference	629,309	Wenatchee	-74
% Change	-55	Methow	-51
		Okanogan	-57
		Upper Middle Mainstem Columbia River	-49
		Crab	-59

PROTECTION STATUS:

Subbasin	Status 1: High Protection	Status 2: Medium Protection	Status 3: Low Protection	Status 4: No Protection	Total (Subbasin)
Entiat	11	545	43,248	12,008	**55,812**
Lake Chelan	7,556	4,175	28,030	5,715	**45,476**
Wenatchee	674	225	24,616	26,387	**51,902**
Methow	5,151	1,381	119,451	13,851	**139,834**
Okanogan	107	1,799	66,880	72,034	**140,820**
UMM	0	5,127	21,540	24,127	**50,794**
Crab	0	22	457	4,179	**4,658**
TOTAL (Ecoprovince)	**13,499**	**13,274**	**304,222**	**158,301**	**489,296**

FACTORS AFFECTING FOCAL HABITATS AND SPECIES (FROM ASSESSMENT):

1. Timber harvesting has reduced the amount of old growth forest and associated large diameter trees and snags.
2. Urban and residential development has contributed to loss and degradation of properly functioning ecosystems.
3. Fire suppression/exclusion has contributed towards habitat degradation, particularly declines in characteristic herbaceous and shrub understory from increased density of small shade-tolerant trees. High risk of loss of remaining ponderosa pine overstories from stand-replacing fires due to high fuel loads in densely stocked understories.
4. Overgrazing has resulted in lack of recruitment of sapling trees, particularly pines.
5. Invasion of exotic plants has altered understory conditions and increased fuel loads.
6. Fragmentation of remaining tracts has negatively impacted species with large area requirements.
7. Hostile landscapes, particularly those in proximity to agricultural and residential areas, may have high density of nest parasites (brown-headed cowbird), exotic nest competitors (European starling), and domestic predators (cats), and may be subject to high levels of human disturbance.
8. The timing (spring/summer versus fall) of restoration/silviculture practices such mowing, thinning, and burning of understory removal may be especially detrimental to single-clutch species.
9. Spraying insects that are detrimental to forest health may have negative ramifications on lepidopterans and other non-target avian species.

DATA QUALITY/LEVEL OF CERTAINTY:

The basis for the assessment is primarily Washington GAP data, NHI data, and ECA data

1. Washington GAP data: quality: 2.5; certainty: 2
2. NHI data: quality: 3; certainty: 2.5
3. ECA data: quality: 3; certainty: 3
4. Focal species assemblage data (average); quality: 3; certainty: 2

PONDEROSA PINE WORKING HYPOTHESIS STATEMENT:

The near term or major factors affecting this focal habitat type are direct loss of habitat due primarily to timber harvesting, fire reduction/wildfires, mixed forest encroachment, development, reduction of habitat diversity and function resulting from invasion of exotic vegetation and livestock grazing. The principal habitat diversity stressor is the spread and proliferation of mixed forest conifer species within ponderosa pine communities due primarily to fire reduction and intense wildfires. Habitat loss and fragmentation (including fragmentation resulting from extensive areas of undesirable vegetation) coupled with poor habitat quality of extant vegetation have resulted in extirpation and or significant reductions in ponderosa pine habitat obligate wildlife species.

MANAGEMENT STRATEGIES (IN PRIORITY):

1. Protect extant habitat in good condition through easements and acquisitions; protect poor quality habitat and/or lands with habitat potential adjacent to existing protected lands (avoid isolated parcels/wildlife population sinks.
2. Coordinate with public and private land managers on the use of controlled fire regimens and stand management practices.
3. Restore forest functionality by providing key ecological correlates through prescribed burns and silviculture practices.
4. Fund and coordinate weed control efforts on both public and private lands.
5. Identify and protect wildlife habitat corridors/links.

DATA GAPS AND M&E NEEDS (IN PRIORITY):

1. Habitat quality data e.g., ground truth NHI data. Assessment data bases do not address habitat quality.
2. Finer resoluction GIS habitat type maps that include structural component and KEC data.
3. GIS soils products

ASSESSMENT SYNTHESIS
COLUMBIA CASCADE ECOPROVINCE

FOCAL HABITAT/SPECIES: Shrubsteppe/grasshopper sparrow, Brewer's sparrow, sage thrasher, mule deer, pygmy rabbit, sharp-tailed grouse, sage grouse

VEGETATION ZONES: Three-tipped Sage, Central Arid, and Big Sage/Fescue

FOCAL HABITAT DESCRIPTION/CHANGE:

Ecoprovince	Acres	Subbasin	% Change
Historic	4,443,496	Entiat	453
Current	2,557,196	Lake Chelan	393
Difference	-1,886,299	Wenatchee	64
% Change	-41	Methow	268
		Okanogan	304
		Upper Middle Mainstem Columbia River	-39
		Crab	-67

PROTECTION STATUS:

Subbasin	Status 1: High Protection	Status 2: Medium Protection	Status 3: Low Protection	Status 4: No Protection	Total (Subbasin)
Entiat	0	2,331	17,066	13,586	**32,983**
Lake Chelan	2,451	1,034	22,013	19,540	**45,038**
Wenatchee	0	990	6,525	16,702	**24,217**
Methow	42	8,274	65,670	73,647	**147,633**
Okanogan	671	7,863	98,912	455,538	**562,984**
UMM	0	84,291	168,508	500,284	**753,083**
Crab	0	52,231	102,388	836,880	**991,499**
TOTAL (Ecoprovince)	**3,164**	**157,014**	**481,082**	**1,916,177**	**2,557,437**

FACTORS AFECTING FOCAL HABITATS AND SPECIES (FROM ASSESSMENT):

1. Extensive permanent habitat conversions of shrubsteppe habitats resulting in fragmentation of remaining tracts.
2. Degradation of habitat from intensive grazing and invasion of exotic plant species.
3. Fire management, either suppression or over-use, and wildfires.
4. Invasion and seeding of crested wheatgrass and other introduced plant species which reduces wildlife habitat quality and/or availability.
5. Loss and reduction of cryptogamic crusts, which help maintain the ecological integrity of shrubsteppe/grassland communities.
6. Conversion of CRP lands back to cropland.
7. Loss of big sagebrush communities to brush control.
8. Human disturbance during breeding/nesting season, parasitism.

DATA QUALITY/LEVEL OF CERTAINTY:

Basis for assessment is primarily Washington GAP data, NHI data, and ECA data

1. Washington Gap Data: quality-3.5; certainty-3
2. NHI Data: quality-3; certainty-3 (after corrections)
3. ECA data: quality-2.5; certainty-3
4. Focal species assemblage data (average): quality-3, certainty-3

SHRUBSTEPPE WORKING HYPOTHESIS STATEMENT:

The near term or major factors affecting this focal habitat type are direct loss of habitat due primarily to conversion to agriculture, reduction of habitat diversity and function resulting from invasion of exotic vegetation and wildfires, and livestock grazing. The principal habitat diversity stressor is the spread and proliferation of annual grasses and noxious weeds such as cheatgrass and yellow-star thistle that either supplant and/or radically alter entire native bunchgrass communities significantly reducing wildlife habitat quality. Habitat loss and fragmentation (including fragmentation resulting from extensive areas of undesirable vegetation) coupled with poor habitat quality of extant vegetation have resulted in extirpation and or significant reductions in grassland obligate wildlife species.

MANAGEMENT STRATEGIES (IN PRIORITY):

1. Protect extant habitat in good condition through easements and acquisitions; protect poor quality habitat and/or lands with habitat potential adjacent to existing protected lands (avoid isolated parcels/wildlife population sinks.
2. Fund and coordinate weed control efforts on both public and private lands.
3. Restore shrubland functionality by providing vegetation structural elements through reestablishment of native plant communities where practical and cost effective.
4. Identify and protect wildlife habitat corridors/links.

DATA GAPS AND M&E NEEDS (IN PRIORITY):

1. Habitat quality data. Assessment data bases do not address habitat quality.
2. Refined habitat type maps including current CRP program/field delineations
3. GIS soils products including wetland delineations.

ASSESSMENT SYNTHESIS
COLUMBIA CASCADE ECOPROVINCE

FOCAL HABITAT/SPECIES: Eastside (Interior) Riparian Wetlands/ beaver, willow flycatcher, red-eyed vireo, yellow-breasted chat, Lewis' woodpecker

VEGETATION ZONES: Riparian wetlands

FOCAL HABITAT DESCRIPTION/CHANGE:

Ecoprovince	Acres	Subbasin	%Change
Historic	5,928	Entiat	100
Current	35,590	Lake Chelan	100
Difference	29,662	Wenatchee	100
% Change	500	Methow	100
		Okanogan	100
		Upper Middle Mainstem Columbia River	100
		Crab	106

PROTECTION STATUS:

Subbasin	Status 1: High Protection	Status 2: Medium Protection	Status 3: Low Protection	Status 4: No Protection	Total (Subbasin)
Entiat	0	0	17	17	**34**
Lake Chelan	1,488	2,785	337	473	**5,083**
Wenatchee	11	0	4	125	**140**
Methow	0	168	434	3,632	**4,234**
Okanogan	17	288	1,058	8,563	**9,926**
UMM	0	274	647	2,974	**3,895**
Crab	0	1,304	1,008	9,908	**12,220**
TOTAL (Ecoprovince)	**1,516**	**4,819**	**3,505**	**25,692**	**35,532**

FACTORS AFFECTING FOCAL HABITATS AND LIMITING FOCAL SPECIES (FROM ASSESSMENT):

1. Loss of habitat due to numerous factors including riverine recreational developments, innundation from impoundments, cutting and spraying of riparian vegetation for eased access to water courses, gravel mining, etc.
2. Habitat alteration from 1) hydrological diversions and control of natural flooding regimes (e.g., dams) resulting in reduced stream flows and reduction of overall area of riparian habitat, loss of vertical stratification in riparian vegetation, and lack of recruitment of young cottonwoods, ash, willows, etc., and 2) stream bank stabilization which narrows stream channel, reduces the flood zone, and reduces extent of riparian vegetation.
3. Habitat degradation from livestock overgrazing which can widen channels, raise water temperatures, reduce understory cover, etc.
4. Habitat degradation from conversion of native riparian shrub and herbaceous vegetation to invasive exotics such as reed canary grass, purple loosestrife, perennial pepperweed, salt cedar, indigo bush, and Russian olive.
5. Fragmentation and loss of large tracts necessary for area-sensitive species such as yellow-billed cuckoo.
6. Hostile landscapes, particularly those in proximity to agricultural and residential areas, may have high density of nest parasites (brown-headed cowbird), exotic nest competitors (European starling), and domestic predators (cats), and be subject to high levels of human disturbance.
7. High energetic costs associated with high rates of competitive interactions with European starlings for cavities may reduce reproductive success of cavity-nesting species such as Lewis' woodpecker, downy woodpecker, and tree swallow, even when outcome of the competition is successful for these species.
8. Recreational disturbances (e.g., ORVs), particularly during nesting season, and particularly in high-use recreation areas.

DATA QUALITY/LEVEL OF CERTAINTY:

Basis for assessment is primarily Washington GAP data, NHI data, and ECA data

1. Washington Gap Data: quality-N/A; certainty-N/A
2. NHI Data: quality-1; certainty-0
3. ECA data: quality-3; certainty-3
4. Focal species assemblage data (average): quality-3, certainty-2

RIPARIAN WETLANDS WORKING HYPOTHESIS STATEMENT:

The near term or major factors affecting this focal habitat type are direct loss of habitat due primarily to hydropower and urban/agricultural development, reduction of habitat diversity and function resulting from exotic vegetation and livestock grazing, and fragmentation. The principal habitat diversity stressor is the spread and proliferation of invasive exotics such as reed canary grass, purple loosestrife, perennial pepperweed, salt cedar, indigo bush, and Russian olive. This coupled with poor habitat quality of extant vegetation have resulted in extirpation and or significant reductions in riparian habitat obligate wildlife species.

MANAGEMENT STRATEGIES (IN PRIORITY):

1. Protect extant habitat in good condition through easements and acquisitions; protect poor quality habitat and/or lands with habitat potential adjacent to existing protected lands (avoid isolated parcels/wildlife population sinks.
2. Work with CDs, NRCS, Forest Service, landowners, *et al.*, to implement best management practices (BMPs) in riparian areas in conjunction with CRP, CREP, WHIP programs, road abandonments, etc.
3. Restore riparian area functionality with enhancements, livestock exclusions, in-stream structures and bank modifications if necessary (includes removal of structures), and stream channel restoration activities.
4. Fund and coordinate weed control efforts on both public and private lands.
5. Identify and protect wildlife habitat corridors/links.

DATA GAPS AND M&E NEEDS (IN PRIORITY):

1. Updated/fine resolution historic riparian wetland data and GIS products (e.g., structural conditions and KECs) ground truthed maps.
2. Habitat quality data. Assessment data bases do not address habitat quality.
3. Refined habitat type maps including current CREP, WHIP program/field delineations.
4. GIS soils products including wetland delineations.

The Ecoprovince assessment/inventory synthesis cycle is illustrated in Figure_70. Movement through the cycle is summarized below:

1. Document and compare historic and current conditions of focal habitats to determine the extent of change.
2. Review habitat needs of focal wildlife species assemblages to assist in characterizing the “range” of recommended future conditions for focal habitats. Combine species assemblages’ habitat needs with desired ecological/habitat objectives to determine recommended future habitat conditions.
3. Determine the factors that affect habitat conditions and species assemblages (limiting factors) and compare to current and recommended future habitat conditions to establish needed future action/direction.
4. Develop strategies to address habitat “needs” and “road blocks” to obtaining biological goals.
5. Review strategies and compare to existing projects, programs, and regulatory statutes (Inventory) to determine the level at which existing inventory activities address, or contribute towards amelioration of factors that affect habitat conditions and species assemblages.
6. Develop goals and objectives to address strategies that define the key components of the management plan.

Post subbasin planning algorithms are described in 7 through 9 below.

7. Projects are approved, based on management plan strategies, goals, and objectives, and implemented.
8. Habitat and species response to habitat changes are monitored at the project level and compared to anticipated results.
9. Adaptive management principles are applied as needed, which leads back to the “new” current conditions restarting the cycle.

Strategies, goals, and objectives should be developed at the Ecoprovince and subbasin level; however, this does not preclude the possibility that strategies, goals, and objectives are identical at both levels. Ecoprovince/subbasin planners will exercise a “best fit” strategy to determine what subbasin(s) is/are best suited to address a specific need. Similarly, individual subbasins may have strategies, goals, and objectives that compliment and/or are different from Ecoprovince needs. In the latter case, differentiated subbasin strategies, goals, and objectives will be addressed at the subbasin level and related back to Ecoprovince needs.

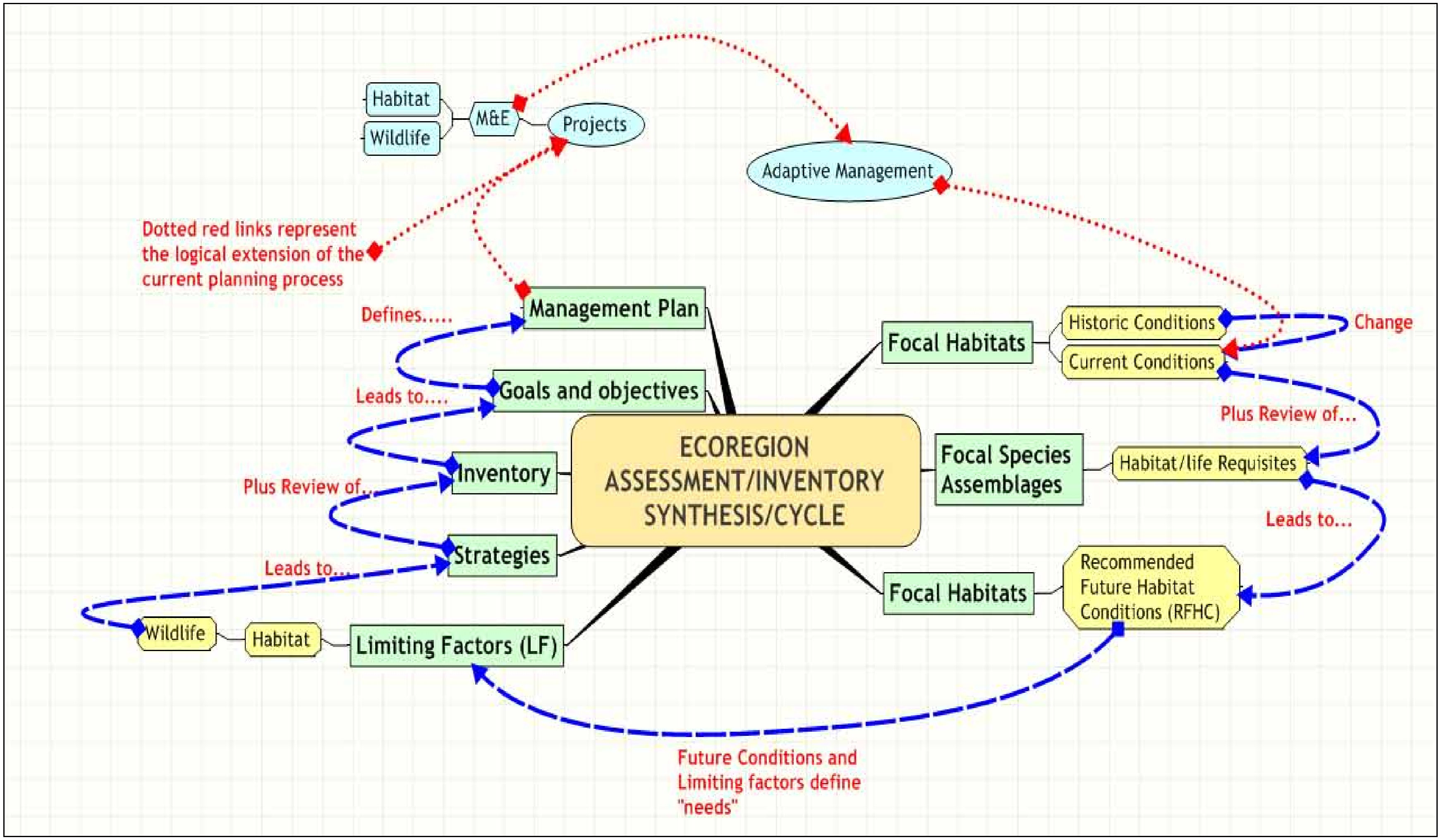


Figure 70. Ecoprovince wildlife assessment and inventory synthesis/cycle.

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Appendix A: Assessment Tools

Interactive Biodiversity Information System

The Interactive Biodiversity Information System (IBIS) is an informational resource developed by the Northwest Habitat Institute (NHI) to promote the conservation of Northwest fish, wildlife, and their habitats through education and the distribution of timely, peer-reviewed scientific data.

The IBIS contains extensive information about Pacific Northwest fish, wildlife, and their habitats, but more noteworthy, IBIS attempts to reveal and analyze the relationships among these species and their habitats. The Northwest Habitat Institute hopes to make the NHI web site a place where students, scientists, resource managers or any other interested user can discover and analyze these relationships without having to purchase special software (such as geographic information systems) or hassle with the integration of disparate data sets. The Northwest Habitat Institute will, however, provide downloadable data for users who desire to perform more advanced analyses or to integrate their own data sets with NHI data. Finally, NHI sees IBIS as not only a fish, wildlife, and habitat information distribution system but also as a peer-review system for species data. We acknowledge that in a system as extensive as IBIS, there are going to be errors as well as disagreement among scientists regarding the attributes of species and their relationships. The Northwest Habitat Institute encourages IBIS users to provide feedback so we may correct errors and discuss discrepancies.

The NHI web site is in the early stages of development, however, NHI staff, with the support of many project partners, has been developing the data for over five years. The IBIS database was initially developed by NHI for Oregon and Washington during the Wildlife-Habitat Types in Oregon and Washington project. The IBIS data are currently being refined and extended to include all of Idaho, Oregon, Washington, and the Columbia River Basin portions of Montana, Nevada, Utah and Wyoming. The IBIS will eventually include species range maps, wildlife-habitat maps, extensive species-habitat data queries, and interactive wildlife-habitat mapping applications allowing dynamic spatial queries for the entire Pacific Northwest as previously defined.

Internet Access:
The NHI home page can be accessed via the internet: http://www.nwhi.org/NHI/home/NHI.asp

Questions about IBIS may be directed to:

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Washington Priority Habitats and Species List

The Priority Habitats and Species (PHS) List is a catalog of those species and habitat types identified by the Washington Department of Fish and Wildlife (WDFW) as priorities for management and preservation. Because information on fish, wildlife, and their habitats is dynamic, the PHS List is updated periodically.

The PHS List is a catalog of habitats and species considered to be priorities for conservation and management. Priority species require protective measures for their perpetuation due to their population status, sensitivity to habitat alteration, and/or recreational, commercial, or tribal importance. Priority species include State Endangered, Threatened, Sensitive, and Candidate species; animal aggregations considered vulnerable; and those species of recreational, commercial, or tribal importance that are vulnerable. Priority habitats are those habitat types or elements with unique or significant value to a diverse assemblage of species. A Priority habitat may consist of a unique vegetation type or dominant plant species, a described successional stage, or a specific structural element.

There are 18 habitat types, 140 vertebrate species, 28 invertebrate species, and 14 species groups currently on the PHS List. These constitute about 16% of Washington's approximately 1,000 vertebrate species and a fraction of the state's invertebrate fauna.

Mapping of priority habitats and species was initiated in 1990 and includes about two-thirds of Washington's 43 million acres. The remaining third generally involves federal and tribal lands. Mapping consists of recording locational and descriptive data in a Geographic Information System (GIS). These GIS databases represent WDFW's best knowledge of fish and wildlife resources and occurrences. It is important to note, however, that priority species or priority habitats may occur in areas not currently known to WDFW biologists or in areas for which comprehensive surveys have not been conducted. Site-specific surveys may be necessary to rule out the presence of priority habitats or species on individual sites.

Included in the PHS system of databases are WDFW's PHS Points and Polygon Databases, StreamNet, and the Wildlife Heritage Database. Other information sources include the Department of Natural Resources' Aquatic Lands Division database on kelp beds and the U.S. Fish and Wildlife Service's information on the National Wetlands Inventory (NWI).

PHS Definitions:

PRIORITY HABITAT: A habitat type with unique or significant value to many species. An area identified and mapped as priority habitat has one or more of the following attributes:

- comparatively high fish and wildlife density
- comparatively high fish and wildlife species diversity
- important fish and wildlife breeding habitat
- important fish and wildlife seasonal ranges
- important fish and wildlife movement corridors
- limited availability
- high vulnerability to habitat alteration
- unique or dependent species

A priority habitat may be described by a unique vegetation type or by a dominant plant species that is of primary importance to fish and wildlife (e.g., oak woodlands, eelgrass meadows). A priority habitat may also be described by a successional stage (e.g., old growth and mature forests). Alternatively, a priority habitat may consist of a specific habitat element (e.g., consolidated marine/estuarine shorelines, talus slopes, caves, snags) of key value to fish and wildlife.

PRIORITY SPECIES: Fish and wildlife species requiring protective measures and/or management guidelines to ensure their perpetuation.

SPECIES CRITERIA

Criterion 1. State Listed and Candidate Species

State listed species are those native fish and wildlife species legally designated as Endangered

(WAC 232-12-014), Threatened (WAC 232-12-011), or Sensitive (WAC 232-12-011). State Candidate species are those fish and wildlife species that will be reviewed by the department (POL-M-6001) for possible listing as Endangered, Threatened, or Sensitive according to the process and criteria defined in WAC-232-12-297.

Criterion 2. Vulnerable Aggregations

Vulnerable aggregations include those species or groups of animals susceptible to significant population declines, within a specific area or statewide, by virtue of their inclination to aggregate. Examples include heron rookeries, seabird concentrations, marine mammal haulouts, shellfish beds, and fish spawning and rearing areas.

Criterion 3. Species of Recreational, Commercial, and/or Tribal Importance that are Vulnerable

Native and non-native fish and wildlife species of recreational or commercial importance, and recognized species used for tribal ceremonial and subsistence purposes that are vulnerable to habitat loss or degradation.

WASHINGTON STATUS: Identifies State Listed or Candidate species (Species of Concern) and species classified as game, food fish, or shellfish. For the latest Species of Concern List, call (360) 902-2515, or visit the following web site:
http://www.wa.gov/wdfw/wlm/diversty/soc/soc.htm.

PRIORITY AREA: Species are often considered a priority only within known limiting habitats (e.g., breeding areas) or within areas that support a relatively high number of individuals (e.g., regular large concentrations). These important areas are identified in the PHS List under the heading Priority Area. For example, great blue herons are often found feeding along shorelines, but they are considered a priority only in areas used for breeding (see criterion 2). If limiting habitats are not known, or if a species is so rare that any occurrence is important in land-use decisions, then the priority area is described as any occurrence.

Priority areas are described with the following terms:

Breeding Site: The immediate area and features associated with producing and rearing young (e.g., nest tree, den). Typically, a point location.

Breeding Area: The area necessary to support reproduction and the rearing of young; includes breeding sites and adjacent foraging habitat, and may include a disturbance buffer.

Lek: An assembly area where sage and sharp-tailed grouse engage in courtship behavior.

Artificial Nesting Feature: Man-made features used for nesting (e.g., nest box, platform).

Occurrence: Fish and wildlife observation from a source deemed reliable by WDFW biologists. Occurrences may represent an observation of an individual animal or a group of animals.

Regular Occurrence: Areas or features (e.g., trees, cliffs) that are commonly or traditionally used on a seasonal or year-round basis by species that do not typically occur in groups.

Regular Concentration: Areas that are commonly or traditionally used by a group of animals on a seasonal or year-round basis.

Regular Large Concentrations: Areas that are commonly or traditionally used by significantly large aggregations of animals, relative to what is expected for a particular species or geographic area.

Communal Roosts: Habitat features (e.g., trees, caves, cliffs) that are regularly or traditionally used by a group of animals for resting, hibernation, breeding, or young-rearing.

Regularly Used Perches: Habitat features (e.g., trees, cliffs) that are regularly or traditionally used by one or more birds for perching.

Haulouts: Areas where marine mammals regularly remove themselves from the water for resting.

Migration Corridors: Areas regularly or traditionally used as travel routes between seasonal ranges.

Foraging Area: Feeding areas that are regularly used by individuals or groups of animals.

Hack Site: A location where juvenile diurnal raptors (usually captive-bred) are released in order to acclimate them to the wild.

Questions and requests for additional PHS information may be directed to:

Priority Habitats and Species
WDFW Habitat Program
600 Capitol Way N
Olympia WA 98501-1091

Internet Access:

The PHS home page can be accessed: www.wa.gov/wdfw/hab/phspage.htm

For information on rare plants and plant communities, contact:

Washington Department of Natural Resources
Natural Heritage Program
P.O. Box 47016
Olympia, WA 98504-7016
(360) 902-1667
www.wa.gov/dnr/htdocs/fr/nhp

Washington GAP Analysis Project
The Gap Analysis Program (GAP) is a nation-wide program currently administered by the Biological Resources Division of the US Geological Survey (BRD-USGS; formerly the National Biological Service [NBS]). The overall goal of Gap Analysis is to identify elements of biodiversity that lack adequate representation in the nation's network of reserves (i.e., areas managed primarily for the protection of biodiversity). Gap Analysis is a coarse-filter approach to biodiversity protection. It provides an overview of the distribution and conservation status of several components of biodiversity, with particular emphasis on vegetation and terrestrial vertebrates. Digital map overlays in a Geographic Information System (GIS) are used to identify vegetation types, individual species, and species-rich areas that are unrepresented or underrepresented in existing biodiversity management areas. Gap Analysis functions as a preliminary step to more detailed studies needed to establish actual boundaries for potential additions to the existing network of reserves.

The primary filter in Gap Analysis is vegetation type (defined by the Washington Gap Analysis Project as the composite of actual vegetation, vegetation zone, and ecoregion). Vegetation types are mapped and their conservation status evaluated based on representation on biodiversity management areas, conversion to human-dominated landscapes, and spatial context. Vegetation is used as the primary filter in Gap Analysis because vegetation patterns are determinants of overall biodiversity patterns (Levin 1981, Noss 1990, Franklin 1993). It is impractical to map the distributions of all plants and animals, but Gap Analysis makes the assumption that if all vegetation types are adequately represented in biodiversity management areas, then most plant and animal species will also be adequately represented. The second major Gap Analysis filter is composed of information on the distribution of individual species. This filter can be used to identify individual species that lack adequate protection and, when individual species maps are overlaid, areas of high species richness. In most states, including Washington, vertebrates are the only taxa mapped because there is relatively little information available for other taxa, and because vertebrates currently command the most attention in conservation issues.

The following are general limitations of Gap Analysis; specific limitations for particular datasets are described in the appropriate sections:

Gap Analysis data are derived from remote sensing and modeling to make general assessments about conservation status. Any decisions based on the data must be supported by ground-truthing and more detailed analyses.

Gap Analysis is not a substitute for the listing of threatened and endangered species and associated recovery efforts. A primary argument in favor of Gap Analysis is that it is proactive in recognizing areas of high biodiversity value for the long-term maintenance of populations of native species and natural ecosystems before individual species and plant communities become threatened with extinction. A goal of Gap Analysis is to reduce the rate at which species require listing as threatened or endangered.

The static nature of the Gap Analysis data limits their utility in conservation risk assessment. Our database provides a snapshot of a region in which land cover and land ownership are dynamic and where trend data would be especially useful.
Gap Analysis is not a substitute for a thorough national biological inventory. As a response to rapid habitat loss, Gap Analysis is intended to provide a quick assessment of the distribution of vegetation and associated species before they are lost and to provide focus and direction for local, regional, and national efforts to maintain biodiversity. The process of improving knowledge

in systematics, ecology, and distribution of species is lengthy and expensive. That process must be continued and expedited in order to provide the detailed information needed for a comprehensive assessment of the nation's biodiversity.

Gap Analysis is a coarse-filter approach. The network of Conservation Data Centers (CDC) and Natural Heritage Programs established cooperatively by The Nature Conservancy and various state agencies maintain detailed databases on the locations of rare elements of biodiversity. Conservation of such elements is best accomplished through the fine-filter approach of the above organizations. It is not the role of Gap to duplicate or disseminate Natural Heritage Program or CDC Element Occurrence Records. Users interested in more specific information about the location, status, and ecology of populations of such species are directed to their state Natural Heritage Program or CDC.

Internet Access:

The Washington GAP Analysis Internet Home Page can be accessed via the World Wide Web at: http://www.fish.washington.edu/naturemapping/wagap/public_html/index.html

Questions about the Washington GAP Analysis Project may be directed to:

Washington Cooperative Fish and Wildlife Research Unit
University of Washington Box 355020
Seattle, WA 98195-5020
(206)543-6475

Partners in Flight

Partners in Flight was launched in 1990 in response to growing concerns about declines in the populations of many land bird species, and in order to emphasize the conservation of birds not covered by existing conservation initiatives. The initial focus was on Neotropical migrants, species that breed in the Nearctic (North America) and winter in the Neotropics (Central and South America), but the focus has spread to include most landbirds and other species requiring terrestrial habitats. The central premise of Partners in Flight (PIF) has been that the resources of public and private organizations in North and South America must be combined, coordinated, and increased in order to achieve success in conserving bird populations in this hemisphere. Partners in Flight is a cooperative effort involving partnerships among federal, state and local government agencies, philanthropic foundations, professional organizations, conservation groups, industry, the academic community, and private individuals. All Partners in Flight meetings at all levels are open to anyone interested in bird conservation and we eagerly seek your contribution.

Partners in Flight's goal is to focus resources on the improvement of monitoring and inventory, research, management, and education programs involving birds and their habitats. The PIF strategy is to stimulate cooperative public and private sector efforts in North America and the Neotropics to meet these goals.

Bird Conservation Planning Information
One of the primary activities being conducted by Partners in Flight - U.S. is the development of bird conservation plans for the entire continental United States.

The Flight Plan
The guiding principles for PIF bird conservation planning can be found in the Partners in Flight bird conservation strategy, The Flight Plan. It is composed of four parts:
(1) setting priorities
(2) establishing objectives
(3) conservation action
(4) evaluation.

Physiographic Areas
The spatial unit chosen by Partners in Flight for planning purposes is the physiographic area. There are 58 physiographic areas wholly or partially contained within the contiguous United States and several others wholly or partially in Alaska. Partners in Flight bird conservation plans in the West use state boundaries as their first sorting unit for planning, with each plan internally arranged by physiographic area or habitat type.

Integrated Bird Conservation
A common spatial language can greatly enhance the potential for communication among conservation initiatives. Under the auspices of the North American Bird Conservation Initiative (NABCI), Partners in Flight worked with the North American Waterfowl Management Plan, the Unites States Shorebird Conservation Plan, and the North American Waterbird Conservation Plan, as well as with counterparts in Mexico and Canada, to develop a standard map of planning regions to be shared by all initiatives. These Bird Conservation Regions are intended to serve as planning, implementation, and evaluation units for integrated bird conservation for the entire continent. Future revisions of PIF Bird Conservation Plans will begin to utilize Bird Conservation Regions as the planning units, facilitating integration with planning efforts of the other initiatives.

Species Assessment
An important component in The PIF Flight Plan is the identification of priority species. PIF recognized that existing means of setting conservation priorities did not capture the complexities and needs of birds. The PIF Species Assessment process uses the best of traditional methods modified by our knowledge of bird biology to create a scientifically credible means of prioritizing birds and their habitat. It is a dynamic method that uses several criteria to rank a species' vulnerability. Numerical scores are given for each criterion, with higher scores reflecting higher vulnerability. The most vulnerable species are those with declining population trends, limited geographic ranges, and/or deteriorating habitats.

PIF Watch List
The Partners in Flight Watch List was developed using the Species Assessment to highlight those birds of the continental United States, not already listed under the Endangered Species Act, that most warrant conservation attention. There is no single reason why all of these birds are on the list. Some are relatively common but undergoing steep population declines; others are rare but actually increasing in numbers. The Watch List is not intended to drive local conservation agendas, which should be based on priorities identified within each physiographic area.

Species Account Resources
Species accounts that synthesize scientific literature on the life histories and effects of management practices on particular bird species are available from a variety of sources.

Bird Conservation Plans Summary Document
The development of Bird Conservation Plans is a complicated process. More detailed information about the PIF Bird Conservation Planning Process and PIF Bird Conservation Plans is provided in the recent PIF publication - Partners in Flight: Conservation of the Land Birds of the United States.

Internet Access:
The Partners in Flight Internet Home Page can be accessed via the World Wide Web at:
http://www.partnersinflight.org/

National Wetland Inventory

The National Wetlands Inventory (NWI) of the U.S. Fish and Wildlife Service produces information on the characteristics, extent, and status of the Nation's wetlands and deepwater habitats. The National Wetlands Inventory Center information is used by Federal, State, and local agencies, academic institutions, U.S. Congress, and the private sector. The NWIC has mapped 90 percent of the lower 48 states, and 34 percent of Alaska. About 44 percent of the lower 48 states and 13 percent of Alaska are digitized. Congressional mandates require the NWIC to produce status and trends reports to Congress at ten-year intervals. In addition to status and trends reports, the NWIC has produced over 130 publications, including manuals, plant and hydric soils lists, field guides, posters, wall size resource maps, atlases, state reports, and numerous articles published in professional journals.

The NWI National Center in St. Petersburg, Florida, includes a state-of-the-art computer operation which is responsible for constructing the wetlands layer of the National Spatial Data Infrastructure. Digitized wetlands data can be integrated with other layers of the NSDI such as natural resources and cultural and physical features, leading to production of selected color and customized maps of the information from wetland maps, and the transfer of digital (computer-readable) data to users and researchers world-wide. Dozens of organizations, including Federal, State, county agencies, and private sector organizations such as Ducks Unlimited, have supported conversion of wetland maps into digital data for computer use. Statewide databases have been built for 9 States and initiated in 5 other States. Digitized wetland data are also available for portions of 37 other States. Once a digital database is constructed, users can obtain the data at no cost over the Internet, or through the U.S. Geological Survey for the cost of reproduction.

NWI maintains a MAPS database of metadata containing production information, history, and availability of all maps and digital wetlands data produced by NWI. This database is available over the Internet.

The Emergency Wetlands Resources Act requires that NWI archive and disseminate wetlands maps and digitized data as it becomes available. The process prescribed by Office of Management and Budget (OMB) Circular A-16, "Coordination of Surveying, Mapping, and Related Spatial Data", provides an avenue for increased NWI coordination activities with other Federal agencies to reduce waste in government programs. As chair of the Federal Geographic Data Committee's Wetlands Subcommittee, the NWI Project Leader is responsible for promoting the development, sharing, and dissemination of wetlands related spatial data. The Secretary of the Interior chairs the Federal Geographic Data Committee. NWI continues to coordinate mapping activities under 36 cooperative agreements or memoranda of understanding. NWI is involved in training and providing technical assistance to the public and other agencies.

NWI maps and digital data are distributed widely throughout the country and the world. NWI has distributed over 1.7 million maps nationally since they were first introduced. Map distribution is accomplished through Cooperator-Run Distribution centers.

Users of NWI maps and digital data are as varied as are the uses. Maps are used by all levels of government, academia, Congress, private consultants, land developers, and conservation organizations. The public makes extensive use of NWI maps in a myriad of applications including planning for watershed and drinking water supply protection; siting of transportation corridors; construction of solid waste facilities; and siting of schools and other municipal buildings. Resource managers in the Service and the States are provided with maps which are essential for effective habitat management and acquisition of important wetland areas needed to perpetuate migratory bird populations as called for in the North American Waterfowl and Wetlands Management Plan; for fisheries restoration; floodplain planning; and endangered species recovery plans. Agencies from the Department of Agriculture use the maps as a major tool in the identification of wetlands for the administration of the Swampbuster provisions of the 1985 and 1990 Farm Bills. Regulatory agencies use the maps to help in advanced wetland identification procedures, and to determine wetland values and mitigation requirements. Private sector planners use the maps to determine location and nature of wetlands to aid in framing alternative plans to meet regulatory requirements. The maps are instrumental in preventing problems from developing and in providing facts that allow sound business decisions to be made quickly, accurately, and efficiently. Good planning protects the habitat value of wetlands for wildlife, preserves water quality, provides flood protection, and enhances ground water recharge, among many other wetland values.

Additional sources of data are maintained by the Service to complement the information available from the maps themselves. The Service maintains a National List of Vascular Plant Species that Occur in Wetlands. This list is referenced in the Federal Manual for Identifying and Delineating Jurisdictional Wetlands, and in the Natural Resources Conservation Service's procedures to identify wetlands for the Swampbuster provision of the Farm Bill. The recent report on wetlands by the National Academy of Sciences found the National List to be scientifically sound and recommended that the Service continue development of the list. The Service has developed a protocol to allow other agencies and private individuals to submit additions, deletions, or changes to the list. The National List and Regional Lists are available over the Internet through the NWI Homepage.

NWI digital data have been available over the Internet since 1994. In the first year alone 93,000 data files were distributed through anonymous file transfer protocol (FTP) access to wetland maps digital line graph (DLG) data. To date, over 250,000 electronic copies of wetland maps are in the hands of resource managers and the general public. One-third of the digital wetlands files downloaded off Internet went to government agencies at Federal, State, Regional, and local levels. Other users include commercial enterprises, environmental organizations, universities, and the military. Users from 25 countries from Estonia to New Zealand to Chile obtained NWI maps from the Internet. This excellent partnership provides information to any government, private, or commercial entity that requires assistance to address issues throughout the world.

The National Wetlands Inventory Internet Home Page can be accessed via the World Wide Web at: http://wetlands.fws.gov/

Ecoregional Conservation Assessment

The following information was taken from Andelman *et al.* 1999:4. Ecoregional planning entails identifying a set of sites that collectively capture viable examples of all native species and communities from among a larger set of "planning units" within the ecoregion. This collection of selected planning units, termed the "conservation portfolio," provides a systematic basis for site planning and acquisition.

Reserve system (or portfolio) design has been described as a "hard and wicked" problem. It is a hard problem because the number of conservation elements and planning units is large (typically hundreds of elements and hundreds-to-thousands of planning units), making the number of possible portfolios far too large to search exhaustively for the portfolio that best meets the stated conservation goals. It is a wicked problem because one never has complete information for making informed choices, and instead must rely on very limited evidence.
Over the past fifteen years conservation planners have developed computer-based approaches to make the site selection process more systematic and more explicit. These approaches respond to the perceived need for reserve siting to be as efficient or cost-effective as possible, given the competing social and economic demands for land and water. They also address the concern that reserve system design should be repeatable, so that the reserve systems can be readily re-evaluated and modified over time as conditions change and new information is acquired. These approaches assist planners in sorting through the large volume of data to identify good initial solutions to this "hard and wicked" problem. A planning team must still review the initial solutions and modify them using local knowledge, judgment, and other evidence not considered in the reserve selection approach.

Sites 1.0 was developed at the University of California, Santa Barbara, to meet the needs of The Nature Conservancy's Ecoregional Planning Process (The Nature Conservancy Ecoregional Working Group 1997). This manual is intended to be a complete user's guide to Sites 1.0. To make the manual easier to follow, program names are always in bold font and pre-defined input and output file names are always in bold Italics. Menus and their options are listed in 'single quotes.' Pre-defined program variables and parameters are generally underlined.

Sites 1.0 is a customized ArcView project that facilitates designing and analyzing alternative portfolios. The software in Sites 1.0 to select of regionally representative systems of nature reserves for the conservation of biodiversity is called the Site Selection Module (SSM). It is a streamlined derivative of SPEXAN 3.0 (Spatially Explicit Annealing) that was developed by Ian Ball and Hugh Possingham. SPEXAN was originally developed as a stand-alone program with no GIS interface for displaying portfolios and ancillary spatial data.

SSM provides two heuristic procedures for selecting a conservation portfolio that attempts to meet stated, quantitative conservation goals as efficiently (using as few sites) as possible. The first procedure, known as the Greedy Heuristic, is a stepwise, iterative procedure that accumulates one site at a time, choosing the best site at each step, until the goals have been met. This procedure, which has been widely used in the past, has the advantage of being extremely fast and producing reasonably efficient solutions. The second procedure, known as Simulated Annealing, evaluates alternative complete reserve systems at each step, and compares a very large number of alternative reserve systems to identify a good solution. Neither procedure is guaranteed to find "the best" solution. The major advance of SSM over other reserve siting approaches is that it allows the analyst to better control the spatial configuration of the conservation portfolio. One can specify portfolios that have a high level of connectivity among sites, or portfolios in which sites are more dispersed, depending upon which spatial properties are perceived as being more important to the viability of the conservation elements and/or the feasibility of reserve system acquisition and management.

The following was taken from TNC 1999:
The purpose of the Columbia Plateau Ecoregional Assessment is to identify a “first credible” iteration of a portfolio of sites that, collectively and with appropriate conservation action, could maintain all viable native species and communities. In addition the assessment provides an assessment of threats to the sites and develops multi-site strategies to conserve the biodiversity of the ecoregion. The Columbia Plateau assessment is a pilot project that experimented with several methods of portfolio development and threats assessment in order to test techniques that may prove useful in other ecoregional planning efforts. The planning team was made up of TNC Heritage, Regional and Field Office staff and operated essentially as two teams, the first which developed the conservation portfolio and the second which conducted the threats assessment and worked on developing conservation strategies.

The Columbia Plateau is a broad expanse of sagebrush covered volcanic plains and valleys in the semi-arid Intermountain West that is crossed by the large riverine systems of the Columbia, Snake, Boise, and Owyhee. The Ecoregion covers over 301,000 sq km of land in Oregon, Idaho, Washington, Nevada, California, Utah, and Wyoming with 97% of the land occurring in the first 4 states. The ecoregion is comprised of 7 geographically distinct sections based on Bailey’s ECOMAP developed for USDA. The biologically diverse Ecoregion contains at least 239 vulnerable plant and animal species that are threatened with extinction; this includes 72 endemic plant species that, in large part, are restricted to unique habitats. Other important taxa include nearly all aquatic species, especially anadromous fishes, which have suffered significant declines throughout their range. Out of the 450 plant communities known from the ecoregion, 105 are considered vulnerable.

Ownership patterns in the ecoregion are dominated by the federal government which manages 48% of the land; an equal percentage of land is privately owned. The economy of the ecoregion is largely natural resource based, with intensive agriculture and grazing dominating much of the landscape. The population is mostly rural with only a few population centers greater than 50,000 present to date.

Data gathering was one of the first tasks undertaken by the project team. Heritage programs were the main source of element occurrence data. GAP analysis provided the vegetation layer information, and other sources supplied supplementary environmental data. The information was organized in a GIS format which was used for nearly all of the portfolio selection and analysis and threats assessment aspects of the project. Conservation targets representing fine filter aspects of biodiversity and comprising 154 plant species, 45 invertebrates, 49 vertebrates, 42 aquatic species, and 103 plant communities were identified for the purposes of selecting portfolio sites based on their occurrences.

Conservation goals were then chosen for the targets, based on the following levels of representation in the ecoregion: for targets found only in 1 section of the ecoregion, the goal is to protect all occurrences up to 5; for targets found in more than 1 section, the goal is to protect all occurrences up to 3 per section. Coarse filter aspects of biodiversity were represented by common plant communities and were cross-walked with GAP cover type alliances; the alliances were grouped into 4 categories based primarily on extent of coverage with percent cover on a section basis established as goals for each category. Due to the paucity of data for aquatic targets, an Aquatic Integrity Index developed by the Interior Columbia Basin Ecosystem

Management Project (ICBEMP) and based on a subwatershed scale was used as a data surrogate.

The Columbia Plateau pilot project utilized three approaches to developing a portfolio of conservation sites. First, an experts workshop was convened that was organized around 6 panels of different biological disciplines: botany, mammals, birds, herptiles, invertebrates, and aquatic resources. Each panel selected a suite of sites that, if protected, would protect the biotic diversity represented by their discipline within the ecoregion. The composite portfolio of all 6 panels covered over 60% of the ecoregion. The second approach utilized a GIS-driven site selection model developed by the Institute for Computational Earth System Science, University of California at Santa Barbara, termed the Biodiversity Management Area Selection model (BMAS). This innovative approach utilized extensive data to select sites with one of the objectives being to meet all target goals using the least amount of land. BMAS used “seed” sites or sites agreed upon by at least 4 experts workshop panels, as well as managed areas, such as RNAs and ACECs, that were deemed to be adequately protected. All sites were identified using 6th order HUCs subwatersheds as the site selection units. BMAS selected approximately 20% of the ecoregion when all targets and coarse filter community goals were met. The third approach used BMAS as a starting point and then relied upon site design concepts to reconfigure sites and add or delete sites based on known site quality. This approach was interactive with the GIS so as to insure that targets were not lost due to site modifications. The final portfolio was developed from this third approach.

The final portfolio resulted in the selection of 139 sites, most of which have public land components, covering a total of 66,860 sq km or 20% of the ecoregion. The sites are distributed throughout the ecoregion with a general tendency to have more sites and greater area of sites in sections that have a greater percentage of public lands. Roughly 30% of the Upper Snake River Plains section was in the portfolio, including two large sites, Big Desert (INEEL) and Craters of the Moon. The Western Basin & Range section had the greatest combined acreage in the portfolio, over 17,000 sq km. The Palouse section had only 7% of the section included in sites. The largest site covers over 5300 sq km while the smallest sites were fixed at a minimum size of 0.202 sq km or 50 acres. The smallest sites usually were locations of G1 ranked species.

A large number of conservation targets were not met by the final portfolio. On closer examination, it was determined that most of these targets were at the edges of their ranges or had been poorly inventoried to date. Lack of inventories resulted in many vulnerable plant communities and rare invertebrates not meeting target goals. The next iteration of the ecoregion plan should focus on acquiring better information for these groups of targets.

The threats assessment for the conservation portfolio was also conducted in a GIS format with a site-based database being developed to compile information regarding ownership, conservation targets and threats. The dominant threats in the ecoregion, in order of number of occurrences in the portfolio sites were: grazing (105), non-native species (85), altered fire regimes (49), recreation (44), crop agriculture (42), residential development (27), diversions (26), and hydrologic alteration (19). Some threats tend to be aggregated in certain sections, for instance, agriculture was most often cited as a dominant threat in the Columbia Basin section, while other threats, such as grazing, were more evenly spread throughout the ecoregion. The threats assessment database allows for extensive sorting and querying of information to assist in the development of conservation strategies.

Due to the nearly overwhelming possible ways to analyze the threats database a finite number of categories, termed strategic groupings, were created to develop strategies. The groupings included all of the dominant threats listed above, as well as the following categories: Palouse grasslands, BLM WSAs, Opportunity sites, Managed areas, Easily conserved sites, Sites with TNC presence, and DOD/DOE sites. Team members were responsible for analyzing the groupings in order to craft multi-site strategies. Preliminary strategies include working with federal partners--especially the BLM; developing links to ranchers and grazing management; working on water-related issues; and making linkages between recreation, residential development and site-based conservation.

Given that not all 139 sites in the ecoregion are equally documented, prioritizing sites was necessary. Sites were prioritized on the basis of the number of and immediacy of threats and on their biodiversity value, calculated on the basis of number of G1 targets and overall number of target occurrences. A matrix was created that resulted in the selection of 27 sites for TNC to work on in the next 5 years.

The experimental nature of this project provided several invaluable lessons for future ecoregional assessment efforts. The computer-driven site selection method was a useful technique to employ but its reliance on abundant, quality data needs to be taken into account. Considerable time should be allotted for data compilation. Similarly, the experts workshop was a very positive and worthwhile effort but more time should have been allocated to fully utilize the information collected. There was also a shortage of time when it came to refiningthe BMAS model in an interactive mode with the GIS. Some shortcomings related to target goals not being met could have been corrected with more effort at this phase. One of the key lessons learned is that the time commitment required of planning team members should not be underestimated. Many of the delays in the project can be attributed to team members having planning responsibilities merely added to their already full workloads. The organization of the project using two planning teams resulted in a lack of cohesiveness in the process, which should be avoided in the future.

Appendix B: NHI Wildlife Habitat Types

Westside Lowlands Conifer-Hardwood Forest

Christopher B. Chappell and Jimmy Kagan

Geographic Distribution. This forest habitat occurs throughout low-elevation western Washington, except on extremely dry or wet sites. In Oregon it occurs on the western slopes of the Cascade, around the margins of the Willamette Valley, in the Coast Range, and along the outer coast. The global distribution extends from southeastern Alaska south to southwestern Oregon.

Physical Setting. Climate is relatively mild and moist to wet. Mean annual precipitation is mostly 35-100 inches (90-254 cm), but can vary locally. Snowfall ranges from rare to regular, but is transitory. Summers are relatively dry. Summer fog is a major factor on the outer coast in the Sitka spruce zone. Elevation ranges from sea level to a maximum of about 2,000 ft (610 m) in much of northern Washington and 3,500 ft (1,067 m) in central Oregon. Soils and geology are very diverse. Topography ranges from relatively flat glacial till plains to steep mountainous terrain.

Landscape Setting. This is the most extensive habitat in the lowlands on the west side of the Cascade, except in southwestern Oregon, and forms the matrix within which other habitats occur as patches, especially Westside Riparian-Wetlands and less commonly Herbaceous Wetlands or Open Water. It also occurs adjacent to or in a mosaic with Urban and Mixed Environs (hereafter Urban) or Agriculture, Pasture and Mixed Environs (hereafter Agriculture) habitats. In the driest areas, it occurs adjacent to or in a mosaic with Westside Oak and Dry Douglas-fir Forest and Woodlands. Bordering this habitat at upper elevations is Montane Mixed Conifer Forest. Along the coastline, it often occurs adjacent to Coastal Dunes and Beaches. In southwestern Oregon, it may border Southwest Oregon Mixed Conifer-Hardwood Forest. The primary land use for this habitat is forestry.

Structure. This habitat is forest, or rarely woodland, dominated by evergreen conifers, deciduous broadleaf trees, or both. Late seral stands typically have an abundance of large (>164 ft [50 m] tall) coniferous trees, a multi-layered canopy structure, large snags, and many large logs on the ground. Early seral stands typically have smaller trees, single-storied canopies, and may be dominated by conifers, broadleaf trees, or both. Coarse woody debris is abundant in early seral stands after natural disturbances but much less so after clearcutting. Forest understories are structurally diverse: evergreen shrubs tend to dominate on nutrient-poor or drier sites; deciduous shrubs, ferns, and/or forbs tend to dominate on relatively nutrient-rich or moist sites. Shrubs may be low (1.6 ft [0.5 m] tall), medium-tall (3.3-6.6 ft [1-2 m]), or tall (6.6-13.1 ft [2-4 m]). Almost all structural stages are represented in the successional sequence within this habitat. Mosses are often a major ground cover. Lichens are abundant in the canopy of old stands.

Composition. Western hemlock (*Tsuga heterophylla*) and Douglas-fir (*Pseudotsuga menziesii*) are the most characteristic species and 1 or both are typically present. Most stands are dominated by 1 or more of the following: Douglas-fir, western hemlock, western redcedar (*Thuja plicata*), Sitka spruce (*Picea sitchensis*), red alder (*Alnus rubra*), or bigleaf maple (*Acer macrophyllum*). Trees of local importance that may be dominant include Port-Orford cedar (*Chamaecyparis lawsoniana*) in the south, shore pine (*Pinus contorta* var. *contorta*) on stabilized dunes, and grand fir (*Abies grandis*) in drier climates. Western white pine (*Pinus monticola*) is frequent but subordinate in importance through much of this habitat. Pacific silver fir (*Abies amabilis*) is largely absent except on the wettest low-elevation portion of the western Olympic Peninsula, where it is common and sometimes co-dominant. Common small subcanopy trees are cascara buckthorn (*Rhamnus purshiana*) in more moist climates and Pacific yew (*Taxus brevifolia*) in somewhat drier climates or sites.

Sitka spruce is found as a major species only in the outer coastal area at low elevations where summer fog is a significant factor. Bigleaf maple is most abundant in the Puget Lowland, around the Willamette Valley, and in the central Oregon Cascade, but occurs elsewhere also. Douglas-fir is absent to uncommon as a native species in the very wet maritime outer coastal area of Washington, including the coastal plain on the west side of the Olympic Peninsula. However, it has been extensively planted in that area. Port-Orford cedar occurs only in southern Oregon. Paper birch (*Betula papyrifera*) occurs as a co-dominant only in Whatcom County, Washington. Grand fir occurs as an occasional co-dominant only in the Puget Lowland and Willamette Valley.

Dominant or co-dominant understory shrub species of more than local importance include salal (*Gaultheria shallon*), dwarf Oregongrape (*Mahonia nervosa*), vine maple (*Acer circinatum*), Pacific rhododendron (*Rhododendron macrophyllum*), salmonberry (*Rubus spectabilis*), trailing blackberry (*R. ursinus*), red elderberry (*Sambucus racemosa*), fools huckleberry (*Menziesia ferruginea*), beargrass (*Xerophyllum tenax*), oval-leaf huckleberry (*Vaccinium ovalifolium*), evergreen huckleberry *(V. ovatum*), and red huckleberry (*V. parvifolium*). Salal and rhododendron are particularly associated with low nutrient or relatively dry sites.

Swordfern (*Polystichum munitum*) is the most common herbaceous species and is often dominant on nitrogen-rich or moist sites. Other forbs and ferns that frequently dominate the understory are Oregon oxalis (*Oxalis oregana*), deerfern (*Blechnum spicant*), bracken fern (*Pteridium aquilinum*), vanillaleaf (*Achlys triphylla*), twinflower (*Linnaea borealis*), false lily-of-the-valley (*Maianthemum dilatatum*), western springbeauty (*Claytonia siberica*), foamflower (*Tiarella trifoliata*), inside-out flower (*Vancouveria hexandra*), and common whipplea (*Whipplea modesta*).

Other Classifications and Key References. This habitat includes most of the forests and their successional seres within the *Tsuga heterophylla* and *Picea sitchensis* zones [88]. This habitat is also referred to as Douglas-fir-western hemlock and Sitka spruce-western hemlock forests [87], spruce-cedar-hemlock forest (*Picea-Thuja-Tsuga*, No. 1) and cedar-hemlock-Douglas-fir forest (*Thuja-Tsuga-Pseudotsuga*, No. 2) [136]. The Oregon Gap II Project [126] and Oregon Vegetation Landscape-Level Cover

Types [127] would crosswalk with Sitka spruce-western hemlock maritime forest, Douglas-fir-western hemlock-red cedar forest, red alder forest, red alder-bigleaf maple forest, mixed conifer/mixed deciduous forest, south coast mixed-deciduous forest, and coastal lodgepole forest. The Washington Gap Vegetation map includes this vegetation as conifer forest, mixed hardwood/conifer forest, and hardwood forest in the Sitka spruce, western hemlock, Olympic Douglas-fir, Puget Sound Douglas-fir, Cowlitz River and Willamette Valley zones [37]. A number of other references describe elements of this habitat [13, 25, 26, 40, 42, 66, 90, 104, 110, 111, 114, 115, 210].

Natural Disturbance Regime. Fire is the major natural disturbance in all but the wettest climatic area (Sitka spruce zone), where wind becomes the major source of natural disturbance. Natural fire-return intervals generally range from about 100 years or less in the driest areas to several hundred years [1, 115, 160]. Mean fire-return interval for the western hemlock zone as a whole is 250 years, but may vary greatly. Major natural fires are associated with occasional extreme weather conditions [1]. Fires are typically high-severity, with few trees surviving. However, low- and moderate-severity fires that leave partial to complete live canopies are not uncommon, especially in drier climatic areas. Occasional major windstorms hit outer coastal forests most intensely, where fires are rare. Severity of wind disturbance varies greatly, with minor events being extremely frequent and major events occurring once every few decades. Bark beetles and fungi are significant causes of mortality that typically operate on a small scale. Landslides are another natural disturbance that occur in some areas.

Succession and Stand Dynamics. After a severe fire or blowdown, a typical stand will be briefly occupied by annual and perennial ruderal forbs and grasses as well as predisturbance understory shrubs and herbs that resprout [102]. Herbaceous species generally give way to dominance by shrubs or a mixture of shrubs and young trees within a few years. If shrubs are dense and trees did not establish early, the site may remain as a shrubland for an indeterminate period. Early seral tree species can be any of the potential dominants for the habitat, depending on environment, type of disturbance, and seed source. All of these species except the short-lived red alder are capable of persisting for at least a few hundred years. Douglas-fir is the most common dominant after fire, but is uncommon in the wettest zones. It is also the most fire resistant of the trees in this habitat and survives moderate-severity fires well. After the tree canopy closes, the understory may become sparse, corresponding with the stem-exclusion stage [168]. Eventually tree density will decrease and the understory will begin to flourish again, typically at stand age 60-100 years. As trees grow larger and a new generation of shade-tolerant understory trees (usually western hemlock, less commonly western redcedar) grows up, a multi-layered canopy will gradually develop and be well expressed by stand age 200-400 years [89]. Another fire is likely to return before the loss of shade-intolerant Douglas-fir from the canopy at stand age 800-1,000 years, unless the stand is located in the wet maritime zone. Throughout this habitat, western hemlock tends to increase in importance as stand development proceeds. Coarse woody debris peaks in abundance in the first 50 years after a fire and is least abundant at about stand age 100-200 years [193].

Effects of Management and Anthropogenic Impacts. Red alder is more successful after typical logging disturbance than after fire alone on moist, nutrient-rich sites, perhaps because of the species' ability to establish abundantly on scarified soils [100]. Alder is much more common now because of large-scale logging activities [87]. Alder grows more quickly in height early in succession than the conifers, thereby prompting many forest managers to apply herbicides for alder control. If alder is allowed to grow and dominate early successional stands, it will decline in importance after about 70 years and die out completely by age 100. Often there are suppressed conifers in the subcanopy that potentially can respond to the death of the alder canopy. However, salmonberry sometimes forms a dense shrub layer under the alder, which can exclude conifer regeneration [88]. Salmonberry responds positively to soil disturbance, such as that associated with logging [19]. Bigleaf maple sprouts readily after logging and is therefore well adapted to increase after disturbance as well. Clearcut logging and plantation forestry have resulted in less diverse tree canopies, and have focused mainly on Douglas-fir, with reductions in coarse woody debris over natural levels, a shortened stand initiation phase, and succession truncated well before late-seral characteristics are expressed. Douglas-fir has been almost universally planted, even in wet coastal areas of Washington, where it is rare in natural stands.

Status and Trends. Extremely large areas of this habitat remain. Some loss has occurred, primarily to development in the Puget Lowland. Condition of what remains has been degraded by industrial forest practices at both the stand and landscape scale. Most of the habitat is probably now in Douglas-fir plantations. Only a fraction of the original old-growth forest remains, mostly in national forests in the Cascade and Olympic mountains. Areal extent continues to be reduced gradually, especially in the Puget Lowland. An increase in alternative silviculture practices may be improving structural and species diversity in some areas. However, intensive logging of natural-origin mature and young stands and even small areas of old growth continues. Of the 62 plant associations representing this habitat listed in the National Vegetation Classification, 27 percent are globally imperiled or critically imperiled [10].

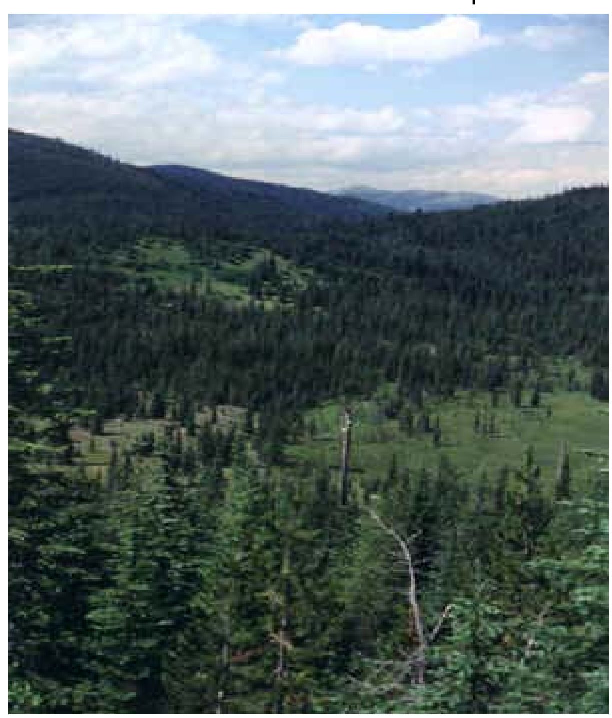
Montane Mixed Conifer Forest

Christopher B. Chappell

Geographic Distribution. These forests occur in mountains throughout Washington and Oregon, excepting the Basin and Range of southeastern Oregon. These include the Cascade Range, Olympic Mountains, Okanogan Highlands, Coast Range (rarely), Blue and Wallowa Mountains, and Siskiyou Mountains.

Physical Setting. This habitat is typified by a moderate to deep winter snow pack that persists for 3 to 9 months. The climate is moderately cool and wet to moderately dry and very cold. Mean annual precipitation ranges from about 40 inches (102 cm) to >200 inches (508 cm). Elevation is mid to upper montane, as low as 2,000 ft (610 m) in northern Washington, to as high as 7,500 ft (2,287 m) in southern Oregon. On the west side, it occupies an elevational zone of about 2,500 to 3,000 vertical feet (762 to 914 m), and on the eastside it occupies a narrower zone of about 1,500 vertical feet (457 m). Topography is generally mountainous. Soils are typically not well developed, but varied in their parent material: glacial till, volcanic ash, residuum, or colluvium. Spodosols are common.

Landscape Setting. This habitat is found adjacent to Westside Lowlands Conifer-Hardwood Forest, Eastside Mixed Conifer Forests, or Southwest Oregon Mixed Conifer-Hardwood Forest at its lower elevation limits and to Subalpine Parkland at its upper elevation limits. Inclusions of Montane Forested Wetlands, Westside Riparian Wetlands, and less commonly Open Water or Herbaceous Wetlands occur within the matrix of montane forest habitat. The typical land use is forestry or recreation. Most of this type is found on public lands managed for timber values and much of it has been harvested in a dispersed-patch pattern.



Structure. This is a forest, or rarely woodland, dominated by evergreen conifers. Canopy structure varies from single- to multi-storied. Tree size also varies from small to very large. Large snags and logs vary from abundant to uncommon. Understories vary in structure: shrubs, forbs, ferns, graminoids or some combination of these usually dominate, but they can be depauperate as well. Deciduous broadleaf shrubs are most typical as understory dominants. Early successional structure after logging or fire varies depending on understory species present. Mosses are a major ground cover and epiphytie lichens are typically abundant in the canopy.

Composition. This forest habitat is recognized by the dominance or prominence of 1 of the following species: Pacific silver fir (*Abies amabilis*), mountain hemlock (*Tsuga mertensiana*), subalpine fir (*A.*

lasiocarpa), Shasta red fir (*A. magnific var. shastensi*), Engelmann spruce (*Picea engelmannii*), noble fir (*A. procera*), or Alaska yellow-cedar (*Chamaecyparis nootkatensis*). Several other trees may co-dominate: Douglas-fir (*Pseudotsuga menziesii*), lodgepole pine (*Pinus contorta*), western hemlock (*Tsuga heterophylla*), western redcedar (*Thuja plicata*), or white fir (*A. concolor*). Tree regeneration is typically dominated by Pacific silver fir in moist westside middle-elevation zones; by mountain hemlock, sometimes with silver fir, in cool, very snowy zones on the west side and along the Cascade Crest; by subalpine fir in cold, drier eastside zones; and by Shasta red fir in the snowy mid- to upper-elevation zone of southwestern and south-central Oregon.

Subalpine fir and Engelmann spruce are major species only east of the Cascade Crest in Washington, in the Blue Mountains ecoregion, and in the northeastern Olympic Mountains (spruce is largely absent in the Olympic Mountains). Lodgepole pine is important east of the Cascade Crest throughout and in central and southern Oregon. Douglas-fir is important east of the Cascade Crest and at lower elevations on the west side. Pacific silver fir is a major species on the west side as far south as central Oregon. Noble fir, as a native species, is found primarily in the western Cascade from central Washington to central Oregon. Mountain hemlock is a common dominant at higher elevations along the Cascade Crest and to the west. Western hemlock, and to a lesser degree western redcedar, occur as dominants primarily with silver fir at lower elevations on the west side. Alaska yellow-cedar occurs as a co-dominant west of the Cascade Crest in Washington, rarely in northern Oregon. Shasta red fir and white fir occur only from central Oregon south, the latter mainly at lower elevations.

Deciduous shrubs that commonly dominate or co-dominate the understory are oval-leaf huckleberry (*Vaccinium ovalifolium*), big huckleberry (*V. membranaceum*), grouseberry (*V. scoparium*), dwarf huckleberry (*V. cespitosum*), fools huckleberry (*Menziesia ferruginea*), Cascade azalea (*Rhododendron albiflorum*), copperbush (*Elliottia pyroliflorus*), devil's-club (*Oplopanax horridus*), and, in the far south only, baldhip rose (*Rosa gymnocarpa*), currants (*Ribes* spp.), and creeping snowberry (*Symphoricarpos mollis*). Important evergreen shrubs include salal (*Gaultheria shallon*), dwarf Oregongrape (*Mahonia nervosa*), Pacific rhododendron (*Rhododendron macrophyllum*), deer oak (*Quercus sadleriana*), pinemat manzanita (*Arctostaphylos nevadensis*), beargrass (*Xerophyllum tenax*), and Oregon boxwood (*Paxistima myrsinites*).

Graminoid dominants are found primarily just along the Cascade Crest and to the east and include pinegrass (*Calamagrostis rubescens*), Geyer's sedge (*Carex geyeri*), smooth woodrush (*Luzula glabrata* var. *hitchcockii*), and long-stolon sedge (*Carex inops*). Deerfern (*Blechnum spicant*) and western oakfern (*Gymnocarpium dryopteris*) are commonly co-dominant. The most abundant forbs include Oregon oxalis (*Oxalis oregana*), single-leaf foamflower (*Tiarella trifoliata* var. *unifoliata*), rosy twisted-stalk (*Streptopus roseus*), queen's cup (*Clintonia uniflora*), western bunchberry (*Cornus unalaschkensis*), twinflower (*Linnaea borealis*), prince's pine (*Chimaphila umbellata*), five-leaved bramble (*Rubus pedatus*), and dwarf bramble (*R. lasiococcus*), sidebells (*Orthilia secunda*), avalanche lily (*Erythronium montanum*), Sitka valerian (*Valeriana sitchensis*), false lily-of-the-valley (*Maianthemum dilatatum*), and Idaho goldthread (*Coptis occidentalis*).

Other Classifications and Key References. This habitat includes most of the upland forests and their successional stages, except lodgepole pine dominated forests, in the *Tsuga mertensiana*, *Abies amabilis*, *A. magnifica* var. *shastensis*, *A. lasiocarpa* zones of Franklin and Dyrness [88]. Portions of this habitat have also been referred to as *A. amabilis-Tsuga heterophylla* forests, *A. magnifica* var. *shastensis* forests, and *Tsuga mertensiana* forests [87]. It is equivalent to Silver fir-Douglas-fir forest No. 3, closed portion of Fir-hemlock forest No. 4, Red fir forest No. 7, and closed portion of Western spruce-fir forest No. 15 [136]; The Oregon Gap II Project [126] and Oregon Vegetation Landscape-Level Cover Types [127] that would represent this type are mountain hemlock montane forest, true fir-hemlock montane forest, montane mixed conifer forest, Shasta red fir-mountain hemlock forest, and subalpine fir-lodgepole pine montane conifer; also most of the conifer forest in the Silver Fir, Mountain Hemlock, and Subalpine Fir Zones of Washington Gap [37]. A number of other references describe this habitat [13, 15, 17, 25, 26, 36, 38, 90, 108, 111, 114, 115, 118, 144, 148, 158, 212, 221].

Natural Disturbance Regime. Fire is the major natural disturbance in this habitat. Fire regimes are primarily of the high-severity type [1], but also include the moderate-severity regime (moderately frequent and highly variable) for Shasta red fir forests [39]. Mean fire-return intervals vary greatly, from ³800 years for some mountain hemlock-silver fir forests to about 40 years for red fir forests. Windstorms are a common small-scale disturbance and occasionally result in stand replacement. Insects and fungi are often important small-scale disturbances. However, they may affect larger areas also, for example, laminated root rot (*Phellinus weirii*) is a major natural disturbance, affecting large areas of mountain hemlock forests in the Oregon Cascade [72].

Succession and Stand Dynamics. After fire, a typical stand will briefly be occupied by annual and perennial ruderal forbs and grasses, as well as predisturbance understory shrubs and herbs that resprout. Stand initiation can take a long time, especially at higher elevations, resulting in shrub/herb dominance (with or without a scattered tree layer) for extended periods [3, 109]. Early seral tree species can be any of the potential dominants for the habitat, or lodgepole pine, depending on the environment, type of disturbance, and seed source. Fires tend to favor early seral dominance of lodgepole pine, Douglas-fir, noble fir, or Shasta red fir, if their seeds are present [1]. In some areas, large stand-replacement fires will result in conversion of this habitat to the Lodgepole Pine Forest and Woodland habitat, distinguished by dominance of lodgepole. After the tree canopy closes, the understory typically becomes sparse for a time. Eventually tree density will decrease and the understory will begin to flourish again, but this process takes longer than in lower elevation forests, generally at least 100 years after the disturbance, sometimes much longer [1]. As stand development proceeds, relatively shade-intolerant trees (lodgepole pine, Douglas-fir, western hemlock, noble fir, Engelmann spruce) typically decrease in importance and more shade-tolerant species (Pacific silver fir, subalpine fir, Shasta red fir, mountain hemlock) increase. Complex multi-layered canopies with large trees will typically take at least 300 years to develop, often much longer, and on some sites may never develop. Tree growth rates, and therefore the potential to develop these structural features, tend to decrease with increasing elevation.

Effects of Management and Anthropogenic Impacts. Forest management practices, such as clearcutting and plantations, have in many cases resulted in less diverse tree canopies with an emphasis on Douglas-fir. They also reduce coarse woody debris compared to natural levels, and truncate succession well before late-seral characteristics are expressed. Post-harvest regeneration of trees has been a perpetual problem for forest managers in much of this habitat [16, 97]. Planting of Douglas-fir has often failed at higher elevations, even where old Douglas-fir were present in the unmanaged stand [115]. Slash burning often has negative impacts on productivity and regeneration [186]. Management has since shifted away from burning and toward planting noble fir or native species, natural regeneration, and advance regeneration [16, 103]. Noble fir plantations are now fairly common in managed landscapes, even outside the natural range of the species. Advance regeneration management tends to simulate wind disturbance but without the abundant downed wood component. Shelterwood cuts are a common management strategy in Engelmann spruce or subalpine fir stands [221].

Status and Trends. This habitat occupies large areas of the region. There has probably been little or no decline in the extent of this type over time. Large areas of this habitat are relatively undisturbed by human impacts and include significant old-growth stands. Other areas have been extensively affected by logging, especially dispersed patch clearcuts. The habitat is stable in area, but is probably still declining in condition because of continued logging. This habitat is one of the best protected, with large areas represented in national parks and wilderness areas. The only threat is continued road building and clearcutting in unprotected areas. None of the 81 plant associations representing this habitat listed in the National Vegetation Classification is considered imperiled [10].

Eastside (Interior) Mixed Conifer Forest

Rex C. Crawford

Geographic Distribution. The Eastside Mixed Conifer Forest habitat appears primarily the Blue Mountains, East Cascade, and Okanogan Highland Ecoregions of Oregon, Washington, adjacent Idaho, and western Montana. It also extends north into British Columbia.

Douglas-fir-ponderosa pine forests occur along the eastern slope of the Oregon and Washington Cascade, the Blue Mountains, and the Okanogan Highlands of Washington. Grand fir-Douglas-fir forests and western larch forests are widely distributed throughout the Blue Mountains and, lesser so, along the east slope of the Cascade south of Lake Chelan and in the eastern Okanogan Highlands. Western hemlock-western redcedar-Douglas-fir forests are found in the Selkirk Mountains of eastern Washington, and on the east slope of the Cascade south of Lake Chelan to the Columbia River Gorge.

Physical Setting. The Eastside Mixed Conifer Forest habitat is primarily mid-montane with an elevation range of between 1,000 and 7,000 ft (305-2,137 m), mostly between 3,000 and 5,500 ft (914-1,676 m). Parent materials for soil development vary. This habitat receives some of the greatest amounts of precipitation in the inland northwest, 30-80 inches (76-203 cm)/year. Elevation of this habitat varies geographically, with generally higher elevations to the east.

Landscape Setting. This habitat makes up most of the continuous montane forests of the inland Pacific Northwest. It is located between the subalpine portions of the Montane Mixed Conifer Forest habitat in eastern Oregon and Washington and lower tree line Ponderosa Pine and Forest and Woodlands.

Structure. Eastside Mixed Conifer habitats are montane forests and woodlands. Stand canopy structure is generally diverse, although single-layer forest canopies are currently more common than multi-layered forests with snags and large woody debris. The tree layer varies from closed forests to more open-canopy forests or woodlands. This habitat may include very open stands. The undergrowth is complex and diverse. Tall shrubs, low shrubs, forbs or any combination may dominate stands. Deciduous shrubs typify shrub layers. Prolonged canopy closure may lead to development of a sparsely vegetated undergrowth.

Composition. This habitat contains a wide array of tree species (9) and stand dominance patterns. Douglas-fir (*Pseudotsuga menziesii*) is the most common tree species in this habitat. It is almost always present and dominates or co-dominates most overstories. Lower elevations or drier sites may have ponderosa pine (*Pinus ponderosa*) as a co-dominant with Douglas-fir in the overstory and often have other shade-tolerant tree species growing in the undergrowth. On moist sites, grand fir (*Abies* *grandis*), western redcedar (*Thuja plicata*) and/or western hemlock (*Tsuga heterophylla*) are dominant or co-dominant with Douglas-fir. Other conifers include western larch (*Larix occidentalis*) and western white pine (*Pinus monticola)* on mesic sites, Engelmann spruce (*Picea engelmannii*)*,* lodgepole pine (*Pinus contorta*)*,* and subalpine fir (*Abies lasiocarpa*) on colder sites. Rarely, Pacific yew (*Taxus brevifolia*) may be an abundant undergrowth tree or tall shrub. Undergrowth vegetation varies from open to nearly closed shrub thickets with 1 to many layers. Throughout the eastside conifer habitat, tall deciduous shrubs include vine maple (*Acer circinatum*) in the Cascade*,* Rocky Mountain maple (*A. glabrum*)*,* serviceberry (*Amelanchier alnifolia*)*,* oceanspray (*Holodiscus discolor*)*,* mallowleaf ninebark (*Physocarpus malvaceus*)*,* and Scouler's willow (*Salix scouleriana*) at mid- to lower elevations. Medium-tall deciduous shrubs at higher elevations include fools huckleberry (*Menziesia ferruginea*), Cascade azalea (*Rhododendron albiflorum*)*,* and big huckleberry (*Vaccinium membranaceum*). Widely distributed, generally drier site mid-height to short deciduous shrubs include baldhip rose (*Rosa gymnocarpa*), shiny-leaf spirea (*Spiraea betulifolia*)*,* and snowberry (*Symphoricarpos albus*, *S. mollis,* and *S. oreophilus*). Low shrubs of higher elevations include low huckleberries (*Vaccinium cespitosum,* and *V. scoparium*) and five-leaved bramble (*Rubus pedatus*). Evergreen shrubs represented in this habitat are chinquapin (*Castanopsis chrysophylla*), a tall shrub in southeastern Cascade*,* low to mid-height dwarf Oregongrape (*Mahonia nervosa* in the east Cascade and *M. repens* elsewhere), tobacco brush (*Ceanothus velutinus*), an increaser with fire*,* Oregon boxwood *(Paxistima myrsinites*) generally at mid- to lower elevations, beargrass (*Xerophyllum tenax),* pinemat manzanita (*Arctostaphylos nevadensis*) and kinnikinnick (*A. uva-ursi*).Herbaceous broadleaf plants are important indicators of site productivity and disturbance. Species generally indicating productive sites include western oakfern (*Gymnocarpium dryopteris*)*,* vanillaleaf (*Achlys triphylla*), wild sarsparilla (*Aralia nudicaulis*), wild ginger (*Asarum caudatum*), queen's cup (*Clintonia uniflora*), goldthread (*Coptis occidentalis*), false bugbane (*Trautvetteria caroliniensis*), windflower (*Anemone oregana, A. piperi, A. lyallii*), fairybells (*Disporum hookeri*), Sitka valerian (*Valeriana sitchensis*), and pioneer violet (*Viola glabella*). Other indicator forbs are dogbane (*Apocynum androsaemifolium*), false solomonseal (*Maianthemum stellata*), heartleaf arnica (*Arnica cordifolia*), several lupines (*Lupinus caudatus, L. latifolius, L. argenteus* ssp. *argenteus* var *laxiflorus*), western meadowrue *(Thalictrum occidentale*), rattlesnake plantain (*Goodyera oblongifolia*), skunkleaf polemonium (*Polemonium pulcherrimum*), trailplant (*Adenocaulon bicolor*), twinflower (*Linnaea borealis*), western starflower (*Trientalis latifolia*), and several wintergreens (*Pyrola asarifolia, P. picta*, *Orthilia secunda*).

Graminoids are common in this forest habitat. Columbia brome (*Bromus vulgaris*), oniongrass (*Melica bulbosa*), northwestern sedge (*Carex concinnoides*) and western fescue (*Festuca occidentalis*) are found mostly in mesic forests with shrubs or mixed with forb species. Bluebunch wheatgrass (*Pseudoroegneria spicata*), Idaho fescue (*Festuca idahoensis*), and junegrass (*Koeleria macrantha*) are found in drier more open forests or woodlands. Pinegrass (*Calamagrostis rubescens*) and Geyer's sedge *(C. geyeri)* can form a dense layer under Douglas-fir or grand fir trees.

Other Classifications and Key References. This habitat includes the moist portions of the *Pseudotsuga menziesii*, the *Abies grandis*, and the *Tsuga heterophylla* zones of eastern Oregon and Washington [88]. This habitat is called Douglas-fir (No. 12), Cedar-Hemlock-Pine (No. 13), and Grand fir-Douglas-fir (No. 14) forests in Kuchler [136]. The Oregon Gap II Project [126] and Oregon Vegetation Landscape-Level Cover Types [127] that would represent this type are the eastside Douglas-fir dominant-mixed conifer forest, ponderosa pine dominant mixed conifer forest, and the northeast Oregon mixed conifer forest. Quigley and Arbelbide [181] referred to this habitat as Grand fir/White fir, the Interior Douglas-fir, Western larch, Western redcedar/Western hemlock, and Western white pine cover types and the Moist Forest potential vegetation group. Other references detail forest associations for this habitat [45, 59, 117, 118, 123, 122, 144, 148, 208, 209, 212, 221, 228].

Natural Disturbance Regime. Fires were probably of moderate frequency (30-100 years) in presettlement times. Inland Pacific Northwest Douglas-fir and western larch forests have a mean fire interval of 52 years [22]. Typically, stand-replacement fire-return intervals are 150-500 years with moderate severity-fire intervals of 50-100 years. Specific fire influences vary with site characteristics. Generally, wetter sites burn less frequently and stands are older with more western hemlock and western redcedar than drier sites. Many sites dominated by Douglas-fir and ponderosa pine, which were formerly maintained by wildfire, may now be dominated by grand fir (a fire sensitive, shade-tolerant species).

Succession and Stand Dynamics. Successional relationships of this type reflect complex interrelationships between site potential, plant species characteristics, and disturbance regime [228]. Generally, early seral forests of shade-intolerant trees (western larch, western white pine, ponderosa pine, Douglas-fir) or tolerant trees (grand fir, western redcedar, western hemlock) develop some 50 years following disturbance. This stage is preceded by forb- or shrub- dominated communities. These early stage mosaics are maintained on ridges and drier topographic positions by frequent fires. Early seral forest develops into mid-seral habitat of large trees during the next 50-100 years. Stand replacing fires recycle this stage back to early seral stages over most of the landscape. Without high-severity fires, a late-seral condition develops either single-layer or multi-layer structure during the next 100-200 years. These structures are typical of cool bottomlands that usually only experience low-intensity fires.

Effects of Management and Anthropogenic Impacts. This habitat has been most affected by timber harvesting and fire suppression. Timber harvesting has focused on large shade-intolerant species in mid- and late-seral forests, leaving shade-tolerant species. Fire suppression enforces those logging priorities by promoting less fire-resistant, shade-intolerant trees. The resultant stands at all seral stages tend to lack snags, have high tree density, and are composed of smaller and more shade-tolerant trees. Mid-seral forest structure is currently 70% more abundant than in historical, native systems [181]. Late-seral forests of shade-intolerant species are now essentially absent. Early-seral forest abundance is similar to that found historically but lacks snags and other legacy features.

Status and Trends. Quigley and Arbelbide [181] concluded that the Interior Douglas-fir, Grand fir, and Western redcedar/Western hemlock cover types are more abundant now than before 1900, whereas the

Western larch and Western white pine types are significantly less abundant. Twenty percent of Pacific Northwest Douglas-fir, grand fir, western redcedar, western hemlock, and western white pine associations listed in the National Vegetation Classification are considered imperiled or critically imperiled [10]. Roads, timber harvest, periodic grazing, and altered fire regimes have compromised these forests. Even though this habitat is more extensive than pre-1900, natural processes and functions have been modified enough to alter its natural status as functional habitat for many species.

Lodgepole Pine Forest and Woodlands

Rex C. Crawford

Geographic Distribution. This habitat is found along the eastside of the Cascade Range, in the Blue Mountains, the Okanogan Highlands and ranges north into British Columbia and south to Colorado and California.

With grassy undergrowth, this habitat appears primarily along the eastern slope of the Cascade Range and occasionally in the Blue Mountains and Okanogan Highlands. Subalpine lodgepole pine habitat occurs on the broad plateau areas along the crest of the Cascade Range and the Blue Mountains, and in the higher elevations in the Okanogan Highlands. On pumice soils this habitat is confined to the eastern slope of the Cascade Range from near Mt. Jefferson south to the vicinity of Crater Lake.

Physical Setting. This habitat is located mostly at mid- to higher elevations (3,000-9,000 ft [914-2,743 m]). These environments can be cold and relatively dry, usually with persistent winter snowpack. A few of these forests occur in low-lying frost pockets, wet areas, or under edaphic control (usually pumice) and are relatively long-lasting features of the landscape. Lodgepole pine is maintained as a dominant by the well-drained, deep Mazama pumice in eastern Oregon.

Landscape Setting. This habitat appears within Montane Mixed Conifer Forest east of the Cascade crest and the cooler Eastside Mixed Conifer Forest habitats. Most pumice soil lodgepole pine habitat is intermixed with Ponderosa Pine Forest and Woodland habitats and is located between Eastside Mixed Conifer Forest habitat and either Western Juniper Woodland or Shrubsteppe habitat.

Structure. The lodgepole pine habitat is composed of open to closed evergreen conifer tree canopies. Vertical structure is typically a single tree layer. Reproduction of other more shade-tolerant conifers can be abundant in the undergrowth. Several distinct undergrowth types develop under the tree layer: evergreen or deciduous medium-tall shrubs, evergreen low shrub, or graminoids with few shrubs. On pumice soils, a sparsely developed shrub and graminoid undergrowth appears with open to closed tree canopies.

Composition. The tree layer of this habitat is dominated by lodgepole pine (*Pinus contorta* var. *latifolia* and *P. c*. var. *murrayana*), but it is usually associated with other montane conifers (*Abies concolor, A. grandis, A. magnifici var. shastensi, Larix occidentalis, Calocedrus decurrens, Pinus lambertiana, P. monticola, P. ponderosa, Pseudotsuga menziesii*). Subalpine fir (*Abies lasiocarpa*), mountain hemlock (*Tsuga mertensiana*), Engelmann spruce (*Picea engelmannii*), and whitebark pine (*Pinus albicaulis*), indicators of subalpine environments, are present in colder or higher sites. Quaking aspen (*Populus tremuloides)* sometimes occur in small numbers.

Shrubs can dominate the undergrowth. Tall deciduous shrubs include Rocky Mountain maple (*Acer glabrum*), serviceberry (*Amelanchier alnifolia*), oceanspray (*Holodiscus discolor*), or Scouler's willow (*Salix scouleriana*). These tall shrubs often occur over a layer of mid-height deciduous shrubs such as baldhip rose *(Rosa gymnocarpa),* russet buffaloberry *(Shepherdia canadensis*), shiny-leaf spirea (*Spiraea betulifolia*), and snowberry (*Symphoricarpos albus* and/or *S. mollis*). At higher elevations, big huckleberry (*Vaccinium membranaceum*) can be locally important, particularly following fire. Mid-tall evergreen shrubs can be abundant in some stands, for example, creeping Oregongrape (*Mahonia repens*), tobacco brush (*Ceanothus velutinus*), and Oregon boxwood (*Paxistima myrsinites*). Colder and drier sites support low-growing evergreen shrubs, such as kinnikinnick (*Arctostaphylos uva-ursi*) or pinemat manzanita (*A. nevadensis*). Grouseberry (*V. scoparium*) and beargrass (*Xerophyllum tenax*) are consistent evergreen low shrub dominants in the subalpine part of this habitat. Manzanita (*Arctostaphylos patula),* kinnikinnick, tobacco brush, antelope bitterbrush (*Purshia tridentata*), and wax current (*Ribes cereum*) are part of this habitat on pumice soil. Some undergrowth is dominated by graminoids with few shrubs. Pinegrass (*Calamagrostis rubescens*) and/or Geyer's sedge (*Carex geyeri*) can appear with grouseberry in the subalpine zone. Pumice soils support grassy undergrowth of long-stolon sedge (*C. inops*), Idaho fescue (*Festuca idahoensis*) or western needlegrass (*Stipa occidentalis*). The latter 2 species may occur with bitterbrush or big sagebrush and other bunchgrass steppe species. Other nondominant indicator graminoids frequently encountered in this habitat are California oatgrass (*Danthonia californica*), blue wildrye (*Elymus glaucus*), Columbia brome (*Bromus vulgaris*) and oniongrass (*Melica bulbosa*). Kentucky bluegrass (*Poa pratensis*), and bottlebrush squirreltail (*Elymus elymoides*) can be locally abundant where livestock grazing has persisted.

The forb component of this habitat is diverse and varies with environmental conditions. A partial forb list includes goldthread (*Coptis occidentalis*), false solomonseal (*Maianthemum stellata*), heartleaf arnica *(Arnica cordifolia),* several lupines (*Lupinus caudatus, L. latifolius, L. argenteus* ssp. *argenteus* var*. laxiflorus),* meadowrue (*Thalictrum occidentale*), queen's cup (*Clintonia uniflora*), rattlesnake plantain (*Goodyera oblongifolia*), skunkleaf polemonium (*Polemonium pulcherrimum*), trailplant (*Adenocaulon bicolor*), twinflower (*Linnaea borealis*), Sitka valerian (*Valeriana sitchensis*), western starflower (*Trientalis latifolia*), and several wintergreens (*Pyrola asarifolia, P. picta, Orthilia secunda*).

Other Classifications and Key References. The Lodgepole Pine Forest and Woodland habitat includes the *Pinus contorta* zone of eastern Oregon and Washington [88]. The Oregon Gap II Project [126] and Oregon

Vegetation Landscape-Level Cover Type [127] that would represent this type is lodgepole pine forest and woodlands. Quigley and Arbelbide [181] referred to this habitat as Lodgepole pine cover type and as a part of the Dry Forest potential vegetation group. Other references detail forest associations with this habitat [117, 118, 122, 123, 144, 212, 221].

Natural Disturbance Regime. This habitat typically reflects early successional forest vegetation that originated with fires. Inland Pacific Northwest lodgepole pine has a mean fire interval of 112 years [22]. Summer drought areas generally have low to medium-intensity ground fires occurring at intervals of 25-50 years, whereas areas with more moisture have a sparse undergrowth and slow fuel build-up that results in less frequent, more intense fire. With time, lodgepole pine stands increase in fuel loads. Woody fuels accumulate on the forest floor from insect (mountain pine beetle) and disease outbreaks and residual wood from past fires. Mountain pine beetle outbreaks thin stands that add fuel and create a drier environment for fire or open canopies and create gaps for other conifer regeneration. High-severity crown fires are likely in young stands, when the tree crowns are near deadwood on the ground. After the stand opens up, shade-tolerant trees increase in number.

Succession and Stand Dynamics. Most Lodgepole Pine Forest and Woodlands are early- to mid seral stages initiated by fire. Typically, lodgepole pine establishes within 10-20 years after fire. This can be a gap phase process where seed sources are scarce. Lodgepole stands break up after 100-200 years. Without fires and insects, stands become more closed-canopy forest with sparse undergrowth. Because lodgepole pine cannot reproduce under its own canopy, old unburned stands are replaced by shade-tolerant conifers. Lodgepole pine on pumice soils is not seral to other tree species; these extensive stands, if not burned, thin naturally, with lodgepole pine regenerating in patches. On poorly drained pumice soils, quaking aspen sometimes plays a mid-seral role and is displaced by lodgepole when aspen clones die. Serotinous cones (cones releasing seeds after fire) are uncommon in eastern Oregon lodgepole pine (*P. c*. var. *murrayana*). On the Colville National Forest in Washington, only 10% of lodgepole pine (*P. c*. var. *latifolia*) trees in low-elevation Douglas-fir habitats had serotinous cones, whereas 82% of cones in high-elevation subalpine fir habitats were serotinous [4].

Effects of Management and Anthropogenic Impacts. Fire suppression has left many single-canopy lodgepole pine habitats unburned to develop into more multilayered stands. Thinning of serotinous lodgepole pine forests with fire intervals <20 years can reduce their importance over time. In pumice-soil lodgepole stands, lack of natural

regeneration in harvest units has lead to creation of "pumice deserts" within otherwise forested habitats [47].

Status and Trends. Quigley and Arbelbide [181] concluded that the extent of the lodgepole pine cover type in Oregon and Washington is the same as before 1900 and in regions may exceed its historical extent. Five percent of Pacific Northwest lodgepole pine associations listed in the National Vegetation Classification are considered imperiled [10]. At a finer scale, these forests have been fragmented by roads, timber harvest, and influenced by periodic livestock grazing and altered fire regimes.

Ponderosa Pine Forest and Woodlands (includes Eastside Oak)

Rex C. Crawford and Jimmy Kagan

Geographic Distribution. This habitat occurs in much of eastern Washington and eastern Oregon, including the eastern slopes of the Cascade, the Blue Mountains and foothills, and the Okanogan Highlands. Variants of it also occur in the Rocky Mountains, the eastern Sierra Nevada, and mountains within the Great Basin. It extends into south-central British Columbia as well.

In the Pacific Northwest, ponderosa pine-Douglas-fir woodland habitats occur along the eastern slope of the Cascade, the Okanogan Highlands, and in the Blue Mountains. Ponderosa pine woodland and savanna habitats occur in the foothills of the Blue Mountains, along the eastern base of the Cascade Range, the Okanogan Highlands, and in the Columbia Basin in northeastern Washington. Ponderosa pine is widespread in the pumice zone of south-central Oregon between Bend and Crater Lake east of the Cascade Crest. Ponderosa pine-Oregon white oak habitat appears east of the Cascade in the vicinity of Mt. Hood near the Columbia River Gorge north to the Yakama Nation and south to the Warm Springs Nation. Oak dominated woodlands follow a similar distribution as Ponderosa Pine-White Oak habitat but are more restricted and less common.

Physical Setting. This habitat generally occurs on the driest sites supporting conifers in the Pacific Northwest. It is widespread and variable, appearing on moderate to steep slopes in canyons, foothills, and on plateaus or plains near mountains. In Oregon, this habitat can be maintained by the dry pumice soils, and in Washington it can be associated with serpentine soils. Average annual precipitation ranges from about 14 to 30 inches (36 to 76 cm) on ponderosa pine sites in Oregon and Washington and often as snow. This habitat can be found at elevations of 100 ft (30m) in the Columbia River Gorge to dry, warm areas over 6,000 ft (1,829 m). Timber harvest, livestock grazing, and pockets of urban development are major land uses.

Landscape Setting. This woodland habitat typifies the lower treeline zone forming transitions with Eastside Mixed Conifer Forest and Western Juniper and Mountain Mahogany Woodland, Shrubsteppe, Eastside Grassland, or Agriculture habitats. Douglas-fir-ponderosa pine woodlands are found near or within the Eastside Mixed Conifer Forest habitat. Oregon oak woodlands appear in the driest most restricted landscapes in transition to Eastside Grassland or Shrubsteppe.

Structure. This habitat is typically a woodland or savanna with tree canopy coverage of 10- 60%, although closed-canopy stands are possible. The tree layer is usually composed of widely spaced large conifer trees. Many stands tend towards a multi-layered condition with encroaching conifer regeneration. Isolated taller conifers above broadleaf deciduous trees characterize part of this habitat. Deciduous woodlands or forests are an important part of the structural variety of this habitat. Clonal deciduous trees can create dense patches across a grassy landscape rather than scattered individual trees. The undergrowth may include dense stands of shrubs or, more often, be dominated by grasses, sedges, or forbs. Shrubsteppe shrubs may be prominent in some stands and create a distinct tree-shrub-sparse-grassland habitat.

Composition. Ponderosa pine (*Pinus ponderosa*) and Douglas-fir (*Pseudotsuga menziesii*) are the most common evergreen trees in this habitat. The deciduous conifer, western larch (*Larix occidentalis*), can be a co-dominant with the evergreen conifers in the Blue Mountains of Oregon, but seldom as a canopy dominant. Grand fir (*Abies grandis*) may be frequent in the undergrowth on more productive sites giving stands a multi-layer structure. In rare instances, grand fir can be co-dominant in the upper canopy. Tall ponderosa pine over Oregon white oak (*Quercus garryana*) trees form stands along part of the east Cascade. These stands usually have younger cohorts of pines. Oregon white oak dominates open woodlands or savannas in limited areas.

The undergrowth can include dense stands of shrubs or, more often, be dominated by grasses, sedges, and/or forbs. Some Douglas-fir and ponderosa pine stands have a tall to medium-tall deciduous shrub layer of mallowleaf ninebark (*Physocarpus malvaceus*) or common snowberry (*Symphoricarpos albus*). Grand fir seedlings or saplings may be present in the undergrowth. Pumice soils support a shrub layer represented by green-leaf or white-leaf manzanita *(Arctostaphylos patula* or *A. viscida*). Short shrubs, pinemat manzanita (*Arctostaphylos nevadensis*) and kinnikinnick (*A. uva-ursi*) are found across the range of this habitat. Antelope bitterbrush (*Purshia tridentata*), big sagebrush (*Artemisia tridentata*), black sagebrush (*A. nova*), green rabbitbrush (*Chrysothamnus viscidiflorus*), and in southern Oregon, curl-leaf mountain mahogany (*Cercocarpus ledifolius*) often grow with Douglas-fir, ponderosa pine and/or Oregon white oak, which typically have a bunchgrass and shrubsteppe ground cover.

Undergrowth is generally dominated by herbaceous species, especially graminoids. Within a forest matrix, these woodland habitats have an open to closed sodgrass undergrowth dominated by pinegrass (*Calamagrostis rubescens*), Geyer's sedge (*Carex geyeri*), Ross' sedge (*C. rossii*), long-stolon sedge (*C. inops*), or blue wildrye (*Elymus glaucus*). Drier savanna and woodland undergrowth typically contains bunchgrass steppe species, such as Idaho fescue (*Festuca idahoensis*), rough fescue (*F. campestris*), bluebunch wheatgrass (*Pseudoroegneria spicata*), Indian ricegrass (*Oryzopsis hymenoides*), or needlegrasses (*Stipa comata, S. occidentalis*). Common exotic grasses that may appear in abundance are cheatgrass (*Bromus tectorum*), and bulbous bluegrass (*Poa bulbosa*). Forbs are common associates in this habitat and are too numerous to be listed.

Other Classifications and Key References. This habitat is referred to as Merriam's Arid Transition Zone, Western ponderosa forest (*Pinus*), and Oregon Oak wood (*Quercus*) in Kuchler[136], and as Pacific ponderosa pine-Douglas-fir and Pacific ponderosa pine, and Oregon white oak by the Society of American Foresters. The Oregon Gap II Project [126] and Oregon Vegetation Landscape-Level Cover Types [127] that would represent this type are ponderosa pine forest and woodland, ponderosa pine-white oak forest and woodland, and ponderosa pine-lodgepole pine on pumice. Other references describe elements of this habitat [45, 62, 88, 117, 118, 121, 122, 123, 144, 148, 209, 212, 221, 222].

Natural Disturbance Regime. Fire plays an important role in creating vegetation structure and composition in this habitat. Most of the habitat has experienced frequent low-severity fires that maintained woodland or savanna conditions. A mean fire interval of 20 years for ponderosa pine is the shortest of the vegetation types listed by Barrett *et al.*[22]. Soil drought plays a role in maintaining an open tree canopy in part of this dry woodland habitat.

Succession and Stand Dynamics. This habitat is climax on sites near the dry limits of each of the dominant conifer species and is more seral as the environment becomes more favorable for tree growth. Open seral stands are gradually replaced by more closed shade-tolerant climax stands. Oregon white oak can reproduce under its own shade but is intolerant of overtopping by conifers. Oregon white oak woodlands are considered fire climax and are seral to conifers. In drier conditions, unfavorable to conifers, oak is climax. Oregon white oak sprouts from the trunk and root crown following cutting or burning and form clonal patches of trees.

Effects of Management and Anthropogenic Impacts. Pre-1900, this habitat was mostly open and park like with relatively few undergrowth trees. Currently, much of this habitat has a younger tree cohort of more shade-tolerant species that gives the habitat a more closed, multi-layered canopy. For example, this habitat includes previously natural fire-maintained stands in which grand fir can eventually become the canopy dominant. Fire suppression has lead to a buildup of fuels that in turn increase the likelihood of stand-replacing fires. Heavy grazing, in contrast to fire, removes the grass cover and tends to favor shrub and conifer species. Fire suppression combined with grazing creates conditions that support cloning of oak and invasion by conifers. Large late-seral ponderosa pine, Douglas-fir, and Oregon white oak are harvested in much of this habitat. Under most management regimes, typical tree size decreases and tree density increases in this habitat. Ponderosa pine-Oregon white oak habitat is now denser than in the past and may contain more shrubs than in pre-settlement habitats. In some areas, new woodlands have been created by patchy tree establishment at the forest-steppe boundary.

Status and Trends. Quigley and Arbelbide [181] concluded that the Interior Ponderosa Pine cover type is significantly less in extent than pre-1900 and that the Oregon White Oak cover type is greater in extent than pre-1900. They included much of this habitat in their Dry Forest potential vegetation group [181], which they concluded has departed from natural succession and disturbance conditions. The greatest structural change in this habitat is the reduced extent of the late-seral, single-layer condition. This habitat is generally degraded because of increased exotic plants and decreased native bunchgrasses. One third of Pacific Northwest Oregon white oak, ponderosa pine, and dry Douglas-fir or grand fir community types listed in the National Vegetation Classification are considered imperiled or critically imperiled [10].

Upland Aspen Forest

Rex C. Crawford and Jimmy Kagan

Geographic Distribution. Quaking aspen groves are the most widespread habitat in North America, but are a minor type throughout eastern Washington and Oregon. Upland Aspen habitat is found in isolated mountain ranges of Southeastern Oregon, e.g. Steens Mountains, and in the northeastern Cascade of Washington. Aspen stands are much more common in the Rocky Mountain states.

Physical Setting. This habitat generally occurs on well-drained mountain slopes or canyon walls that have some moisture. Rockfalls, talus, or stony north slopes are often typical sites. It may occur in steppe on moist microsites. This habitat is not associated with streams, ponds, or wetlands. This habitat is found from 2,000 to 9,500 ft (610 to 2,896 m) elevation.

Landscape Setting. Aspen forms a "subalpine belt" above the Western Juniper and Mountain Mahogany Woodland habitat and below Montane Shrubsteppe Habitat on Steens Mountain in southern Oregon. It can occur in seral stands in the lower Eastside Mixed Conifer Forest and Ponderosa Pine Forest and Woodlands habitats. Primary land use is livestock grazing.

Structure. Deciduous trees usually <48 ft (15 m) tall dominate this woodland or forest habitat. The tree layer grows over a forb-, grass-, or low-shrub-dominated undergrowth. Relatively simple 2-tiered stands characterize the typical vertical structure of woody plants in this habitat. This habitat is composed of 1 to many clones of trees with larger trees toward the center of each clone. Conifers invade and create mixed evergreen-deciduous woodland or forest habitats.

Composition. Quaking aspen (*Populus tremuloides*) is the characteristic and dominant tree in this habitat. It is the sole dominant in many stands although scattered ponderosa pine (*Pinus ponderosa*) or Douglas-fir (*Pseudotsuga menziesii*) may be present. Snowberry (*Symphoricarpos oreophilus* and less frequently, *S. albus*) is the most common dominant shrub. Tall shrubs, Scouler's willow (*Salix scouleriana*) and serviceberry (*Amelanchier alnifolia*) may be abundant. On mountain or canyon slopes, antelope bitterbrush (*Purshia tridentata*), mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*), low sagebrush (*A. arbuscula*), and curl-leaf mountain mahogany (*Cercocarpus ledifolius*) often occur in and adjacent to this woodland habitat.
In some stands, pinegrass (*Calamagrostis rubescens*) may dominate the ground cover without shrubs. Other common grasses are Idaho fescue (*Festuca idahoensis*), California brome (*Bromus carinatus*), or blue wildrye (*Elymus glaucus*). Characteristic tall forbs include horsemint (*Agastache* spp.), aster (*Aster* spp.), senecio (*Senecio* spp.), coneflower (*Rudbeckia* spp.). Low forbs include meadowrue (*Thalictrum* spp.), bedstraw (*Galium* spp.), sweetcicely (*Osmorhiza* spp.), and valerian (*Valeriana* spp.).

Other Classifications and Key References. This habitat is called "Aspen" by the Society of American Foresters and "Aspen woodland" by the Society of Range Management. The Oregon Gap II Project [126] and Oregon Vegetation Landscape-Level Cover Type [127] that would represent this type is aspen groves. Other references describe this habitat [2, 88, 119, 161, 222].

Natural Disturbance Regime. Fire plays an important role in maintenance of this habitat. Quaking aspen will colonize sites after fire or other stand disturbances through root sprouting. Research on fire scars in aspen stands in central Utah [119] indicated that most fires occurred before 1885, and concluded that the natural fire return interval was 7-10 years. Ungulate browsing plays a variable role in aspen habitat; ungulates may slow tree regeneration by consuming aspen sprouts on some sites, and may have little influence in other stands.

Succession and Stand Dynamics. There is no generalized successional pattern across the range of this habitat. Aspen sprouts after fire and spreads vegetatively into large clonal or multi-clonal stands. Because aspen is shade intolerant and cannot reproduce under its own canopy, conifers can invade most aspen habitat. In central Utah, quaking aspen was invaded by conifers in 75-140 years. Apparently, some aspen habitat is not invaded by conifers, but eventually clones deteriorate and succeed to shrubs, grasses, and/or forbs. This transition to grasses and forbs occurs more likely on dry sites.

Effects of Management and Anthropogenic Impacts. Domestic sheep reportedly consume 4 times more aspen sprouts than do cattle. Heavy livestock browsing can adversely impact aspen growth and regeneration. With fire suppression and alteration of fine fuels, fire rejuvenation of aspen habitat has been greatly reduced since about 1900. Conifers now dominate many seral aspen stands and extensive stands of young aspen are uncommon.

Status and Trends. With fire suppression and change in fire regimes, the Aspen Forest habitat is less common than before 1900. None of the 5 Pacific Northwest upland quaking aspen community types in the National Vegetation Classification is considered imperiled [10].

Subalpine Parkland

Rex C. Crawford and Christopher B. Chappell

Geographic Distribution. The Subalpine Parkland habitat occurs throughout the high mountain ranges of Washington and Oregon (e.g., Cascade crest, Olympic Mountains, Wallowa and Owyhee Mountains, and Okanogan Highlands), extends into mountains of Canada and Alaska, and to the Sierra Nevada and Rocky Mountains.

Physical Setting. Climate is characterized by cool summers and cold winters with deep snowpack, although much variation exists among specific vegetation types. Mountain hemlock sites receive an average precipitation of >50 inches (127 cm) in 6 months and several feet of snow typically accumulate. Whitebark pine sites receive 24-70 inches (61-178 cm) per year and some sites only rarely accumulate a significant snowpack. Summer soil drought is possible in eastside parklands but rare in west side areas. Elevation varies from 4,500 to 6,000 ft (1,371 to 1,829 m) in the western Cascade and Olympic Mountains and from 5,000 to 8,000 ft (1,524 to 2,438 m) in the eastern Cascade and Wallowa Mountains.

Landscape Setting. The Subalpine Parkland habitat lies above the Mixed Montane Conifer Forest or Lodgepole Pine Forest habitat and below the Alpine Grassland and Shrubland habitat. Associated wetlands in subalpine parklands extend up a short distance into the alpine zone. Primary land use is recreation, watershed protection, and grazing.

Structure. Subalpine Parkland habitat has a tree layer typically between 10 and 30% canopy cover. Openings among trees are highly variable. The habitat appears either as parkland, that is, a mosaic of treeless openings and small patches of trees often with closed canopies, or as woodlands or savanna-like stands of scattered trees. The ground layer can be composed of (1) low to matted dwarf-shrubs (<1 ft [0.3 m] tall) that are evergreen or deciduous and often small-leaved; (2) sod grasses, bunchgrasses, or sedges; (3) forbs; or (4) moss- or lichen-covered soils. Herb or shrub-dominated wetlands appear within the parkland areas and are considered part of this habitat; wetlands can occur as deciduous shrub thickets up to 6.6 ft (2 m) tall, as scattered tall shrubs, as dwarf shrub thickets, or as short herbaceous plants <1.6 ft (0.5 m) tall. In general, western Cascade and Olympic areas are mostly parklands composed of a mosaic of patches of trees interspersed with heather shrublands or wetlands, whereas, eastern Cascade and Rocky mountain areas are parklands and woodlands typically dominated by grasses or sedges, with fewer heathers.

Composition. Species composition in this habitat varies with geography or local site conditions. The tree layer can be composed of 1 or several tree species. Subalpine fir (*Abies lasiocarpa*), Engelmann spruce (*Picea engelmannii*) and lodgepole pine (*Pinus contorta*) are found throughout the Pacific Northwest, whereas limber pine (*P. flexilis*) is restricted to southeastern Oregon. Alaska yellowcedar (*Chamaecyparis nootkatensis*), Pacific silver fir (*A. amabilis*), and mountain hemlock (*Tsuga mertensiana*) are most common in the Olympics and Cascade. Whitebark pine (*P. albicaulis*) is found primarily in the eastern

Cascade Mountains Okanogan Highlands, and Blue Mountains. Subalpine larch (*Larix lyallii*) occurs only in the northern Cascade Mountains, primarily east of the crest.

West Cascade and Olympic areas generally are parklands. Tree islands often have big huckleberry (*Vaccinium membranaceum*) in the undergrowth interspersed with heather shrublands between. Openings are composed of pink mountain-heather (*Phyllodoce empetriformis*), and white mountain-heather (*Cassiope mertensiana*) and Cascade blueberry (*Vaccinium deliciosum*). Drier areas are more woodland or savanna like, often with low shrubs, such as common juniper (*Juniperus communis*), kinnikinnick (*Arctostaphylos uva-ursi*), low whortleberries or grouseberries (*Vaccinium myrtillus or V. scoparium*) or beargrass (*Xerophyllum tenax*) dominating the undergrowth. Wetland shrubs in the Subalpine Parkland habitat include bog-laurel (*Kalmia microphylla*), Booth's willow (*Salix boothii*), undergreen willow (*S. commutata*), Sierran willow (*S. eastwoodiae*), and blueberries (*Vaccinium uliginosum* or *V. deliciosum*)

Undergrowth in drier areas may be dominated by pinegrass (*Calamagrostis rubescens*), Geyer's sedge (*Carex geyeri*), Ross' sedge (*C. rossii*), smooth woodrush (*Luzula glabrata* var. *hitchcockii*), Drummond's rush *(Juncus drummondii)*, or short fescues (*Festuca viridula*, *F. brachyphylla, F. saximontana*). Various sedges are characteristic of wetland graminoid-dominated habitats: black (*Carex nigricans*), Holm's Rocky Mountain (*C. scopulorum*), Sitka (*C. aquatilis* var. *dives*) and Northwest Territory (*C. utriculatia*) sedges. Tufted hairgrass (*Deschampsia caespitosa*) is characteristic of subalpine wetlands.

The remaining flora of this habitat is diverse and complex. The following herbaceous broadleaf plants are important indicators of differences in the habitat: American bistort (*Polygonum bistortoides*), American false hellebore (*Veratrum viride*), fringe leaf cinquefoil (*Potentilla flabellifolia*), marsh marigolds (*Caltha leptosepala*), avalanche lily (*Erythronium montanum*), partridgefoot (*Luetkea pectinata*), Sitka valerian (*Valeriana sitchensis*), subalpine lupine (*Lupinus arcticus* ssp. *subalpinus*), and alpine aster (*Aster alpigenus*). Showy sedge (*Carex spectabilis*) is also locally abundant.

Other Classifications and Key References. This habitat is called the Hudsonian Zone [155], Parkland subzone [134], meadow-forest mosaic [74], upper subalpine zone [88], Meadows and Park, and Subalpine Parkland [20]. Quigley and Arbelbide [181] called this habitat Whitebark pine and Whitebark pine-Subalpine larch cover types. Kuchler [136] included this within the subalpine fir-mountain hemlock forest. The Oregon Gap II Project [126] and Oregon Vegetation Landscape-Level Cover Types [127] that would represent this type are whitebark-lodgepole pine montane forest and subalpine parkland. Additional references describe this habitat [11, 49, 75, 105, 112, 114, 115, 139, 144, 221].

Natural Disturbance Regime. Although fire is rare to infrequent in this habitat, it plays an important role, particularly in drier environments. Whitebark pine woodland fire intervals varied from 50 to 300 years before 1900. Mountain hemlock parkland fire reoccurrence is 400-800 years. Wind blasting by ice and snow crystals is a critical factor in these woodlands and establishes the higher limits of the habitat. Periodic shifts in climatic factors, such as drought, snowpack depth, or snow duration either allow tree invasions into meadows and shrublands or eliminate or retard tree growth. Volcanic activity plays a long-term role in establishing this habitat. Wetlands are usually seasonally or perennially flooded by snowmelt and springs, or by subirrigation.

Succession and Stand Dynamics. Succession in this habitat occurs through a complex set of relationships between vegetation response to climatic shifts and catastrophic disturbance, and plant species interactions and site modification that create microsites. A typical succession of subalpine trees into meadows or shrublands begins with the invasion of a single tree, subalpine fir and mountain hemlock in the wetter climates and whitebark pine and subalpine larch in drier climates. If the environment allows, tree density slowly increases (over decades to centuries) through seedlings or branch layering by subalpine fir. The tree patches or individual trees change the local environment and create microsites for shade-tolerant trees, Pacific silver fir in wetter areas, and subalpine fir and Engelmann spruce in drier areas. Whitebark pine, an early invading tree, is dispersed long distances by Clark's nutcrackers and shorter distances by mammals. Most other tree species are wind dispersed.

Effects of Management and Anthropogenic Impacts. Fire suppression has contributed to change in habitat structure and functions. For example, the current "average" whitebark pine stand will burn every 3,000 years or longer because of fire suppression. Blister rust, an introduced pathogen, is increasing whitebark pine mortality in these woodlands [4]. Even limited logging can have prolonged effects because of slow invasion rates of trees. This is particularly important on drier sites and in subalpine larch stands. During wet cycles, fire suppression can lead to tree islands coalescing and the conversion of parklands into a more closed forest habitat. Parkland conditions can displace alpine conditions through tree invasions. Livestock use and heavy horse or foot traffic can lead to trampling and soil compaction. Slow growth in this habitat prevents rapid recovery.

Status and Trends. This habitat is generally stable with local changes to particular tree variants. Whitebark pine maybe declining because of the effects of blister rust or fire suppression that leads to conversion of parklands to more closed forest. Global climate warming will likely have an amplified effect throughout this habitat. Less than 10 percent of Pacific Northwest subalpine parkland community types listed in the National Vegetation Classification are considered imperiled [10].

Alpine Grassland and Shrublands

Christopher B. Chappell and Jimmy Kagan

Geographic Distribution. This habitat occurs in high mountains throughout the region, including the Cascade, Olympic Mountains, Okanogan Highlands, Wallowa Mountains, Blue Mountains, Steens Mountain in southeastern Oregon, and, rarely, the Siskiyous. It is most extensive in the Cascade from Mount Rainier north and in the Wallowa Mountains. Similar habitats occur throughout mountains of northwestern North America.

Physical Setting. The climate is the coldest of any habitat in the region. Winters are characterized by moderate to deep snow accumulations, very cold temperatures, and high winds. Summers are relatively cool. Growing seasons are short because of persistent snow pack or frost. Blowing snow and ice crystals on top of the snow pack at and above treeline prevent vegetation such as trees from growing above the depth of the snow pack. Snow pack protects vegetation from the effects of this winter wind-related disturbance and from excessive frost heaving. Community composition is much influenced by relative duration of snow burial and exposure to wind and frost heaving [75]. Elevation ranges from a minimum of 5,000 ft (1,524 m) in parts of the Olympics to ^{3}10,000 ft (3,048 m). The topography varies from gently sloping broad ridgetops, to glacial cirque basins, to steep slopes of all aspects. Soils are generally poorly developed and shallow, though in subalpine grasslands they may be somewhat deeper or better developed. Geologic parent material varies with local geologic history.

Landscape Setting. This habitat always occurs above upper treeline in the mountains or a short distance below it (grasslands in the subalpine parkland zone). Typically, it occurs adjacent to, or in a mosaic with, Subalpine Parkland. Occasionally, it may grade quickly from this habitat down into Montane Mixed Conifer Forest without intervening Subalpine Parkland. In southeastern Oregon, this habitat occurs adjacent to and above Upland Aspen Forest and Shrubsteppe habitats. Small areas of Open Water, Herbaceous Wetlands, and Subalpine Parkland habitats sometimes occur within a matrix of this habitat. Cliffs, talus, and other barren areas are common features within or adjacent to this habitat. Land use is primarily recreation, but in some areas east of the Cascade Crest, it is grazing, especially by sheep.

Structure. This habitat is dominated by grassland, dwarf-shrubland (mostly evergreen microphyllous), or forbs. Cover of the various life forms is extremely variable, and total cover of vascular plants can range from sparse to complete. Patches of krummholz (coniferous tree species maintained in shrub form by extreme environmental conditions) are a common component of this habitat, especially just above upper treeline. In subalpine grasslands, which are considered part of this habitat, widely scattered coniferous trees sometimes occur. Five major structural types can be distinguished: (1) subalpine and alpine bunchgrass grasslands, (2) alpine sedge turf, (3) alpine heath or dwarf-shrubland, (4) fellfield and boulderfield, and (5) snowbed forb community. Fellfields have a large amount of bare ground or rocks with a diverse and variable open layer of forbs, graminoids, and less commonly dwarf-shrubs. Snowbed forb communities have relatively sparse cover of few species of mainly forbs. In the alpine zone, these types often occur in a complex fine-scale mosaic with each other.

Composition. Most subalpine or alpine bunchgrass grasslands are dominated by Idaho fescue (*Festuca idahoensis*), alpine fescue (*F. brachyphylla*), green fescue (*F. viridula*), Rocky Mountain fescue (*F. saximontana*), or timber oatgrass (*Danthonia intermedia*), and to a lesser degree, purple reedgrass (*Calamagrostis purpurascens*), downy oat-grass (*Trisetum spicatum*) or muttongrass (*Poa fendleriana*). Forbs are diverse and sometimes abundant in the grasslands. Alpine sedge turfs may be moist or dry and are dominated by showy sedge (*Carex spectabilis*), black alpine sedge (*C. nigricans*), Brewer's sedge (*C. breweri*), capitate sedge (*C. capitata*), nard sedge (*C. nardina*), dunhead sedge (*C. phaeocephala*), or western single-spike sedge (*C. pseudoscirpoidea*).

One or more of the following species dominates alpine heaths: pink mountain-heather (*Phyllodoce empetriformis*), green mountain-heather (*P. glanduliflora*), white mountain-heather (*Cassiope mertensiana*), or black crowberry (*Empetrum nigrum*). Other less extensive dwarf-shrublands may be dominated by the evergreen coniferous common juniper (*Juniperus communis*), the evergreen broadleaf kinnikinnick (*Arctostaphylos uva-ursi*), the deciduous shrubby cinquefoil (*Pentaphylloides floribunda*) or willows (*Salix cascadensis* and *S. reticulata* ssp. *nivalis*). Tree species occurring as shrubby krummholz in the alpine are subalpine fir (*Abies lasiocarpa*), whitebark pine (*Pinus albicaulis*), mountain hemlock (*Tsuga mertensiana*), Engelmann spruce (*Picea engelmannii*), and subalpine larch (*Larix lyallii*).

Fellfields and similar communities are typified by variable species assemblages and co-dominance of multiple species, including any of the previously mentioned species, especially the sedges, as well as golden fleabane (*Erigeron aureus*), Lobb's lupine (*Lupinus sellulus* var. *lobbii*), spreading phlox (*Phlox diffusa*), eight-petal mountain-avens (*Dryas octopetala*), louseworts (*Pedicularis contorta, P. ornithorhyncha*) and many others. Snowbed forb communities are dominated by Tolmie's saxifrage (*Saxifraga tolmiei*), Shasta buckwheat (*Eriogonum pyrolifolium*), or Piper's woodrush (*Luzula piperi*).

Other Classifications and Key References. This habitat is equivalent to the alpine communities and the subalpine *Festuca* communities of Franklin and Dyrness [88]. It is also referred to as Alpine meadows and barren No. 52 [136]. The Oregon Gap II Project [126] and Oregon Vegetation Landscape-Level Cover Types [127] that would represent this type are subalpine grassland and alpine fell-snowfields; represented by non-forest in the alpine/parkland zone of Washington Gap [37]. Other references describe this habitat [61, 65, 75, 80, 94, 105, 112, 123, 139, 195, 207].

Natural Disturbance Regime. Most natural disturbances seem to be small scale in their effects or very infrequent. Herbivory and associated trampling disturbance by elk, mountain goats, and occasionally bighorn sheep seems to be an important disturbance in some areas, creating patches of open ground, though the current distribution and abundance of these ungulates is in part a result of introductions. Small mammals can also have significant effects on vegetation: e.g., the heather vole occasionally overgrazes heather communities [80]. Frost heaving is a climatically related small-scale disturbance that is extremely important in structuring the vegetation [80]. Extreme variation from the norm in snow pack depth and duration can act as a disturbance, exposing plants to winter dessication [80], shortening the growing season, or facilitating summer drought. Subalpine grasslands probably burn on occasion and can be formed or expanded in area by fires in subalpine parkland [139].

Succession and Stand Dynamics. Little is known about vegetation changes in these communities, in part because changes are relatively slow. Tree invasion rates into subalpine grasslands are relatively slow compared to other subalpine communities [139]. Seedling establishment for many plant species in the alpine zone is poor. Heath communities take about 200 years to mature after initial establishment and may occupy the same site for thousands of years [139].

Effects of Management and Anthropogenic Impacts. The major human impacts on this habitat are trampling and associated recreational impacts, e.g., tent sites. Resistance and resilience of vegetation to impacts varies by life form [48]. Sedge turfs are perhaps most resilient to trampling and heaths are least resilient. Trampling to the point of significantly opening an alpine heath canopy will initiate a degradation and erosion phase that results in continuous bare ground, largely unsuitable for vascular plant growth [80]. Bare ground in the alpine zone left alone after recreational disturbance will typically not revegetate in a time frame that humans can appreciate. Introduction of exotic ungulates can have noticeable impacts (e.g., mountain goats in the Olympic Mountains). Domestic sheep grazing has also had dramatic impacts [196], especially in the bunchgrass habitats east of the Cascade.

Status and Trends. This habitat is naturally very limited in extent in the region. There has been little to no change in abundance over the last 150 years. Most of this habitat is still in good condition and dominated by native species. Some areas east of the Cascade Crest have been degraded by livestock use. Recreational impacts are noticeable in some national parks and wilderness areas. Current trends seem to be largely stable, though there may be some slow loss of subalpine grassland to recent tree invasion. Threats include increasing recreational pressures, continued grazing at some sites, and, possibly, global climate change resulting in expansion of trees into this habitat. Only 1 out of 40 plant associations listed in the National Vegetation Classification is considered imperiled[10].

Eastside (Interior) Grasslands

Rex. C. Crawford and Jimmy Kagan

Geographic Distribution. This habitat is found primarily in the Columbia Basin of Idaho, Oregon, and Washington, at mid- to low elevations and on plateaus in the Blue Mountains, usually within the ponderosa pine zone in Oregon.

Idaho fescue grassland habitats were formerly widespread in the Palouse region of southeastern Washington and adjacent Idaho; most of this habitat has been converted to agriculture. Idaho fescue grasslands still occur in isolated, moist sites near lower treeline in the foothills of the Blue Mountains, the Northern Rockies, and east Cascade near the Columbia River Gorge. Bluebunch wheatgrass grassland habitats are common throughout the Columbia Basin, both as modified native grasslands in deep canyons and the dry Palouse and as fire-induced representatives in the shrubsteppe. Similar grasslands appear on the High Lava Plains ecoregion, where they occur in a matrix with big sagebrush or juniper woodlands. In Oregon they are also found in burned shrubsteppe and canyons in the Basin and Range and Owyhee Uplands. Sand dropseed and three-awn needlegrass grassland habitats are restricted to river terraces in the Columbia Basin, Blue Mountains, and Owyhee Uplands of Oregon and Washington. Primary location of this habitat extends along the Snake River from Lewiston south to the Owyhee River.

Physical Setting. This habitat develops in hot, dry climates in the Pacific Northwest. Annual precipitation totals 8-20 inches (20-51 cm); only 10% falls in the hottest months, July through September. Snow accumulation is low (1-6 inches [3-15 cm]) and occurs only in January and February in eastern portions of its range and November through March in the west. More snow accumulates in grasslands within the forest matrix. Soils are variable: (1) highly productive loess soils up to 51 inches (130 cm) deep, (2) rocky flats, (3) steep slopes, and (4) sandy, gravel or cobble soils. An important variant of this habitat occurs on sandy, gravelly, or silty river terraces or seasonally exposed river gravel or Spokane flood deposits. The grassland habitat is typically upland vegetation but it may also include riparian bottomlands dominated by non-native grasses. This habitat is found from 500 to 6,000 ft (152-1,830 m) in elevation.

Landscape Setting. Eastside grassland habitats appear well below and in a matrix with lower treeline Ponderosa Pine Forests and Woodlands or Western Juniper and Mountain Mahogany Woodlands. It can also be part of the lower elevation forest matrix. Most grassland habitat occurs in 2 distinct large landscapes: plateau and canyon grasslands. Several rivers flow through narrow basalt canyons below plateaus supporting prairies or shrubsteppe. The canyons can be some 2,132 ft (650 m) deep below the plateau. The plateau above is composed of gentle slopes with deep silty loess soils in an expansive rolling dune-like landscape. Grasslands may occur in a patchwork with shallow soil scablands or within biscuit scablands or mounded topography. Naturally occurring grasslands are beyond the range of bitterbrush and sagebrush species. This habitat exists today in the shrubsteppe landscape where grasslands are created by brush removal, chaining or spraying, or by fire. Agricultural uses and introduced perennial plants on abandoned or planted fields are common throughout the current distribution of eastside grassland habitats.

Structure. This habitat is dominated by short to medium-tall grasses (<3.3 ft [1 m]). Total herbaceous cover can be closed to only sparsely vegetated. In general, this habitat is an open and irregular arrangement of grass clumps rather than a continuous sod cover. These medium-tall grasslands often have scattered and diverse patches of low shrubs, but few or no medium-tall shrubs (<10% cover of shrubs are taller than the grass layer). Native forbs may contribute significant cover or they may be absent. Grasslands in canyons are dominated by bunchgrasses growing in lower densities than on deep-soil prairie sites. The soil surface between perennial plants can be covered with a diverse cryptogamic or microbiotic layer of mosses, lichens, and various soil bacteria and algae. Moister environments can support a dense sod of rhizomatous perennial grasses. Annual plants are a common spring and early summer feature of this habitat.

Composition. Bluebunch wheatgrass (*Pseudoroegneria spicata*) and Idaho fescue (*Festuca idahoensis*) are the characteristic native bunchgrasses of this habitat and either or both can be dominant. Idaho fescue is common in more moist areas and bluebunch wheatgrass more abundant in drier areas. Rough fescue (*F. campestris*) is a characteristic dominant on moist sites in northeastern Washington. Sand dropseed (*Sporobolus cryptandrus*) or three-awn (*Aristida longiseta*) are native dominant grasses on hot dry sites in deep canyons. Sandberg bluegrass (*Poa sandbergii*) is usually present, and occasionally codominant in drier areas. Bottlebrush squirreltail (*Elymus elymoides*) and Thurber needlegrass (*Stipa thurberiana*) can be locally dominant. Annual grasses are usually present; cheatgrass (*Bromus tectorum*) is the most widespread. In addition, medusahead (*Taeniatherum caput-medusae*), and other annual bromes (*Bromus commutatus, B. mollis, B. japonicus*) may be present to co-dominant. Moist environments, including riparian bottomlands, are often co-dominated by Kentucky bluegrass (*Poa pratensis*).

A dense and diverse forb layer can be present or entirely absent; >40 species of native forbs can grow in this habitat including balsamroots *(Balsamorhiza* spp.), biscuitroots (*Lomatium* spp.), buckwheat *(Eriogonum* spp.), fleabane *(Erigeron* spp.), lupines (*Lupinus* spp.), and milkvetches *(Astragalus* spp.). Common exotic forbs that can grow in this habitat are knapweeds (*Centaurea solstitialis*, *C. diffusa*, *C. maculosa*), tall tumblemustard (*Sisymbrium altissimum*), and Russian thistle (*Salsola kali*).

Smooth sumac (*Rhus glabra*) is a deciduous shrub locally found in combination with these grassland species. Rabbitbrushes (*Chrysothamnus nauseosus*, *C. viscidiflorus*) can occur in this habitat in small amounts, especially where grazed by livestock. In moist Palouse regions, common snowberry (*Symphoricarpos albus*) or Nootka rose (*Rosa nutkana*) may be present, but is shorter than the bunchgrasses. Dry sites contain low succulent pricklypear (*Opuntia polyacantha*). Big sagebrush (*Artemisia tridentata*) is occasional and may be increasing in grasslands on former shrubsteppe sites. Black hawthorn (*Crataegus douglasii*) and other tall shrubs can form dense thickets near Idaho fescue grasslands. Rarely, ponderosa pine (*Pinus ponderosa*) or western juniper (*Juniperus occidentalis*) can occur as isolated trees.

Other Classifications and Key References. This habitat is called Palouse Prairie, Pacific Northwest grassland, steppe vegetation, or bunchgrass prairie in general ecological literature. Quigley and Arbelbide [181] called this habitat Fescue-Bunchgrass and Wheatgrass Bunchgrass and the dry Grass cover type. The Oregon Gap II Project [126] and Oregon Vegetation Landscape-Level Cover Types [127] that would represent this type are northeast Oregon canyon grassland, forest-grassland mosaic, and modified grassland; Washington Gap [37] types 13, 21, 22, 24, 29-31, 82, and 99 map this habitat. Kuchler [136] includes this within Fescue-wheatgrass and wheatgrass-bluegrass. Franklin and Dyrness [88] include this habitat in steppe zones of Washington and Oregon. Other references describe this habitat [28, 60, 159, 166, 206, 207].

Natural Disturbance Regime. The fire-return interval for sagebrush and bunchgrass is estimated at 25 years [22]. The native bunchgrass habitat apparently lacked extensive herds of large grazing and browsing animals until the late 1800's. Burrowing animals and their predators likely played important roles in creating small-scale patch patterns.

Succession and Stand Dynamics. Currently fires burn less frequently in the Palouse grasslands than historically because of fire suppression, roads, and conversions to cropland [159]. Without fire, black hawthorn shrubland patches expand on slopes along with common snowberry and rose. Fires covering large areas of shrubsteppe habitat can eliminate shrubs and their seed sources and create eastside grassland habitat. Fires that follow heavy grazing or repeated early season fires can result in annual grasslands of cheatgrass, medusahead, knapweed, or yellow star-thistle. Annual exotic grasslands are common in dry grasslands and are included in modified grasslands as part of the Agriculture habitat.

Effects of Management and Anthropogenic Impacts. Large expanses of grasslands are currently used for livestock ranching. Deep soil Palouse sites are mostly converted to agriculture. Drier grasslands and canyon grasslands, those with shallower soils, steeper topography, or hotter, drier environments, were more intensively grazed and for longer periods than were deep-soil grasslands [207]. Evidently, these drier native bunchgrass grasslands changed irreversibly to persistent annual grass and forblands. Some annual grassland, native bunchgrass, and shrubsteppe habitats were converted to intermediate wheatgrass, or more commonly, crested wheatgrass (*Agropyron cristatum*)-dominated areas. Apparently, these form persistent grasslands and are included as modified grasslands in the Agriculture habitat. With intense livestock use, some riparian bottomlands become dominated by non-native grasses. Many native dropseed grasslands have been submerged by dam reservoirs.

Status and Trends. Most of the Palouse prairie of southeastern Washington and adjacent Idaho and Oregon has been converted to agriculture. Remnants still occur in the foothills of the Blue Mountains and in isolated, moist Columbia Basin sites. The Palouse is one of the most endangered ecosystems in the U.S. [166] with only 1% of the original habitat remaining; it is highly fragmented with most sites <10 acres. All these areas are subject to weed invasions and drift of aerial biocides. Since 1900, 94% of the Palouse grasslands have been converted to crop, hay, or pasture lands. Quigley and Arbelbide [181] concluded that Fescue-Bunchgrass and Wheatgrass bunchgrass cover types have significantly decreased in area since pre-1900, while exotic forbs and annual grasses have significantly increased since pre-1900. Fifty percent of the plant associations recognized as components of eastside grassland habitat listed in the National Vegetation Classification are considered imperiled or critically imperiled [10].

Shrubsteppe

Rex. C. Crawford and Jimmy Kagan

Geographic Distribution. Shrubsteppe habitats are common across the Columbia Plateau of Washington, Oregon, Idaho, and adjacent Wyoming, Utah, and Nevada. It extends up into the cold, dry environments of surrounding mountains.

Basin big sagebrush shrubsteppe occurs along stream channels, in valley bottoms and flats throughout eastern Oregon and Washington. Wyoming sagebrush shrubsteppe is the most widespread habitat in eastern Oregon and Washington, occurring throughout the Columbia Plateau and the northern Great Basin. Mountain big sagebrush shrubsteppe habitat occurs throughout the mountains of the eastern Oregon and Washington. Bitterbrush shrubsteppe habitat appears primarily along the eastern slope of the Cascade, from north-central Washington to California and occasionally in the Blue Mountains. Three-tip sagebrush shrubsteppe occurs mostly along the northern and western Columbia Basin in Washington and occasionally appears in the lower valleys of the Blue Mountains and in the Owyhee Upland ecoregions of Oregon. Interior shrub dunes and sandy steppe and shrubsteppe habitat is concentrated at low elevations near the Columbia River and in isolated pockets in the Northern Basin and Range and Owyhee Uplands. Bolander silver sagebrush shrubsteppe is common in southeastern Oregon. Mountain silver sagebrush is more prevalent in the Oregon East Cascade and in montane meadows in the southern Ochoco and Blue Mountains.

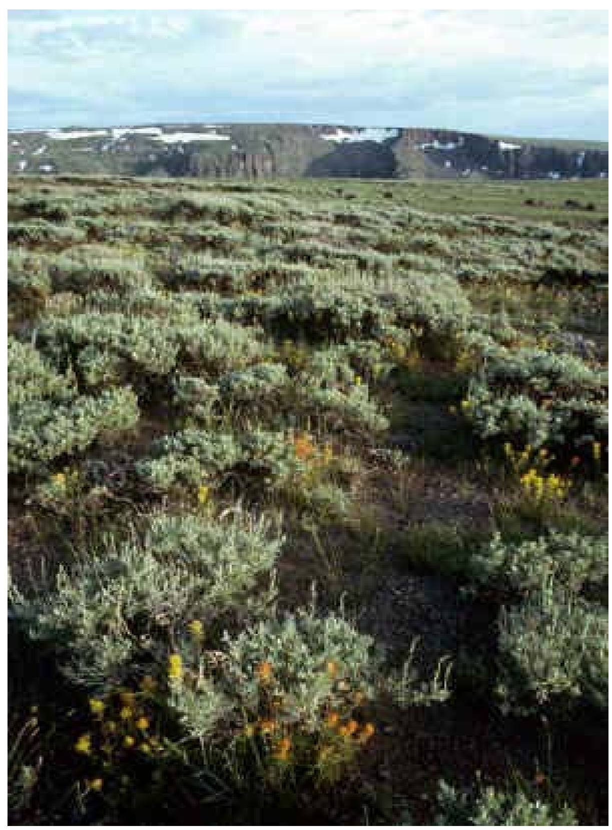
Physical Setting. Generally, this habitat is associated with dry, hot environments in the Pacific Northwest although variants are in cool, moist areas with some snow accumulation in climatically dry mountains. Elevation range is wide (300-9,000 ft [91-2,743 m]) with most habitat occurring between 2,000 and 6,000 ft (610-1,830 m). Habitat occurs on deep alluvial, loess, silty or sandy-silty soils, stony flats, ridges, mountain slopes, and slopes of lake beds with ash or pumice soils.

Landscape Setting. Shrubsteppe habitat defines a biogeographic region and is the major vegetation on average sites in the Columbia Plateau, usually below Ponderosa Pine Forest and Woodlands, and Western Juniper and Mountain Mahogany Woodlands habitats. It forms mosaic landscapes with these woodland habitats and Eastside Grasslands, Dwarf Shrubsteppe, and Desert Playa and Salt Scrub habitats. Mountain sagebrush shrubsteppe occurs at high elevations occasionally within the dry Eastside Mixed Conifer Forest and Montane Mixed Conifer Forest habitats. Shrubsteppe habitat can appear in large landscape patches. Livestock grazing is the primary land use in the shrubsteppe although much has been converted to irrigation or dry land agriculture. Large areas occur in military training areas and wildlife refuges.

Structure. This habitat is a shrub savanna or shrubland with shrub coverage of 10-60%. In an undisturbed condition, shrub cover varies between 10 and 30%. Shrubs are generally evergreen although deciduous shrubs are prominent in many habitats. Shrub height typically is medium-tall (1.6-

3.3 ft [0.5-1.0 m]) although some sites support shrubs approaching 9 ft (2.7 m) tall. Vegetation structure in this habitat is characteristically an open shrub layer over a moderately open to closed bunchgrass layer. The more northern or productive sites generally have a denser grass layer and sparser shrub layer than southern or more xeric sites. In fact, the rare good-condition site is better characterized as grassland with shrubs than a shrubland. The bunchgrass layer may contain a variety of forbs. Good-condition habitat has very little exposed bare ground, and has mosses and lichens carpeting the area between taller plants. However, heavily grazed sites have dense shrubs making up >40% cover, with introduced annual grasses and little or no moss or lichen cover. Moist sites may support tall bunchgrasses (>3.3 ft [1 m]) or rhizomatous grasses. More southern shrubsteppe may have native low shrubs dominating with bunchgrasses.

Composition. Characteristic and dominant mid-tall shrubs in the shrubsteppe habitat include all 3 subspecies of big sagebrush, basin (*Artemisia tridentata* ssp. *tridentata*), Wyoming (*A. t.* ssp. *wyomingensis*) or mountain (*A. t.* ssp. *vaseyana*), antelope bitterbrush (*Purshia tridentata*), and 2 shorter sagebrushes, silver (*A. cana*) and three-tip (*A. tripartita*). Each of these species can be the only shrub or appear in complex seral conditions with other shrubs. Common shrub complexes are bitterbrush and Wyoming big sagebrush, bitterbrush and three-tip sagebrush, Wyoming big sagebrush and three-tip sagebrush, and mountain big sagebrush and silver sagebrush. Wyoming and mountain big sagebrush can codominate areas with tobacco brush (*Ceanothus velutinus)*. Rabbitbrush (*Chrysothamnus viscidiflorus*) and short-spine horsebrush (*Tetradymia spinosa*) are common associates and often dominate sites after disturbance. Big sagebrush occurs with the shorter stiff sagebrush (*A. rigida*) or low sagebrush (*A. arbuscula*) on shallow soils or high elevation sites. Many sandy areas are shrub-free or are open to patchy shrublands of bitterbrush and/or rabbitbrush. Silver sagebrush is the dominant and characteristic shrub along the edges of stream courses, moist meadows, and ponds. Silver sagebrush and rabbitbrush are associates in disturbed areas.



When this habitat is in good or better ecological condition a bunchgrass steppe layer is characteristic. Diagnostic native bunchgrasses that often dominate different shrubsteppe habitats are (1) mid-grasses: bluebunch wheatgrass (*Pseudoroegneria spicata),* Idaho fescue (*Festuca idahoensis*), bottlebrush squirreltail (*Elymus elymoides*), and Thurber needlegrass (*Stipa thurberiana*); (2) short grasses: threadleaf sedge (*Carex filifolia*) and Sandberg bluegrass (*Poa sandbergii*); and (3) the tall grass, basin wildrye (*Leymus cinereus*). Idaho fescue is characteristic of the most productive shrubsteppe vegetation. Bluebunch wheatgrass is co-dominant at xeric locations, whereas western needlegrass (*Stipa occidentalis*), long-stolon *(Carex inops)* or Geyer's sedge (*C. geyeri*) increase in abundance in higher elevation shrubsteppe habitats. Needle-and-thread (*Stipa comata*) is the characteristic native bunchgrass on stabilized sandy soils. Indian ricegrass (*Oryzopsis hymenoides*) characterizes dunes. Grass layers on montane sites contain slender wheatgrass (*Elymus trachycaulus*), mountain fescue (*F. brachyphylla*), green fescue (*F. viridula*), Geyer's sedge, or tall bluegrasses *(Poa* spp.). Bottlebrush squirreltail can be locally important in the Columbia Basin, sand dropseed (*Sporobolus cryptandrus*) is important in the Basin and Range and basin wildrye is common in the more alkaline areas. Nevada bluegrass (*Poa secunda*), Richardson muhly *(Muhlenbergia richardsonis*), or alkali grass (*Puccinella* spp.) can dominate silver sagebrush flats. Many sites support non-native plants, primarily cheatgrass (*Bromus tectorum*) or crested wheatgrass *(Agropyron cristatum*) with or without native grasses. Shrubsteppe habitat, depending on site potential and disturbance history, can be rich in forbs or have little forb cover. Trees may be present in some shrubsteppe habitats, usually as isolated individuals from adjacent forest or woodland habitats.

Other Classifications and Key References. This habitat is called Sagebrush steppe and Great Basin sagebrush by Kuchler [136]. The Oregon Gap II Project [126] and Oregon Vegetation Landscape-Level Cover Types [127] that would represent this type are big sagebrush shrubland, sagebrush steppe, and bitterbrush-big sagebrush shrubland. Franklin and Dyrness [88] discussed this habitat in shrubsteppe zones of Washington and Oregon. Other references describe this habitat [60, 116, 122, 123, 212, 224, 225].

Natural Disturbance Regime. Barrett *et al.* [22] concluded that the fire-return interval for this habitat is 25 years. The native shrubsteppe habitat apparently lacked extensive herds of large grazing and browsing animals until the late 1800's. Burrowing animals and their predators likely played important roles in creating small-scale patch patterns.

Succession and Stand Dynamics. With disturbance, mature stands of big sagebrush are reinvaded through soil-stored or windborne seeds. Invasion can be slow because sagebrush is not disseminated over long distances. Site dominance by big sagebrush usually takes a decade or more depending on fire severity and season, seed rain, post-fire moisture, and plant competition. Three-tip sagebrush is a climax species that reestablishes (from seeds or commonly from sprouts) within 5-10 years following a disturbance. Certain disturbance regimes promote three-tip sagebrush and it can out-compete herbaceous species. Bitterbrush is a climax species that plays a seral role colonizing by seed onto rocky and/or pumice soils. Bitterbrush may be declining and may be replaced by woodlands in the absence of fire. Silver sagebrush is a climax species that establishes during early seral stages and coexists with later arriving species. Big sagebrush, rabbitbrush, and short-spine horsebrush invade and can form dense stands after fire or livestock grazing. Frequent or high-intensity fire can create a patchy shrub cover or can eliminate shrub cover and create Eastside Grasslands habitat.

Effects of Management and Anthropogenic Impacts. Shrub density and annual cover increase, whereas bunchgrass density decreases with livestock use. Repeated or intense disturbance, particularly on drier sites, leads to cheatgrass dominance and replacement of native bunchgrasses. Dry and sandy soils are sensitive to grazing, with needle-and-thread replaced by cheatgrass at most sites. These disturbed sites can be converted to modified grasslands in the Agriculture habitat.

Status and Trends. Shrubsteppe habitat still dominates most of southeastern Oregon although half of its original distribution in the Columbia Basin has been converted to agriculture. Alteration of fire regimes, fragmentation, livestock grazing, and the addition of >800 exotic plant species have changed the character of shrubsteppe habitat. Quigley and Arbelbide [181] concluded that Big Sagebrush and Mountain Sagebrush cover types are significantly smaller in area than before 1900, and that Bitterbrush/Bluebunch Wheatgrass cover type is similar to the pre-1900 extent. They concluded that Basin Big Sagebrush and Big sagebrush-Warm potential vegetation type's successional pathways are altered, that some pathways of Antelope Bitterbrush are altered and that most pathways for Big Sagebrush-Cool are unaltered. Overall this habitat has seen an increase in exotic plant importance and a decrease in native bunchgrasses. More than half of the Pacific Northwest shrubsteppe habitat community types listed in the National Vegetation Classification are considered imperiled or critically imperiled [10].

Agriculture, Pasture and Mixed Environs

W. Daniel Edge, Rex C. Crawford, and David H. Johnson

Geographic Distribution. Agricultural habitat is widely distributed at low to mid-elevations (<6,000 ft [1,830 m]) throughout both states. This habitat is most abundant in broad river valleys throughout both states and on gentle rolling terrain east of the Cascade.

Physical Setting. This habitat is maintained across a range of climatic conditions typical of both states. Climate constrains agricultural production at upper elevations where there are <90 frost-free days. Agricultural habitat in arid regions east of the Cascade with <10 inches (25 cm) of rainfall require supplemental irrigation or fallow fields for 1-2 years to accumulate sufficient soil moisture. Soils types are variable, but usually have a well developed A horizon. This habitat is found from 0 to 6,000 ft (0 to 1,830 m) elevation.

Landscape Setting. Agricultural habitat occurs within a matrix of other habitat types at low to mid-elevations, including Eastside grasslands, Shrubsteppe, Westside Lowlands Conifer-Deciduous Forest and other low to mid-elevation forest and woodland habitats. This habitat often dominates the landscape in flat or gently rolling terrain, on well-developed soils, broad river valleys, and areas with access to abundant irrigation water. Unlike other habitat types, agricultural habitat is often characterized by regular landscape patterns (squares, rectangles, and circles) and straight borders because of ownership boundaries and multiple crops within a region. Edges can be abrupt along the habitat borders within agricultural habitat and with other adjacent habitats.

Structure. This habitat is structurally diverse because it includes several cover types ranging from low-stature annual grasses and row crops (<3.3 ft [1 m]) to mature orchards (>66 ft [20 m]). However, within any cover type, structural diversity is typically low because usually only 1 to a few species of similar height are cultivated. Depending on management intensity or cultivation method, agricultural habitat may vary substantially in structure annually; cultivated cropland and modified grasslands are typified by periods of bare soil and harvest whereas pastures are mowed, hayed, or grazed 1 or more times during the growing season. Structural diversity of agricultural habitat is increased at local scales by the presences of non-cultivated or less intensively managed vegetation such as fencerows, roadsides, field borders, and shelterbelts.

Composition. Agricultural habitat varies substantially in composition among the cover types it includes. Cultivated cropland includes >50 species of annual and perennial plants in Oregon and Washington, and hundreds of varieties ranging from vegetables such as carrots, onions, and peas to annual grains such as wheat, oats, barley, and rye. Row crops of vegetables and herbs are characterized by bare soil, plants, and plant debris along bottomland areas of streams and rivers and areas having sufficient water for irrigation. Annual grains, such as barley, oats, and wheat are typically produced in almost continuous stands of vegetation on upland and rolling hill terrain without irrigation.

The orchard/vineyard/nursery cover type is composed of fruit and nut (apples, peaches, pears, and hazelnuts) trees, vineyards (grapes, Kiwi), berries (strawberries, blueberries, blackberries, and raspberries), Christmas trees, and nursery operations (ornamental container and greenhouses). This cover type is generally located on upland sites with access to abundant irrigation. Cultivation for most orchards, vineyards and Christmas tree farms includes an undergrowth of short-stature perennial grasses between the rows of trees, vines, or bushes. Christmas trees are typically produced without irrigation on upland sites with poorer soils.

Improved pastures are used to produce perennial herbaceous plants for grass seed and hay. Alfalfa and several species of fescue (*Festuca* spp.) and bluegrass (*Poa* spp.), orchardgrass (*Dactylis glomerata*), and timothy (*Phleum pratensis*) are commonly seeded in improved pastures. Grass seed fields are single-species stands, whereas pastures maintained for haying are typically composed of 2 to several species. The improved pasture cover type is one of the most common agricultural uses in both states and produced with and without irrigation.

Unimproved pastures are predominately grassland sites, often abandoned fields that have little or no active management such as irrigation, fertilization, or herbicide applications. These sites may or may not be grazed by livestock. Unimproved pastures include rangelands planted to exotic grasses that are found on private land, state wildlife areas, federal wildlife refuges and U.S. Department of Agriculture Conservation Reserve Program (CRP) sites. Grasses commonly planted on CRP sites are crested wheatgrass (*Agropyron cristatum*), tall fescue (*F. arundinacea*), perennial bromes (*Bromus* spp.) and wheatgrasses (*Elytrigia* spp.). Intensively grazed rangelands, which have been seeded to intermediate wheatgrass (*Elytrigia intermedia*), crested wheatgrass, or are dominated by increaser exotics such as Kentucky wheatgrass (*Poa pratensis*) or tall oatgrass (*Arrhenatherum elatius*) are unimproved pastures. Other unimproved pastures have been cleared and intensively farmed in the past, but are allowed to convert to other vegetation. These sites may be composed of uncut hay, litter from previous seasons, standing dead grass and herbaceous material, invasive exotic plants (tansy ragwort [*Senecio jacobea*], thistle [*Cirsium* spp.], Himalaya blackberry [*Rubus discolor*], and Scot's broom [*Cytisus scoparius*]) with patches of native black hawthorn (*Crataegus douglasii*), snowberry (*Symphoricarpos* spp.), spirea (*Spirea* spp.), poison oak (*Toxicodendron diversilobum*), and encroachment of various tree species, depending on seed source and environment.

Modified grasslands are generally overgrazed habitats that formerly were native grasslands or shrubsteppe but are now dominated by annual plants with only remnant individual plants of the native vegetation. Cheatgrass (*Bromus tectorum*), other annual bromes, medusahead (*Taeniatherum caput-medusae*), bulbous bluegrass (*Poa bulbosa*), and knapweeds (*Centaurea* spp.) are common increasers that form modified grasslands. Fire, following heavy grazing or repeated early season fires can create modified grassland monocultures of cheatgrass.

Agricultural habitat also contains scattered dwellings and outbuildings such as barns and silos, rural cemeteries, ditchbanks, windbreaks, and small inclusions of remnant native vegetation. These sites typically have a discontinuous tree layer or 1 to a few trees over a ground cover similar to improved or unimproved pastures.

Other Classifications and Key References. Quigley and Arbelbide [181] referred to this as agricultural and exotic forbs-annual grasses cover types. Csuti *et al.* [58] referred to this habitat as agricultural. The Oregon Gap II Project [126] and Oregon Vegetation Landscape-Level Cover Type [127] that would represent this type is agriculture. U.S. Department of Agriculture Conservation Reserve Program lands are included in this habitat.

Natural Disturbance Regime. Natural fires are almost totally suppressed in this habitat, except for unimproved pastures and modified grasslands, where fire-return intervals can resemble those of native grassland habitats. Fires are generally less frequent today than in the past, primarily because of fire suppression, construction of roads, and conversion of grass and forests to cropland [159]. Bottomland areas along streams and rivers are subject to periodic floods, which may remove or deposit large amounts of soil.

Succession and Stand Dynamics. Management practices disrupt natural succession and stand dynamics in most of the agricultural habitats. Abandoned eastside agricultural habitats may convert to other habitats, mostly grassland and shrub habitats from the surrounding native habitats. Some agricultural habitats that occur on highly erodible soils, especially east of the Cascade, have been enrolled in the U.S. Department of Agriculture Conservation Reserve Program. In the absence of fire or mowing, west side unimproved pastures have increasing amounts of hawthorn, snowberry, rose (*Rosa* spp.), Himalaya blackberry, spirea, Scot's broom, and poison oak. Douglas-fir or other trees can be primary invaders in some environments.

Effects of Management and Anthropogenic Impacts. The dominant characteristic of agricultural habitat is a regular pattern of management and vegetation disturbance. With the exception of the unimproved pasture cover type, most areas classified as agricultural habitat receive regular inputs of fertilizer and pesticides and have some form of vegetation harvest and manipulation. Management practices in cultivated cropland include different tillage systems, resulting in vegetation residues during the non-growing season that range from bare soil to 100% litter. Cultivation of some crops, especially in the arid eastern portions of both states, may require the land to remain fallow for 1-2 growing seasons in order to store sufficient soil moisture to grow another crop. Harvest in cultivated cropland, Christmas tree plantations, and nurseries, and mowing or haying in improved pasture cover types substantially change the structure of vegetation. Harvest in orchards and vineyards are typically less intrusive, but these crops as well as Christmas trees and some ornamental nurseries are regularly pruned. Improved pastures are often grazed after haying or during the non-growing season. Livestock grazing is the dominant use of unimproved pastures. All of these practices prevent agricultural areas from reverting to native vegetation. Excessive grazing in unimproved pastures may increase the prevalence of weedy or exotic species.

Status and Trends. Agricultural habitat has steadily increased in amount and size in both states since Eurasian settlement of the region. Conversion to agricultural habitat threatens several native habitat types [166]. The greatest conversion of native habitats to agricultural production occurred between 1950 and 1985, primarily as a function of U.S. agricultural policy [96]. Since the 1985 Farm Bill and the economic downturn of the early to mid 1980's, the amount of land in agricultural habitat has stabilized and begun to decline [164]. The 1985 and subsequent Farm Bills contained conservation provisions encouraging farmers to convert agricultural land to native habitats [96, 153]. Clean farming practices and single-product farms have become prevalent since the 1960's, resulting in larger farms and widespread removal of fencerows, field borders, roadsides, and shelterbelts [96, 153, 164]. In Oregon, land-use planning laws prevent or slow urban encroachment and subdivisions into areas zoned as agriculture. Washington's growth management is currently controlled by counties and agricultural land conversion to urban development is much less regulated.

Urban and Mixed Environs

Howard L. Ferguson

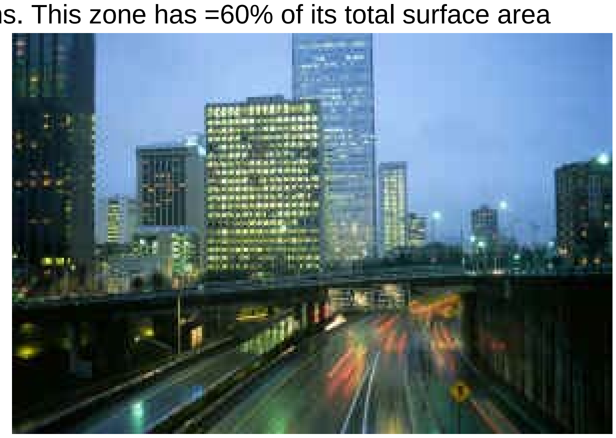
Geographic Distribution. Urban habitat occurs throughout Oregon and Washington. Most urban development is located west of the Cascade of both Oregon and Washington, with the exception of Spokane, Washington, which developed because of early railroad systems and connections to the East. However, urban growth is being felt in almost every small town throughout the Pacific Northwest.

Physical Setting. Urban development occurs in a variety of sites in the Pacific Northwest. It creates a physical setting unique to itself: temperatures are elevated and background lighting is increased; wind velocities are altered by the urban landscape, often reduced except around the tallest structures downtown, where high-velocity winds are funneled around the skyscrapers. Urban development often occurs in areas with little or no slope and frequently includes wetland habitats. Many of these wetlands have been filled in and eliminated. Today, ironically, many artificial "wetland" impoundments are being created for stormwater management, whose function is the same as the original wetland that was destroyed.

Landscape Setting. Urban development occurs within or adjacent to nearly every habitat type in Oregon and Washington, and often replaces habitats that are valuable for wildlife. The highest urban densities normally occur in lower elevations along natural or human-made transportation corridors, such as rivers, railroad lines, coastlines, or interstate highways. These areas often contain good soils with little or no slope and lush vegetation. Once level areas become crowded, growth continues along rivers or shores of lakes or oceans, and eventually up elevated sites with steep slopes or rocky outcrops. Because early settlers often modified the original landscape for agricultural purposes, many of our urban areas are surrounded by agricultural and grazing lands.

Structure. The original habitat is drastically altered in urban environments and is replaced by buildings, impermeable surfaces, bridges, dams, and planting of non-native species. Some human-made structures provide habitats similar to those of cavities, caves, fissures, cliffs, and ledges. With the onset of urban development, total crown cover and tree density are reduced to make way for the construction of buildings and associated infrastructure. Many structural features typical of the historical vegetation, such as snags, dead and downed wood, and brush piles, are often completely removed from the landscape. Understory vegetation may be completely absent, or if present, is diminutive and single-layered. Typically, 3 zones are characteristic of urban habitat.

High-density Zone. The high-density zone is the downtown area of the inner city. It also encompasses the heavy industrial and large commercial interests of the city in addition to high-density housing areas such as apartment buildings or high-rise condominiums. This zone has =60% of its total surface area covered by impervious surfaces. This zone has the smallest lot size, the tallest buildings, the least amount of total tree canopy cover, the lowest tree density, the highest percentage of exotics, the poorest understory and subcanopy, and the poorest vegetative structure [4a, 116a, 185a]. Human structures have replaced almost all vegetation [23b, 148a]. Road density is the highest of all zones. An example of road density can be seen from Washington's Growth Management Plan requiring Master Comprehensive Plans to set aside 20% of the identified urban growth area for roads and road rights-of-way. For example, Spokane's urban growth area is approximately 57,000 acres (23,077 ha); therefore >11,000 acres



(4,453 ha) were set aside for road surfaces.

In the high-density zone, land-use practices have removed most of the native vegetation. Patch sizes of remaining natural areas often are so small that native interior species cannot be supported. Not only are remaining patches of native vegetation typically disconnected, but also they are frequently missing the full complement of vertical strata [149]. Stream corridors become heavily impacted and discontinuous. Most, if not all, wetlands have been filled or removed. Large buildings dominate the landscape and determine the placement of vegetation in this zone [30a]. This zone has the most street tree strips or sidewalk trees, most of which are exotics. There is virtually no natural tree replacement, and new trees are planted only when old ones die or are removed. Replacement trees are chosen for their small root systems and are generally short in stature with small diameters. Ground cover in this zone, if not synthetic or impervious, is typically exotic grasses or exotic annuals, most of which are rarely allowed to go to seed. Snags, woody debris, rock piles, and any other natural structures are essentially nonexistent. There are few tree cavities because of cosmetic pruning, cavity filling, snag removal, and tree thinning [149].

Medium-density Zone. This zone, continuing out from the center of the continuum is the medium-density zone, composed of light industry mixed with high-density residential areas. Housing density of 3-6 single-family homes per acre (7-15 per ha) is typical. Compared with the high-density zone, this zone has more potential wildlife habitat. With 30-59% impervious soil cover, this zone has 41-70% of the ground available for plants. Road density is less than the high-density zone.

Vegetation in this mid-zone is typically composed of non-native plant species. Native plants, when present, represent only a limited range of the natural diversity for the area.

The shrub layer is typically clipped or minimal, even in heavily vegetated areas. Characteristic of this zone are manicured lawns, trimmed hedges, and topped trees. Lawns can be highly productive [82a, 97a]. Tree canopy is still discontinuous and consists of 1-2 levels, if present at all. Consequently, vertical vegetative diversity and total amount of understory are still low. Coarse and fine woody debris is minimal or absent; most snags and diseased live trees are still removed as hazards in this zone [119a, 119b].

Isolated wetlands, stream corridors, open spaces, and greenbelts are more frequently retained in this zone than in the high-density zone. However, remnant wetland and upland areas are often widely separated by urban development.

Low-density Zone. The low-density zone is the outer zone of the urban-rural continuum. This zone contains only 10-29% impervious ground cover and normally contains only single-family homes. It has more natural ground cover than artificial surfaces. Vegetation is denser and more abundant than in the previous two zones. Typical housing densities are 0.4-1.6 single-family homes per acre (1-4 per ha). Road density is lowest of all 3 zones and consists of many secondary and tertiary roads.

Roads, fences, livestock paddocks, and pets are more abundant than in neighboring rural areas. With many animals and limited acreage, pasture conditions may be more overgrazed in this zone than in the rural zone; overgrazing can significantly affect shrub layers as well. Areas around home sites are often cleared for fire protection. Dogs are more likely to be loose and allowed to run free, increasing disturbance levels and wildlife harassment in this zone. Vegetable and flower gardens are widespread;

fencing is prevalent.

Many wetlands remain and are less impacted. Water levels are more stable and peak flows are more typical of historical flows. Water tables are less impacted and vernal wetlands are more frequent; stream corridors are less impacted and more continuous.

Although this zone may have large areas of native vegetation and is generally the least impacted of all 3 zones; it still has been significantly altered by human activities and associated disturbances.

This zone has the most vertical and horizontal structure and diversity of any of the 3 urban zones [30a, 80a, 140a, 187a]. In forested areas, tree conditions are semi-natural, although stand characteristics vary from parcel to parcel. The tree canopy is more continuous and may include multiple levels. Patch sizes are large enough to support native interior species. Large blocks of native vegetation may still be found, and some of these may be connected to large areas of native undeveloped land. In this zone, snags, diseased trees, coarse and fine woody debris, brush piles, and rock piles are widespread. Structural diversity approaches historical levels. Non-native hedges are nearly nonexistent and the native shrub layer, except for small areas around houses, is relatively intact. Lawns are fewer, and native ground covers are more common than in the previous two zones.

Composition. Remnant isolated blocks of native vegetation may be found scattered throughout a town or city mixed with a multitude of introduced exotic vegetation. As urban development increases, these remnant native stands become fragmented and isolated. The dominant species in an urban setting may be exotic or native; for example, in Seattle, the dominant species in 1 area may be Douglas-fir (*Pseudotsuga menziesii*), whereas a few blocks away it may be the exotic silver maple (*Acer saccharinum*). Dominant species will not only vary from city to city but also within each city and within each of the 3 urban zones. Nowack [167] found that in the high-density urban zone, species richness is low, and in 1 case, 4 species made up almost 50% of the cover. In the same study, exotics made up 69% of the total species.

In urban and suburban areas, species richness is often increased because of the introduction of exotics. The juxtaposition of exotics interspersed with native vegetation produces a diverse mosaic with areas of extensive edge. Also, because of irrigation and the addition of fertilizers, the biomass in the urban communities is often increased [149].

Interest in the use of native plants for landscaping is rapidly expanding [135, 172], particularly in the more arid sites where drought-resistant natives are the only plants able to survive without water.

Across the U.S., urban tree cover ranges from 1 to 55% [167]. As expected, tree cover tends to be highest in cities developed in naturally forested areas with an average of 32% cover in forested areas, 28% in grasslands, and 10% in arid areas. Yakima, Washington, has an overall city tree cover of 18%, ranging from 10% to 12% in the industrial/commercial area to 23% in the low-density residential zone [167]. Remnant blocks of native vegetation or native trees left standing in yards and parks will compositionally be related to whatever native habitat was present on site prior to development. In the Puget Sound and Willamette Valley areas, Douglas-fir is a major constituent, whereas the Spokane area has a lot of ponderosa pine (*Pinus ponderosa*).

Other Classifications and Key References. Many attempts have been made to classify or describe the complex urban environment. The Washington GAP Analysis [37] classified urban environments as "developed" land cover using the same 3 zones as described above: (1) high density (>60% impervious surface); (2) medium density (30-60% impervious surface); and (3) low density (10-30% impervious surface). The Oregon Gap II Project [126] and Oregon Vegetation Landscape-Level Cover Types [127] represented this type as an urban class. Several other relevant studies characterizing the urban environment have been reported [182, 129, 34, 70, 151].

Natural Disturbance Regime. In many instances, natural disturbances are modified or prevented from occurring by humans over the landscape and this is particularly true of urban areas. However, disturbances such as ice, wind, or firestorms still occur. The severity of these intermittent disturbances varies greatly in magnitude and their impact on the landscape varies accordingly. One of the differences between urban and non-urban landscapes is the lengthening of the disturbance cycles. Another is found in the aftermath of these disturbances. In urban areas, damaged trees are often entirely removed and if they are replaced, a shorter, smaller tree, often non-native, is selected. The natural fire disturbance interval is highly modified in the urban environment. Fire (mostly accidental or arson) still occurs, and is quickly suppressed. Another natural disturbance in many of our Pacific Northwest towns is flooding, which historically altered and rerouted many of our rivers and streams, and still scarifies fields and deposits soil on flood plains and potentially recharges local aquifers. Floods now are more frequent and more violent than in the past because of the many modifications made to our watersheds. Attempts to lessen flooding in urban areas often lead to channelization, paving, or diking of our waterways, most of which fail in their attempt to stem the flooding and usually result in increased flooding for the communities farther downstream.

Succession and Stand Dynamics. Due to anthropogenic influences found in the urban environment, succession differs in the urban area from that expected for a native stand. Rowntree [185] emphasized that urbanization is not in the same category as natural disturbance in affecting succession. He points out that urbanization is anthropogenic and acts to remove complete vegetation associations and creates new ones made of mixes of native residual vegetation and introduced vegetation. Much human effort in the city goes toward either completely removing native vegetation or sustaining or maintaining a specific vegetative type, e.g., lawns or hedges. Much of the vegetative community remains static. Understory and ground covers are constantly pruned or removed, seedlings are pulled and lawns are planted, fertilized, mowed, and meticulously maintained. Trees may be protected to maturity or even senescence, yet communities are so fragmented or modified that a genuine old-growth community never exists. However, a type of "urban succession" occurs across the urban landscape. The older neighborhoods with their mature stands are at a later seral stage than new developments; species diversity is characteristically higher in older neighborhoods as well. An oddity of the urban environment is the absence of typical structure generally found within the various seral stages. For example, the understory is often removed in a typical mid-seral stand to give it a "park-like" look. Or if the understory is allowed to remain, it is kept pruned to a consistent height. Lawns are the ever-present substitute for native ground covers. Multi-layered habitat is often reduced to 1 or 2 heights. Vertical and horizontal structural diversity is drastically reduced.

Effects of Management and Anthropogenic Impacts. These additional, often irreversible, impacts include more impervious surfaces, more and larger human-made structures, large-scale storm and wastewater management, large-scale sewage treatment, water and air pollution, toxic chemicals, toxic chemical use on urban lawns and gardens, removal of species considered to be pests, predation and disturbance by pets and feral cats and dogs, and the extensive and continual removal of habitat due to expanding urbanization, and in some cases, uncontrolled development. Another significant impact is the introduction and cultivation of exotics in urban areas. Native vegetation is often completely replaced by exotics, leaving little trace of the native vegetative cover.

Status and Trends. From 1970 to 1990, >30,000 mile^2 (77,700 km^2) of rural lands in the U.S. became urban, as classified by the U.S. Census Bureau. That amount of land equals about one third of Oregon's total land area [12]. From 1940 to 1970, the population of the Portland urban region doubled and the amount of land occupied by that population quadrupled [201]. More than 300 new residents arrive in Washington each day, and each day, Washington loses 100 acres (41 ha) of forest to development [215]. Using satellite photos and GIS software, American Forests [9] discovered that nearly one third of Puget Sound's most heavily timbered land has disappeared since the early 1970's. The amount of land with few or no trees more than doubled, from 25% to 57%, an increase of >1 million acres (404,858 ha). Development and associated urban growth was blamed as the single biggest factor affecting the area's environment. This urban growth is predicted to continue to increase at an accelerated pace, at the expense of native habitat.

Open Water - Lakes, Rivers, and Streams

Eva L. Greda, David H. Johnson, and Tom O'Neil

Lakes, Ponds, and Reservoirs

Geographical Distribution. Lakes in Oregon and Washington occur statewide and are found from near sea level to about 10,200 ft (3,110 m) above sea level. There are 3,887 lakes and reservoirs in western Washington and they total 176,920 acres (71,628 ha) [226]. In contrast, there are 4,073 lakes and reservoirs in eastern Washington that total 436,843 acres (176,860 ha) [227]. There are 6,000 lakes, ponds, and reservoirs in Oregon including almost 1,800 named lakes and over 3,800 named reservoirs, all amounting to 270,641 acres (109,571 ha). Oregon has the deepest lake in the nation, Crater Lake, at 1,932 ft (589 m) [23].

Physical Setting. Continental glaciers melted and left depressions, where water accumulated and formed many lakes in the region. These kinds of lakes are predominantly found in Lower Puget Sound. Landslides that blocked natural valleys also allowed water to fill in behind them to form lakes, like Crescent Lake, Washington. The lakes in the Cascade and Olympic ranges were formed through glaciation and range in elevation from 2,500 to 5,000 ft (762 to 1,524 m). Beavers create many ponds and marshes in Oregon and Washington. Craters created by extinct volcanoes, like Battleground Lake, Washington, also formed lakes. Human-made reservoirs created by dams impound water that creates lakes behind them, like Bonneville Dam on the main stem of the Columbia River. In the lower Columbia Basin, many lakes formed in depressions and rocky coulees through the process of seepage from irrigation waters [226].

Structure. There are 4 distinct zones within this aquatic system: (1) the littoral zone at the edge of lakes is the most productive with diverse aquatic beds and emergent wetlands (part of Herbaceous Wetland's habitat); (2) the limnetic zone is deep open water, dominated by phytoplankton and freshwater fish, and extends down to the limits of light penetration; (3) the profundal zone below the limnetic zone, devoid of plant life and dominated with detritivores; (4) and the benthic zone reflecting bottom soil and sediments. Nutrients from the profundal zone are recycled back to upper layers by the spring and fall turnover of the water. Water in temperate climates stratifies because of the changes in water density. The uppermost layer, the epilimnion, is where water is warmer (less dense). Next, the metalimnion or thermocline, is a narrow layer that prevents the mixing of the upper and lowermost layers. The lowest layer is the hypolimnion, with colder and most dense waters. During the fall turnover, the cooled upper layers are mixed with other layers through wind action.

Natural Disturbance Regime. There are seasonal and decadal variations in the patterns of precipitation. In the Coast Range, there is usually 1 month of drought per year (usually July or August) and 2 months of drought once in a decade. The Willamette Valley and the Cascade experience 1 month with no rain every year and a 2-month dry period every third year. In eastern Oregon, dry periods last 2 or 3 months every year, with dry spells as long as 4-6 months occurring once every 4 years. Dry years, with

<33% of normal precipitation occur once every 30 years along the coast, every 20 years in the Willamette Valley, every 30 years in the Cascade, and every 15 years in most of eastern Oregon [23].

Floods occur in Oregon and Washington every year. Flooding season west of the Cascade occurs from October through April, with more than half of the floods occurring during December and January. Floods are the result of precipitation and snow melts. Floods west of the Cascade are influenced by precipitation mostly and thus are short-lived, while east of the Cascade floods are caused by melting snow, and the amount of flooding depends on how fast the snow melts. High water levels frequently last up to 60 days. In 1984, heavy precipitation flooded Malheur and Harney lakes to the point where the 2 lakes were joined together for several years. The worst floods have resulted from cloudbursts caused by thunderstorms, like Heppner, Oregon's 1903 flood. Other "flash floods" in the region were among the largest floods in the U.S. and occurred in the John Day Basin's Meyers Canyon in 1956 and the Umatilla Basin's Lane Canyon in 1965 [23].

Effects of Management and Anthropogenic Impacts. Sewage effluents caused eutrophication of Lake Washington in Seattle, where plants increased in biomass and caused decreased light transmission. The situation was corrected, however, before it became serious as a result of a campaign of public education, and timely cleanup of the lake [146]. Irrigation projects aimed at watering drier portions of the landscape may pose flooding dangers, as was the case with Soap Lake and Lake Leonore in eastern Washington. Finally, natural salinity of lakes can decrease as a result of irrigation withdrawal and can change the biota associated with them [92].

Rivers and Streams

Geographic Distribution. Streams and rivers are distributed statewide in Oregon and Washington, forming a continuous network connecting high mountain areas to lowlands and the Pacific coast. There are >12,000 named rivers and streams in Oregon, totaling 112,640 miles (181,238 km) [23] in length. Oregon's longest stretch of river is the Columbia (309 miles [497 km]) that borders Oregon and Washington. The longest river in Oregon is the John Day (284 miles [457 km]) and the shortest river is the D River (440 ft [134 m]) that is the world's second shortest river. Washington has more streams than any other state except Alaska. In Washington, the coastal region has 3,783 rivers and streams totaling 8,176 miles (13,155 km) [174]. The Puget Sound Region has 10,217 rivers and streams, which add to 16,600 miles (26,709 km) in length [223]. The rivers and streams range from cold, fast-moving high-elevation streams to warmer lowland valley rivers [223]. In all, there are 13,955 rivers and streams that add up to 24,774 miles (39,861 km) [174]. There are many more streams in Washington yet to be catalogued [174].

Physical Setting. Climate of the area's coastal region is very wet. The northern region in Washington is volcanic and bordered to the east by the Olympic Mountain Range, on the north by the Strait of Juan de Fuca, and on the west by the Pacific Ocean. In contrast, the southern portion in Washington is characterized by low-lying, rolling hills [174]. The Puget Sound Region has a wet climate. Most of the streams entering Puget Sound have originated in glacier fields high in the mountains.

Water from melting snowpacks and glaciers provide flow during the spring and winter. Annual rainfall in the lowlands ranges from 35 to 50 inches (89-127 cm), from 75 to 100 inches (191 to 254 cm) in the foothills, and from 100 to >200 inches (254 to 508 cm) in the mountains (mostly in the form of snow) [174].

Rivers and streams in southwestern Oregon are fed by rain and are located in an area composed of sheared bedrock and is thus an unstable terrain. Streams in that area have high suspended-sediment loads. Beds composed of gravel and sand are easily transported during floods. The western Cascade in Washington and Oregon are composed of volcanically derived rocks and are more stable. They have low sediment-transport rates and stable beds composed largely of cobbles and boulders, which move only during extreme events [81]. Velocities of river flow ranges from as little as 0.2 to 12 mph (0.3 to19.3 km/hr) while large streams have an average annual flow of 10 cubic feet (0.3 m^3) per second or greater [23, 169]. Rivers and streams in the Willamette Valley are warm, productive, turbid, and have high ionic strength. They are characterized by deep pools, and highly embedded stream bottoms with claypan and muddy substrates, and the greatest fish species diversity. High desert streams of the interior are similar to those of the Willamette Valley but are shallower, with fewer pools, and more runs, glides, cobbles, boulders, and sand. The Cascade and Blue mountains are similar in that they have more runs and glides and fewer pools, similar fish assemblages, and similar water quality [218].

Landscape setting. This habitat occurs throughout Washington and Oregon. Ponds, lakes, and reservoirs are typically adjacent to Herbaceous Wetlands, while rivers and streams typically adjoin the Westside Riparian Wetlands, Eastside Riparian Wetlands, Herbaceous Wetlands, or Bays and Estuaries habitats.

Other Classifications and Key References. This habitat is called riverine and lacustrine in Anderson *et al.* [10], Cowardin *et al.* [53], Washington Gap Analysis Project [37], Mayer and Laudenslayer [150], and Wetzel [217]. However, this habitat is referred to as Open Water in the Oregon Gap II Project [126] and Oregon Vegetation Landscape-Level Cover Types [127].

Effects of Management and Anthropogenic Impacts. Removal of gravel results in reduction of spawning areas for anadromous fish. Overgrazing, and loss of vegetation caused by logging produces increased water temperatures and excessive siltation, harming the invertebrate communities such as that reported in the John Day River Basin, Oregon [146]. Incorrectly installed culverts may act as barriers to migrating fish and may contribute to erosion and siltation downstream [174]. Construction of dams is associated with changes in water quality, fish passage, competition between species, loss of spawning areas because of flooding, and declines in native fish populations [146]. Historically, the region's rivers contained more braided multi-channels. Flood control measures such as channel straightening, diking, or removal of streambed material along with urban and agriculture development have all contributed to a loss of oxbows, river meanders, and flood plains. Unauthorized or over-appropriated withdrawals of water from the natural drainages also have caused a loss of open water habitat that has been detrimental to fish and wildlife production, particularly in the summer [174].

Agricultural, industrial, and sewage runoff such as salts, sediments, fertilizers, pesticides, and bacteria harm aquatic species [146]. Sludge and heavy waste buildup in estuaries is harmful to fish and shellfish. Unregulated aerial spraying of pesticides over agricultural areas also poses a threat to aquatic and terrestrial life [174]. Direct loss of habitat and water quality occurs through irrigation [130]. The Oregon Department of Environmental Quality, after a study of water quality of the Willamette River, determined that up to 80% of water pollution enters the river from nonpoint sources and especially agricultural activity [23]. Very large floods (e.g., Oregon Flood of 1964) may change the channels permanently through the settling of large amounts of sediments from hillslopes, through debris flow, and through movement of large boulders, particularly in the montane areas. The width of the channel along the main middle fork of the Willamette increased over a period of 8 years. Clearcutting creates excessive intermittent runoff conditions and increases erosion and siltation of streams as well as diminishes shade, and therefore causes higher water temperatures, fewer terrestrial and aquatic food organisms, and increased predation. Landslides, which contributed to the widening of the channel, were a direct result of clearcutting. Clearcut logging can alter snow accumulation and increase the size of peak flows during times of snowmelt [197]. Clearcutting and vegetation removal affects the temperatures of streams, increasing them in the summer and decreasing in winter, especially in eastern parts of the Oregon and Washington [24]. Building of roads, especially those of poor quality, can be a major contributor to sedimentation in the streams [82].

Status and Trends. The principal trend has been in relationship to dam building or channelization for hydroelectric power, flood control, or irrigation purposes. As an example, in 1994, there were >900 dams in Washington alone. The dams vary according to size, primary purpose, and ownership (state, federal, private, local) [214]. The first dam and reservoir in Washington was the Monroe Street Dam and Reservoir, built in 1890 at Spokane Falls. Since then the engineering and equipment necessary for dam building developed substantially, culminating in such projects as the Grand Coulee Dam on the Columbia River [214]. In response to the damaging effects of dams on the indigenous biota and alteration and destruction of freshwater aquatic habitats, Oregon and Washington state governments questioned the benefits of dams, especially in light of the federal listing of several salmon species. There are now talks of possibly removing small dams, like the Savage Rapids Dam in Oregon, to removing large federal dams like those on the lower Snake River [23].

Herbaceous Wetlands

Rex C. Crawford, Jimmy Kagan, and Christopher B. Chappell

Geographic Distribution. Herbaceous wetlands are found throughout the world and are represented in Oregon and Washington wherever local hydrologic conditions promote their development. This habitat includes all those except bogs and those within Subalpine Parkland and Alpine.

Freshwater aquatic bed habitats are found throughout the Pacific Northwest, usually in isolated sites. They are more widespread in valley bottoms and high rainfall areas (e.g., Willamette Valley, Puget Trough, coastal terraces, coastal dunes), but are present in montane and arid climates as well. Hardstem bulrush-cattail-burred marshes occur in wet areas throughout Oregon and Washington. Large marshes are common in the lake basins of Klamath, Lake, and Harney counties, Oregon. Sedge meadows and montane meadows are common in the Blue and Ochoco mountains of central and northeastern Oregon, and in the valleys of the Olympic and Cascade Mountains and Okanogan Highlands. Extensive wet meadow habitats occur in Klamath, Deschutes, and western Lake Counties in Oregon.

Physical Setting. This habitat is found on permanently flooded sites that are usually associated with oxbow lakes, dune lakes, or potholes. Seasonally to semi-permanently flooded wetlands are found where standing freshwater is present through part of the growing season and the soils stay saturated throughout the season. Some sites are temporarily to seasonally flooded meadows and generally occur on clay, pluvial, or alluvial deposits within montane meadows, or along stream channels in shrubland or woodland riparian vegetation. In general, this habitat is flat, usually with stream or river channels or open water present. Elevation varies from sea level to 10,000 ft. (3,048 m), although infrequently above 6,000 ft (1,830 m).

Landscape Setting. Herbaceous wetlands are found in all terrestrial habitats except Subalpine Parkland, Alpine Grasslands, and Shrublands habitats. Herbaceous wetlands commonly form a pattern with Westside and Eastside Riparian-Wetlands and Montane Coniferous Wetlands habitats along stream corridors. These marshes and wetlands also occur in closed basins in a mosaic with open water by lakeshores or ponds. Extensive deflation plain wetlands have developed between Coastal Dunes and Beaches habitat and the Pacific Ocean. Herbaceous wetlands are found in a mosaic with alkali grasslands in the Desert Playa and Salt Scrub habitat.

Structure. The herbaceous wetland habitat is generally a mix of emergent herbaceous plants with a grass-like life form (graminoids). These meadows often occur with deep or shallow water habitats with floating or rooting aquatic forbs. Various wetland communities are found in mosaics or in nearly pure stands of single species. Herbaceous cover is open to dense. The habitat can be comprised of tule marshes >6.6 ft (2 m) tall or sedge meadows and wetlands <3.3 ft (1 m) tall. It can be a dense, rhizomatous sward or a tufted graminoid wetland. Graminoid wetland vegetation generally lacks many forbs, although the open extreme of this type contains a diverse forb component between widely spaced tall tufted grasses.

Composition. Various grasses or grass-like plants dominate or co-dominate these habitats. Cattails (*Typha latifolia*) occur widely, sometimes adjacent to open water with aquatic bed plants. Several bulrush species (*Scirpus acutus, S. tabernaemontani, S. maritimus, S. americanus*, *S. nevadensis*) occur in nearly pure stands or in mosaics with cattails or sedges (*Carex* spp.). Burreed (*Sparganium angustifolium* , *S. eurycarpum*) are the most important graminoids in areas with up to 3.3 ft (1m) of deep standing water. A variety of sedges characterize this habitat. Some sedges (*Carex aquatilis, C. lasiocarpa, C. scopulorum, C. simulata, C. utriculata, C. vesicaria*) tend to occur in cold to cool environments. Other sedges (*C. aquatilis* var. *dives, C. angustata, C. interior, C. micropter*a, *C. nebrascensis*) tend to be at lower elevations in milder or warmer environments. Slough sedge (*C. obnupta*), and several rush species (*Juncus falcatus, J. effusus, J. balticus*) are characteristic of coastal dune wetlands that are included in this habitat. Several spike rush species (*Eleocharis* spp.) and rush species can be important. Common grasses that can be local dominants and indicators of this habitat are American sloughgrass (*Beckmannia syzigachne*), bluejoint reedgrass (*Calamagrostis canadensis*), mannagrass (*Glyceria* spp.) and tufted hairgrass (*Deschampsia caespitosa*). Important introduced grasses that increase and can dominate with disturbance in this wetland habitat include reed canary grass (*Phalaris arundinacea*), tall fescue (*Festuca arundinacea)* and Kentucky bluegrass (*Poa pratensis*).

Aquatic beds are part of this habitat and support a number of rooted aquatic plants, such as, yellow pond lily (*Nuphar lutea*) and unrooted, floating plants such as pondweeds (*Potamogeton* spp.), duckweed (*Lemna minor*), or water-meals (*Wolffia* spp.). Emergent herbaceous broadleaf plants, such as Pacific water parsley (*Oenanthe sarmentosa*), buckbean (*Menyanthes trifoliata*), water star-warts (*Callitriche* spp.), or bladderworts (*Utricularia* spp.) grow in permanent and semi-permanent standing water. Pacific silverweed (*Argentina egedii*) is common in coastal dune wetlands. Montane meadows occasionally are forb dominated with plants such as arrowleaf groundsel (*Senecio triangularis*) or ladyfern (*Athyrium filix-femina*). Climbing nightshade (*Solanum dulcamara*), purple loosestrife (*Lythrum salicaria*), and poison hemlock (*Conium maculatum*) are common non-native forbs in wetland habitats.

Shrubs or trees are not a common part of this herbaceous habitat although willow (*Salix* spp.) or other woody plants occasionally occur along margins, in patches or along streams running through these meadows.

Other Classifications and Key References. This habitat is called palustrine emergent wetlands in Cowardin *et al.* [53]. Other references describe this habitat [43, 44, 57, 71, 131, 132, 138, 147, 219]. This habitat occurs in both lotic and lentic systems. The Oregon Gap II Project [126] and Oregon Vegetation Landscape-Level Cover Types [127] that would represent this type are wet meadow, palustrine emergent, and National Wetland Inventory (NWI) palustrine shrubland.

Natural Disturbance Regime. This habitat is maintained through a variety of hydrologic regimes that limit or exclude invasion by large woody plants. Habitats are permanently flooded, semi-permanently flooded, or flooded seasonally and may remain saturated through most of the growing season. Most wetlands are resistant to fire and those that are dry enough to burn usually burn in the fall. Most plants are sprouting species and recover quickly. Beavers play an important role in creating ponds and other impoundments in this habitat. Trampling and grazing by large native mammals is a natural process that creates habitat patches and influences tree invasion and success.

Succession and Stand Dynamics. Herbaceous wetlands are often in a mosaic with shrub- or tree-dominated wetland habitat. Woody species can successfully invade emergent wetlands when this herbaceous habitat dries. Emergent wetland plants invade open-water habitat as soil substrate is exposed; e.g., aquatic sedge and Northwest Territory sedge (*Carex utriculata*) are pioneers following beaver dam breaks. As habitats flood, woody species decrease to patches on higher substrate (soil, organic matter, large woody debris) and emergent plants increase unless the flooding is permanent. Fire suppression can lead to woody species invasion in drier herbaceous wetland habitats; e.g., Willamette Valley wet prairies are invaded by Oregon ash (*Fraxinus latifolia*) with fire suppression.

Effects of Management and Anthropogenic Impacts. Direct alteration of hydrology (i.e., channeling, draining, damming) or indirect alteration (i.e., roading or removing vegetation on adjacent slopes) results in changes in amount and pattern of herbaceous wetland habitat. If the alteration is long term, wetland systems may reestablish to reflect new hydrology, e.g., cattail is an aggressive invader in roadside ditches. Severe livestock grazing and trampling decreases aquatic sedge, Northwest Territory sedge (*Carex utriculata*), bluejoint reedgrass, and tufted hairgrass. Native species, however, such as Nebraska sedge, Baltic and jointed rush (*Juncus nodosus*), marsh cinquefoil (*Comarum palustris*), and introduced species dandelion (*Taraxacum officinale*), Kentucky bluegrass, spreading bentgrass (*Agrostis stolonifera*), and fowl bluegrass (*Poa palustris*) generally increase with grazing.

Status and Trends. Nationally, herbaceous wetlands have declined and the Pacific Northwest is no exception. These wetlands receive regulatory protection at the national, state, and county level; still, herbaceous wetlands have been filled, drained, grazed, and farmed extensively in the lowlands of Oregon and Washington. Montane wetland habitats are less altered than lowland habitats even though they have undergone modification as well. A keystone species, the beaver, has been trapped to near extirpation in parts of the Pacific Northwest and its population has been regulated in others. Herbaceous wetlands have decreased along with the diminished influence of beavers on the landscape. Quigley and Arbelbide [181] concluded that herbaceous wetlands are susceptible to exotic, noxious plant invasions.

Montane Coniferous Wetlands

Christopher B. Chappell

Geographic Distribution. This habitat occurs in mountains throughout much of Washington and Oregon, except the Basin and Range of southeastern Oregon, the Klamath Mountains of southwestern Oregon, and the Coast Range of Oregon. This includes the Cascade Range, Olympic Mountains, Okanogan Highlands, Blue and Wallowa mountains.

Physical Setting. This habitat is typified as forested wetlands or floodplains with a persistent winter snow pack, ranging from moderately to very deep. The climate varies from moderately cool and wet to moderately dry and very cold. Mean annual precipitation ranges from about 35 to >200 inches (89 to >508 cm). Elevation is mid- to upper montane, as low as 2,000 ft (610 m) in northern Washington, to as high as 9,500 ft (2,896 m) in eastern Oregon. Topography is generally mountainous and includes everything from steep mountain slopes to nearly flat valley bottoms. Gleyed or mottled mineral soils, organic soils, or alluvial soils are typical. Subsurface water flow within the rooting zone is common on slopes with impermeable soil layers. Flooding regimes include saturated, seasonally flooded, and temporarily flooded. Seeps and springs are common in this habitat.

Landscape Setting. This habitat occurs along stream courses or as patches, typically small, within a matrix of Montane Mixed Conifer Forest, or less commonly, Eastside Mixed Conifer Forest or Lodgepole Pine Forest and Woodlands. It also can occur adjacent to other wetland habitats: Eastside Riparian-Wetlands, Westside Riparian-Wetlands, or Herbaceous Wetlands. The primary land uses are forestry and watershed protection.

Structure. This is a forest or woodland (>30% tree canopy cover) dominated by evergreen conifer trees. Deciduous broadleaf trees are occasionally co-dominant. The understory is dominated by shrubs (most often deciduous and relatively tall), forbs, or graminoids. The forb layer is usually well developed even where a shrub layer is dominant. Canopy structure includes single-storied canopies and complex multi-layered ones. Typical tree sizes range from small to very large. Large woody debris is often a prominent feature, although it can be lacking on less productive sites.

Composition. Indicator tree species for this habitat, any of which can be dominant or co-dominant, are Pacific silver fir (*Abies amabilis*), mountain hemlock (*Tsuga mertensiana*), and Alaska yellow-cedar (*Chamaecyparis nootkatensis*) on the westside, and Engelmann spruce (*Picea engelmannii*), subalpine fir (*Abies lasiocarpa*), lodgepole pine (*Pinus contorta*), western hemlock (*T. heterophylla*), or western redcedar (*Thuja plicata*) on the eastside. Lodgepole pine is prevalent only in wetlands of eastern Oregon. Western hemlock and redcedar are common associates with silver fir on the westside. They are diagnostic of this habitat on the east slope of the central Washington Cascade, and in the Okanogan Highlands, but are not diagnostic there. Douglas-fir (*Pseudotsuga menziesii*) and grand fir (*Abies grandis*) are sometimes prominent on the eastside. Quaking aspen (*Populus tremuloides*) and black cottonwood (*P. balsamifera* ssp. *trichocarpa*) are in certain instances important to co-dominant, mainly on the eastside.

Dominant or co-dominant shrubs include devil's-club (*Oplopanax horridus*), stink currant (*Ribes bracteosum*), black currant (*R. hudsonianum*), swamp gooseberry (*R. lacustre*), salmonberry (*Rubus spectabilis*), red-osier dogwood (*Cornus sericea*), Douglas' spirea (*Spirea douglasii*), common snowberry (*Symphoricarpos albus*), mountain alder (*Alnus incana*), Sitka alder (*Alnus viridis* ssp. *sinuata*), Cascade azalea (*Rhododendron albiflorum*), and glandular Labrador-tea (*Ledum glandulosum*). The dwarf shrub bog blueberry (*Vaccinium uliginosum*) is an occasional understory dominant. Shrubs more typical of adjacent uplands are sometimes co-dominant, especially big huckleberry (*V. membranaceum*), oval-leaf huckleberry (*V. ovalifolium*), grouseberry (*V. scoparium*), and fools huckleberry (*Menziesia ferruginea*).

Graminoids that may dominate the understory include bluejoint reedgrass (*Calamagrostis canadensis*), Holm's Rocky Mountain sedge (*Carex scopulorum*), widefruit sedge (*C. angustata*), and fewflower spikerush (*Eleocharis quinquiflora*). Some of the most abundant forbs and ferns are ladyfern (*Athyrium filix-femina*), western oakfern (*Gymnocarpium dryopteris*), field horsetail (*Equisetum arvense*), arrowleaf groundsel (*Senecio triangularis*), two-flowered marshmarigold (*Caltha leptosepala* ssp. *howellii*), false bugbane (*Trautvetteria carolinensis*), skunk-cabbage (*Lysichiton americanus*), twinflower (*Linnaea borealis*), western bunchberry (*Cornus unalaschkensis*), clasping-leaved twisted-stalk (*Streptopus amplexifolius*), singleleaf foamflower (*Tiarella trifoliata* var. *unifoliata*), and five-leaved bramble (*Rubus pedatus*).

Other Classifications and Key References. This habitat includes nearly all of the wettest forests within the *Abies amabilis* and *Tsuga mertensiana* zones of western Washington and northwestern Oregon and most of the wet forests in the *Tsuga heterophylla* and *Abies lasiocarpa* zones of eastern Oregon and Washington [88]. On the eastside, they may extend down into the *Abies grandis* zone also. This habitat is not well represented by the Gap projects because of its relatively limited acreage and the difficulty of identification from satellite images. But in the Oregon Gap II Project [126] and Oregon Vegetation Landscape-Level Cover Types [127] the vegetation types that include this type would be higher elevation palustrine forest, palustrine shrubland, and NWI palustrine emergent. These are primarily palustrine forested wetlands with a seasonally flooded, temporarily flooded, or saturated flooding regime [54]. They occur in both lotic and lentic systems. Other references describe this habitat [36, 57, 90, 101, 108, 111, 114, 115, 118, 123, 132, 221].

Natural Disturbance Regime. Flooding, debris flow, fire, and wind are the major natural disturbances. Many of these sites are seasonally or temporarily flooded. Floods vary greatly in frequency depending on fluvial position. Floods can deposit new sediments or create new surfaces for primary succession. Debris flows/torrents are major scouring events that reshape stream channels and riparian surfaces, and create opportunities for primary succession and redistribution of woody debris. Fire is more prevalent east of the Cascade Crest. Fires are typically high in severity and can replace entire stands, as these tree species have low fire resistance. Although fires have not been studied specifically in these wetlands, fire frequency is probably low. These wetland areas are less likely to burn than surrounding uplands, and so may sometimes escape extensive burns as old forest refugia [1]. Shallow rooting and wet soils are conducive to windthrow, which is a common small-scale disturbance that influences forest patterns. Snow avalanches probably disturb portions of this habitat in the northwestern Cascade and Olympic Mountains. Fungal pathogens and insects also act as important small-scale natural disturbances.

Succession and Stand Dynamics. Succession has not been well studied in this habitat. Following disturbance, tall shrubs may dominate for some time, especially mountain alder, stink currant, salmonberry, willows (*Salix* spp.), or Sitka alder. Quaking aspen and black cottonwood in these habitats probably regenerate primarily after floods or fires, and decrease in importance as succession progresses. Lodgepole pine is often associated with post-fire conditions in eastern Oregon [131], although in some wetlands it can be an edaphic climax species. Pacific silver fir, subalpine fir, or Engelmann spruce would be expected to increase in importance with time since the last major disturbance. Western hemlock, western redcedar, and Alaska yellow-cedar typically maintain co-dominance as stand development progresses because of the frequency of small-scale disturbances and the longevity of these species. Tree size, large woody debris, and canopy layer complexity all increase for at least a few hundred years after fire or other major disturbance.

Effects of Management and Anthropogenic Impacts. Roads and clearcut logging practices can increase the frequency of landslides and resultant debris flows/torrents, as well as sediment loads in streams [198, 199, 229]. This in turn alters hydrologic patterns and the composition and structure of montane riparian habitats. Logging typically reduces large woody debris and canopy structural complexity. Timber harvest on some sites can cause the water table to rise and subsequently prevent trees from establishing [221]. Wind disturbance can be greatly increased by timber harvest in or adjacent to this habitat.

Status and Trends. This habitat is naturally limited in its extent and has probably declined little in area over time. Portions of this habitat have been degraded by the effects of logging, either directly on site or through geohydrologic modifications. This type is probably relatively stable in extent and condition, although it may be locally declining in condition because of logging and road building. Five of 32 plant associations representing this habitat listed in the National Vegetation Classification are considered imperiled or critically imperiled [10].

Eastside (Interior) Riparian-Wetlands

Rex C. Crawford and Jimmy Kagan

Geographic Distribution. Riparian and wetland habitats dominated by woody plants are found throughout eastern Oregon and eastern Washington.

Mountain alder-willow riparian shrublands are major habitats in the forested zones of eastern Oregon and eastern Washington. Eastside lowland willow and other riparian shrublands are the major riparian types throughout eastern Oregon and Washington at lower elevations. Black cottonwood riparian habitats occur throughout eastern Oregon and Washington, at low to middle elevations. White alder riparian habitats are restricted to perennial streams at low elevations, in drier climatic zones in Hells Canyon at the border of Oregon, Washington, and Idaho, in the Malheur River drainage and in western Klickitat and south central Yakima counties, Washington. Quaking aspen wetlands and riparian habitats are widespread but rarely a major component throughout eastern Washington and Oregon. Ponderosa pine-Douglas-fir riparian habitat occurs only around the periphery of the Columbia Basin in Washington and up into lower montane forests.

Physical Setting. Riparian habitats appear along perennial and intermittent rivers and streams. This habitat also appears in impounded wetlands and along lakes and ponds. Their associated streams flow along low to high gradients. The riparian and wetland forests are usually in fairly narrow bands along the moving water that follows a corridor along montane or valley streams. The most typical stand is limited to 100-200 ft (31-61 m) from streams. Riparian forests also appear on sites subject to temporary flooding during spring runoff. Irrigation of streamsides and toeslopes provides more water than precipitation and is important in the development of this habitat, particularly in drier climatic regions. Hydrogeomorphic surfaces along streams supporting this habitat have seasonally to temporarily flooded hydrologic regimes. Eastside riparian and wetland habitats are found from 100- 9,500 ft (31-2,896 m) in elevation.

Landscape Setting. Eastside riparian habitats occur along streams, seeps, and lakes within the Eastside Mixed Conifer Forest, Ponderosa Pine Forest and Woodlands, Western Juniper and Mountain Mahogany Woodlands, and part of the Shrubsteppe habitat. This habitat may be described as occupying warm montane and adjacent valley and plain riparian environments.

Structure. The Eastside riparian and wetland habitat contains shrublands, woodlands, and forest communities. Stands are closed to open canopies and often multi-layered. A typical riparian habitat would be a mosaic of forest, woodland, and shrubland patches along a stream course. The tree layer can be dominated by broadleaf, conifer, or mixed canopies. Tall shrub layers, with and without trees, are deciduous and often nearly completely closed thickets. These woody riparian habitats have an undergrowth of low shrubs or dense patches of grasses, sedges, or forbs. Tall shrub communities (20-98 ft [6-30 m], occasionally tall enough to be considered woodlands or forests) can be interspersed with sedge meadows or moist, forb-rich grasslands. Intermittently flooded riparian habitat has ground cover composed of steppe grasses and forbs. Rocks and boulders may be a prominent feature in this habitat.

Composition. Black cottonwood (*Populus balsamifera* ssp. *trichocarpa*), quaking aspen (*P. tremuloides*), white alder (*Alnus rhombifolia*), peachleaf willow (*Salix amygdaloides*) and, in northeast Washington, paper birch (*Betula papyrifera*) are dominant and characteristic tall deciduous trees. Water birch (*B. occidentalis*), shining willow (*Salix lucida* ssp*. caudata*) and, rarely, mountain alder (*Alnus incana*) are co-dominant to dominant mid-size deciduous trees. Each can be the sole dominant in stands. Conifers can occur in this habitat, rarely in abundance, more often as individual trees. The exception is ponderosa pine (*Pinus ponderosa*) and Douglas-fir (*Pseudotsuga menziesii*) that characterize a conifer-riparian habitat in portions of the shrubsteppe zones.

A wide variety of shrubs are found in association with forest/woodland versions of this habitat. Red-osier dogwood (*Cornus sericea*), mountain alder, gooseberry (*Ribes* spp.), rose (*Rosa* spp.), common snowberry (*Symphoricarpos albus*) and Drummonds willow (*Salix drummondii*) are important shrubs in this habitat. Bog birch (*B. nana*) and Douglas spiraea (*Spiraea douglasii*) can occur in wetter stands. Red-osier dogwood and common snowberry are shade-tolerant and dominate stand interiors, while these and other shrubs occur along forest or woodland edges and openings. Mountain alder is frequently a prominent shrub, especially at middle elevations. Tall shrubs (or small trees) often growing under or with white alder include chokecherry (*Prunus virginiana*), water birch, shining willow, and netleaf hackberry (*Celtis reticulata*).

Shrub-dominated communities contain most of the species associated with tree communities. Willow species (*Salix bebbiana, S. boothii, S. exigua, S geyeriana,* or *S. lemmonii*) dominate many sites. Mountain alder can be dominant and is at least codominant at many sites. Chokecherry, water birch, serviceberry (*Amelanchier alnifolia*), black hawthorn (*Crataegus douglasii*), and red-osier dogwood can also be codominant to dominant. Shorter shrubs, Woods rose, spiraea, snowberry and gooseberry are usually present in the undergrowth.

The herb layer is highly variable and is composed of an assortment of graminoids and broadleaf herbs. Native grasses (*Calamagrostis canadensis, Elymus glaucus, Glyceria* spp., and *Agrostis* spp.) and sedges (*Carex aquatilis, C. angustata, C. lanuginosa, C. lasiocarpa, C. nebrascensis, C. microptera*, and *C. utriculata*) are significant in many habitats. Kentucky bluegrass (*Poa pratensis*) can be abundant where heavily grazed in the past. Other weedy grasses, such as orchard grass *(Dactylis glomerata)*, reed canarygrass (*Phalaris arundinacea*), timothy (*Phleum pratense*), bluegrass (*Poa bulbosa, P. compressa*), and tall fescue (*Festuca arundinacea*) often dominate disturbed areas. A short list of the great variety of forbs that grow in this habitat includes Columbian monkshood (*Aconitum columbianum*), alpine leafybract aster (*Aster foliaceus*), ladyfern (*Athyrium filix-femina*), field horsetail (*Equisetum arvense*), cow parsnip (*Heracleum maximum*), skunkcabbage (*Lysichiton americanus*), arrowleaf groundsel (*Senecio triangularis*), stinging nettle (*Urtica dioica*), California false hellebore (*Veratrum californicum*), American speedwell (*Veronica americana*), and pioneer violet (*Viola glabella*).

Other Classifications and Key References. This habitat is called Palustrine scrub-shrub and forest in Cowardin *et al.* [53]. Other references describe this habitat [44, 57, 60, 131, 132, 147, 156]. This habitat occurs in both lotic and lentic systems. The Oregon Gap II Project [126] and Oregon Vegetation Landscape-Level Cover Types [127] that would represent this type are eastside cottonwood riparian gallery, palustrine forest, palustrine shrubland, and National Wetland Inventory (NWI) palustrine emergent.

Natural Disturbance Regime. This habitat is tightly associated with stream dynamics and hydrology. Flood cycles occur within 20-30 years in most riparian shrublands although flood regimes vary among stream types. Fires recur typically every 25-50 years but fire can be nearly absent in colder regions or on topographically protected streams. Rafted ice and logs in freshets may cause considerable damage to tree boles in mountain habitats. Beavers crop younger cottonwood and willows and frequently dam side channels in these stands. These forests and woodlands require various flooding regimes and specific substrate conditions for reestablishment. Grazing and trampling is a major influence in altering structure, composition, and function of this habitat; some portions are very sensitive to heavy grazing.

Succession and Stand Dynamics. Riparian vegetation undergoes "typical" stand development that is strongly controlled by the site's initial conditions following flooding and shifts in hydrology. The initial condition of any hydrogeomorphic surface is a sum of the plants that survived the disturbance, plants that can get to the site, and the amount of unoccupied habitat available for invasions. Subsequent or repeated floods or other influences on the initial vegetation select species that can survive or grow in particular life forms. A typical woody riparian habitat dynamic is the invasion of woody and herbaceous plants onto a new alluvial bar away from the main channel. If the bar is not scoured in 20 years, a tall shrub and small deciduous tree stand will develop. Approximately 30 years without disturbance or change in hydrology will allow trees to overtop shrubs and form woodland. Another 50 years without disturbance will allow conifers to invade and in another 50 years a mixed hardwood-conifer stand will develop. Many deciduous tall shrubs and trees cannot be invaded by conifers. Each stage can be reinitiated, held in place, or shunted into different vegetation by changes in stream or wetland hydrology, fire, grazing, or an interaction of those factors.

Effects of Management and Anthropogenic Impacts. Management effects on woody riparian vegetation can be obvious, e.g., removal of vegetation by dam construction, roads, logging, or they can be subtle, e.g., removing beavers from a watershed, removing large woody debris, or construction of a weir dam for fish habitat. In general, excessive livestock or native ungulate use leads to less woody cover and an increase in sod-forming grasses particularly on fine-textured soils. Undesirable forb species, such as stinging nettle and horsetail, increase with livestock use.

Status and Trends. Quigley and Arbelbide [181] concluded that the Cottonwood-Willow cover type covers significantly less in area now than before 1900 in the Inland Pacific Northwest. The authors concluded that although riparian shrubland was a minor part of the landscape, occupying 2%, they estimated it to have declined to 0.5% of the landscape. Approximately 40% of riparian shrublands occurred above 3,280 ft (1,000 m) in elevation pre-1900; now nearly 80% is found above that elevation. This change reflects losses to agricultural development, roading, dams and other flood-control activities. The current riparian shrublands contain many exotic plant species and generally are less productive than historically. Quigley and Arbelbide [181] found that riparian woodland was always rare and the change in extent from the past is substantial.

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Appendix C: Percent Change in Wildlife Habitat Types

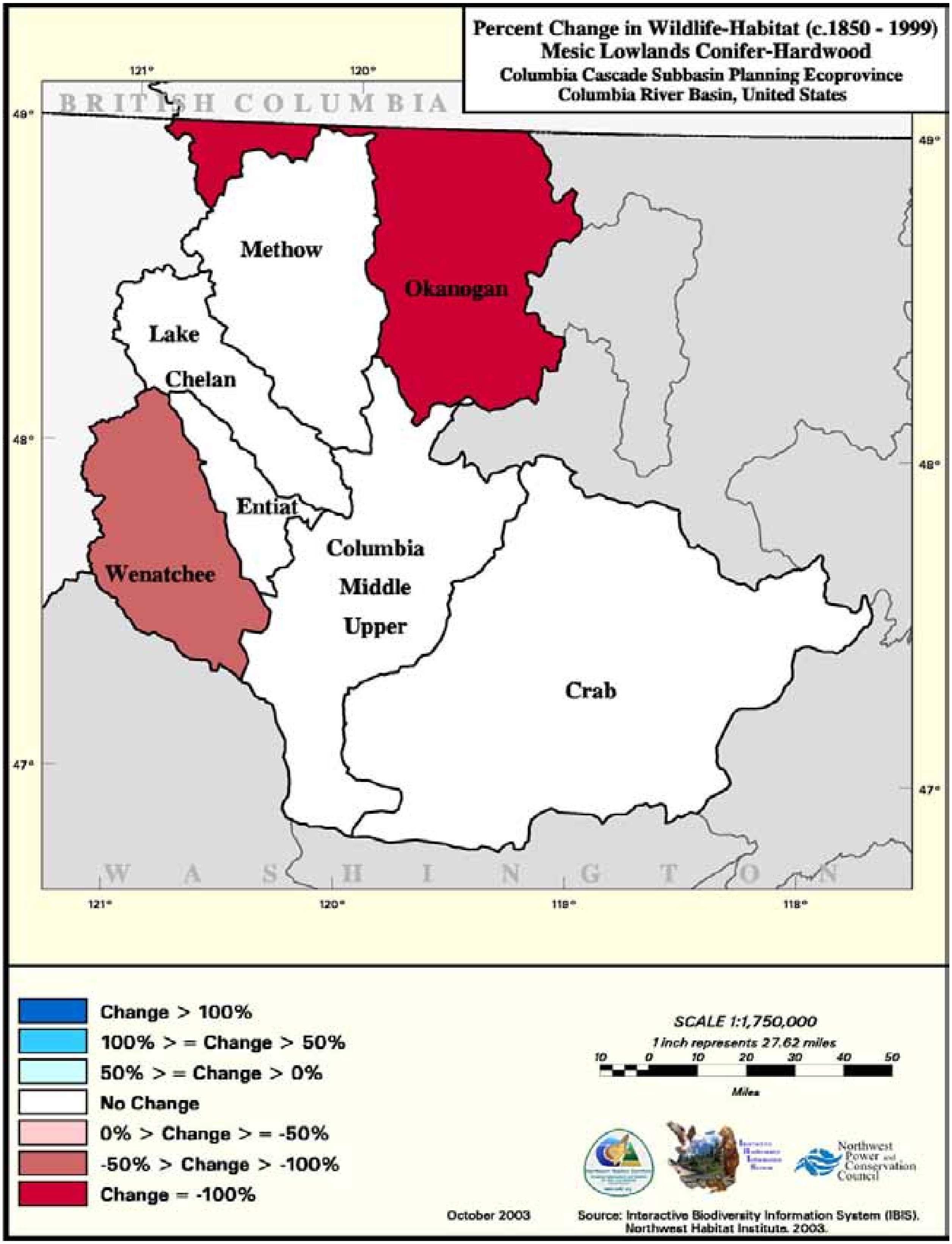

Figure C-1. Percent change in mesic lowlands conifer-hardwood forests in the Columbia Cascade Ecoprovince, Washington (NHI 2003).

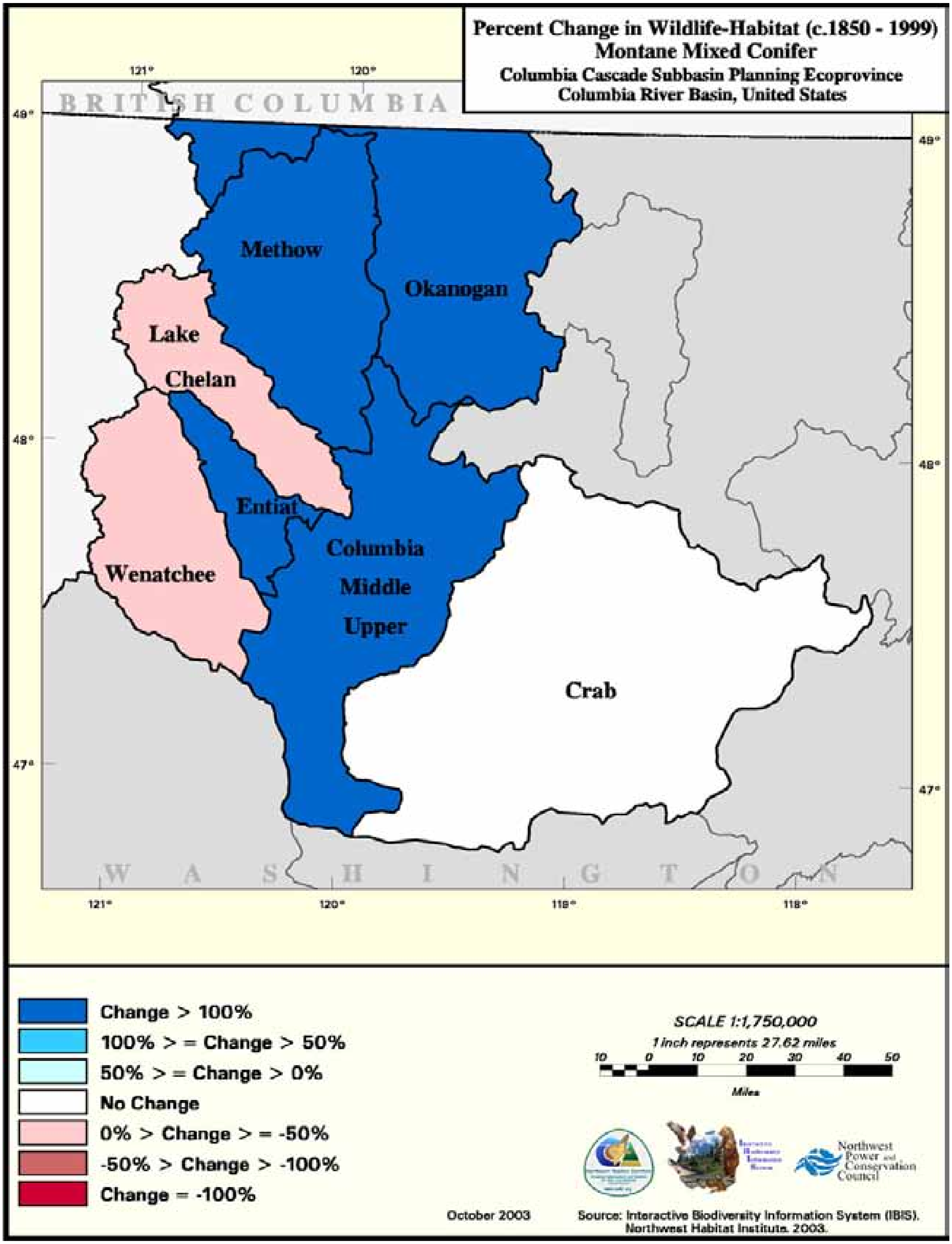

Figure C-2. Percent change in montane mixed conifer forests in the Columbia Cascade Ecoprovince, Washington (NHI 2003).

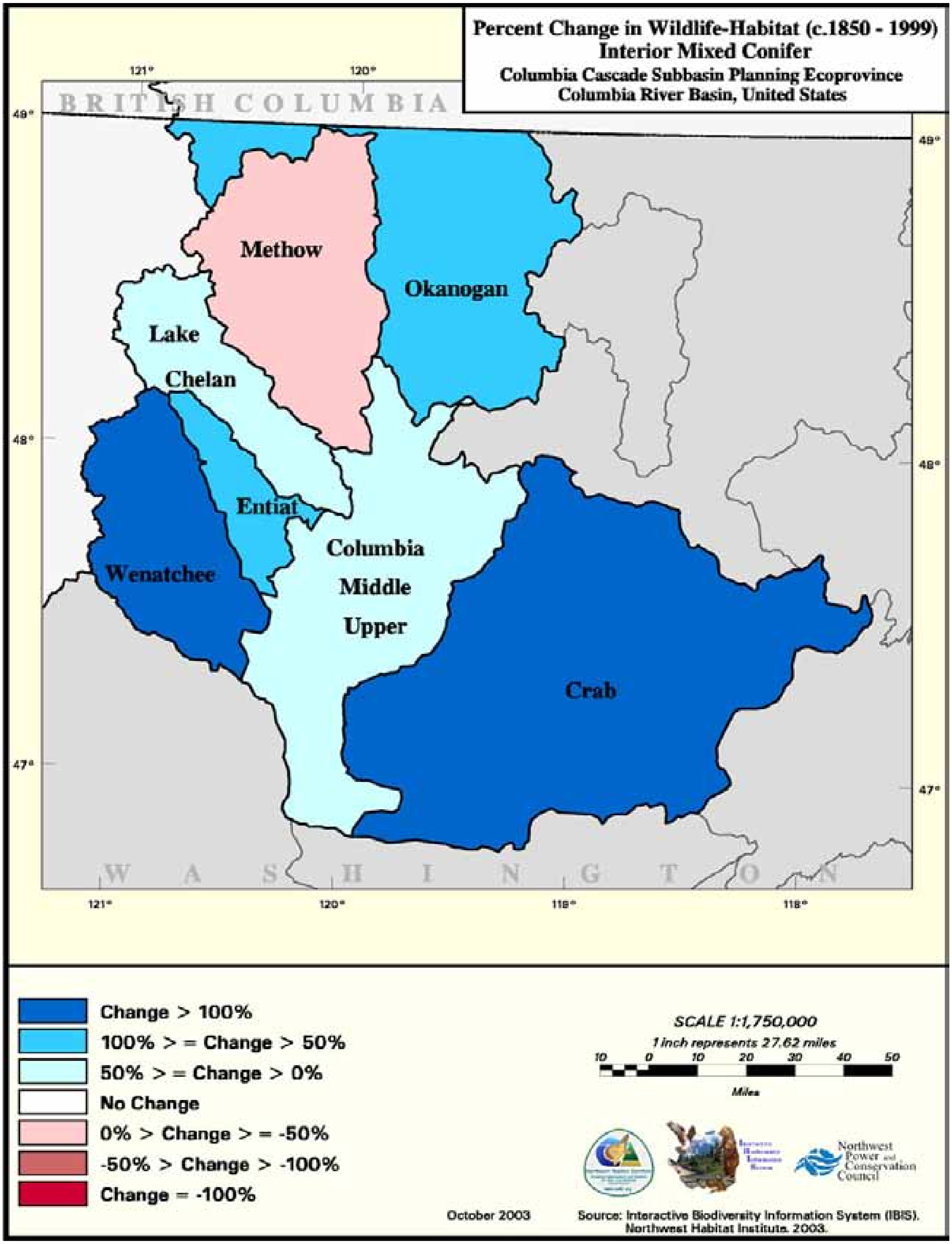

Figure C-3. Percent change in interior mixed conifer forests in the Columbia Cascade Ecoprovince, Washington (NHI 2003).

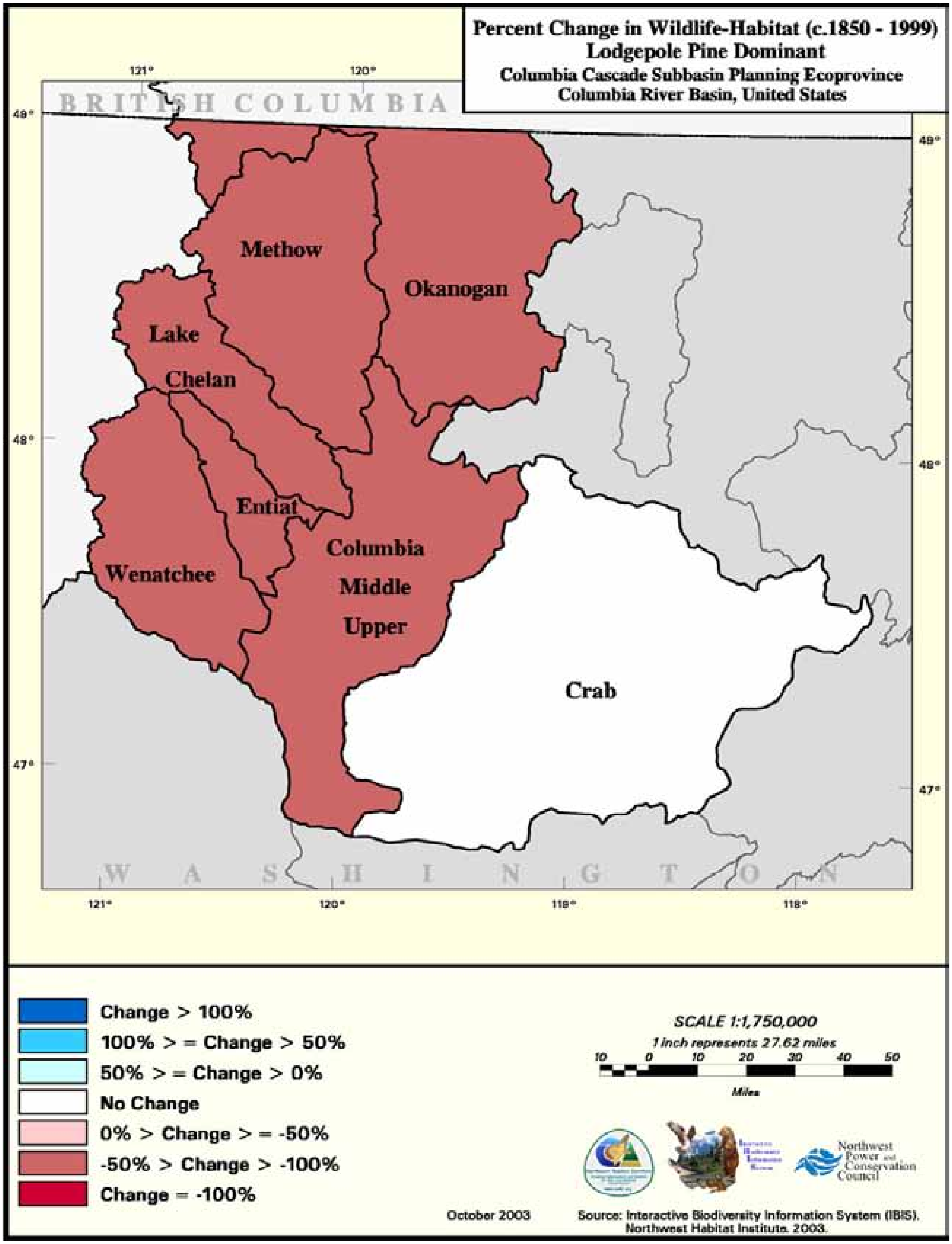

Figure C-4. Percent change in lodgepole pine forests in the Columbia Cascade Ecoprovince, Washington (NHI 2003).

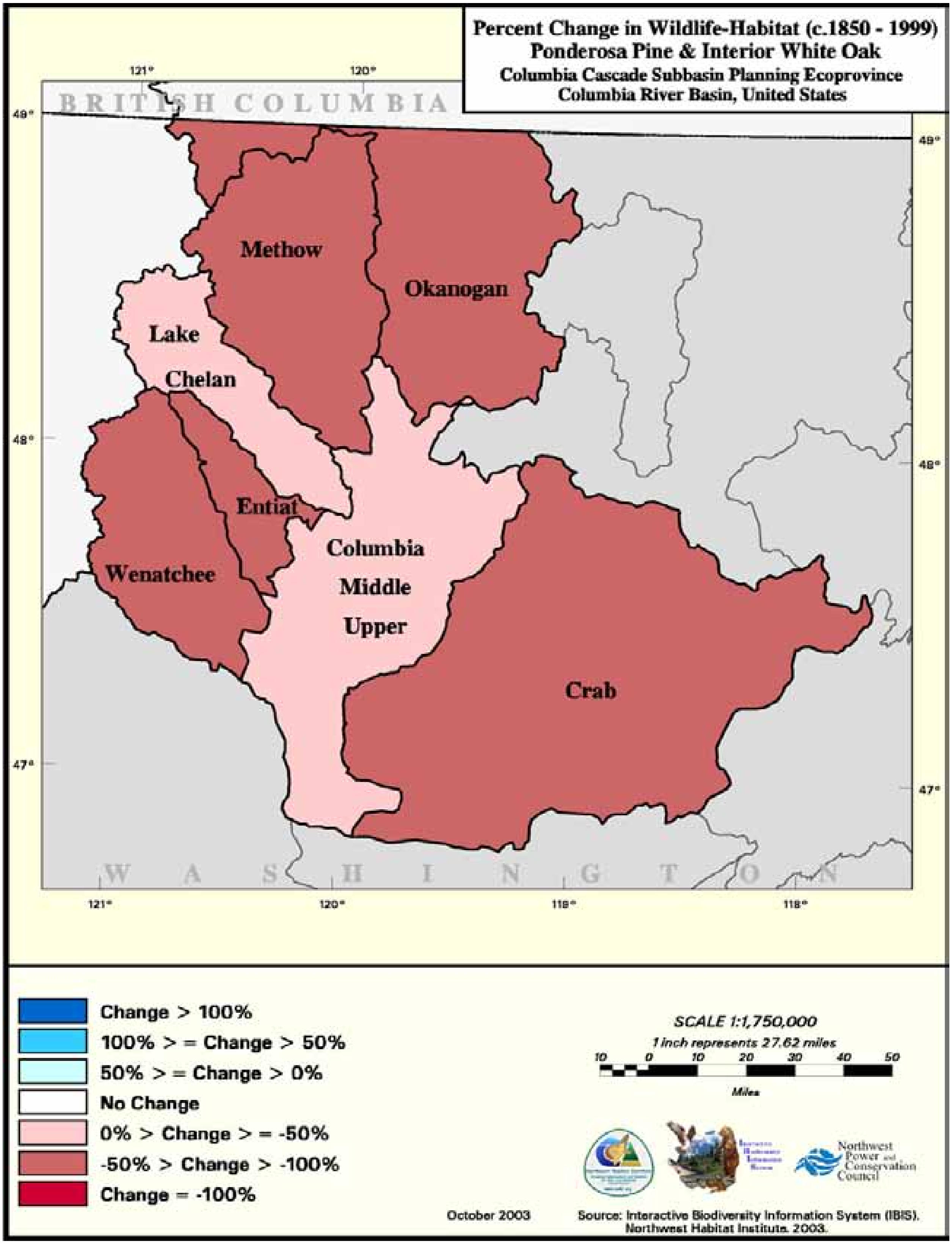

Figure C-5. Percent change in ponderosa pine and Oregon white oak forests in the Columbia Cascade Ecoprovince, Washington (NHI 2003).

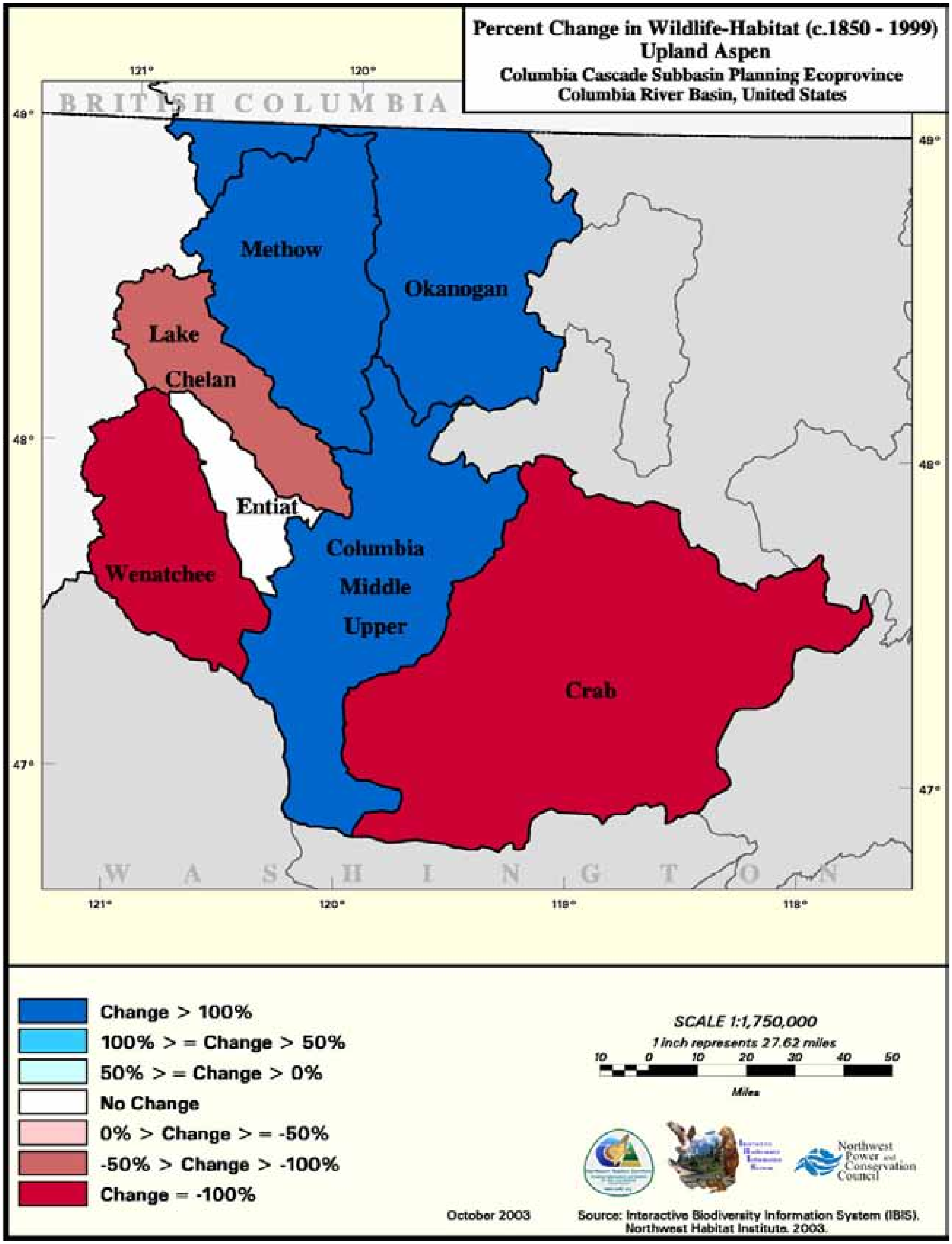

Figure C-6. Percent change in upland aspen forests in the Columbia Cascade Ecoprovince, Washington (NHI 2003).

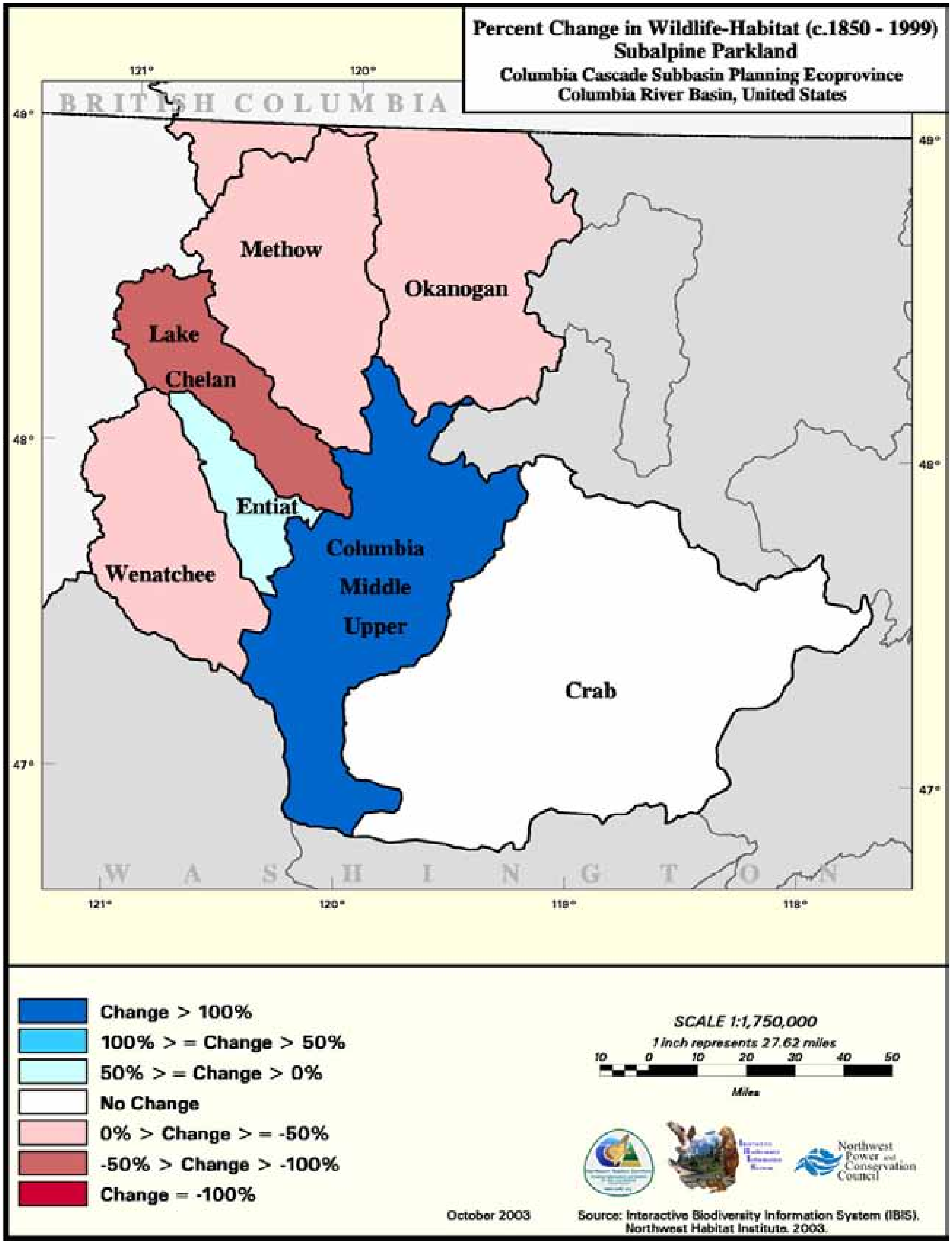

Figure C-7. Percent change in subalpine parkland in the Columbia Cascade Ecoprovince, Washington (NHI 2003).

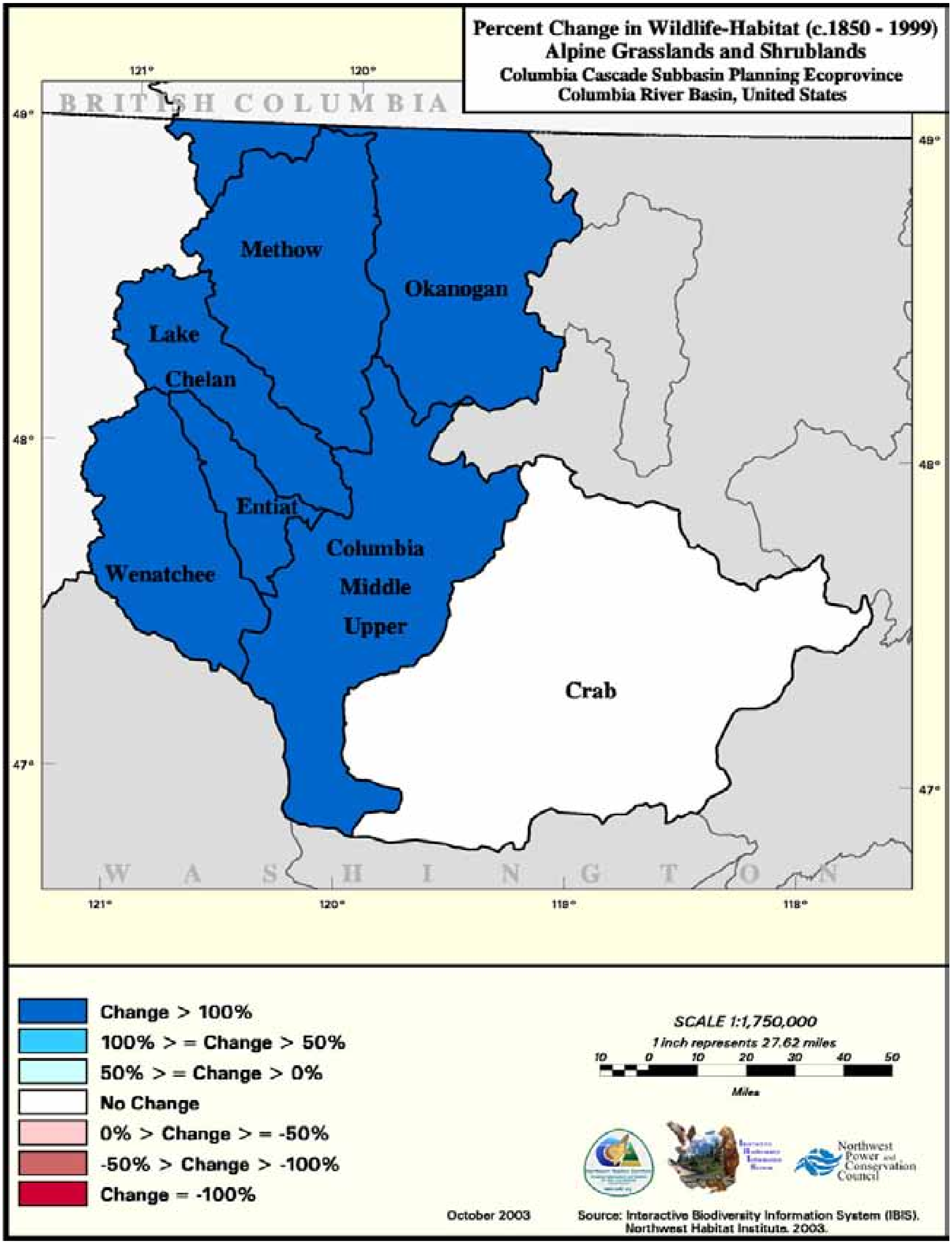

Figure C-8. Percent change in alpine grasslands and shrublands in the Columbia Cascade Ecoprovince, Washington (NHI 2003).

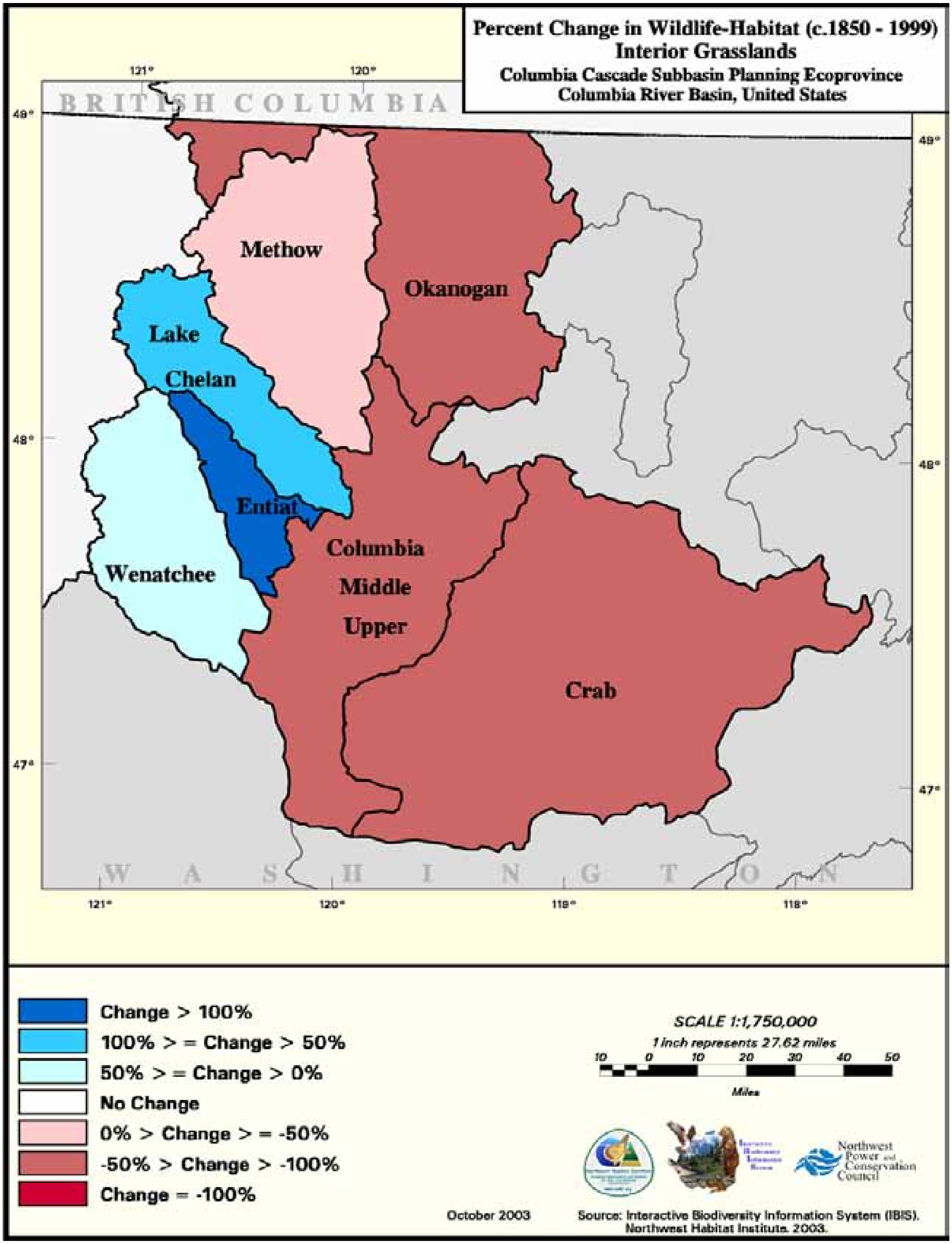

Figure C-9. Percent change in interior grasslands in the Columbia Cascade Ecoprovince, Washington (NHI 2003).

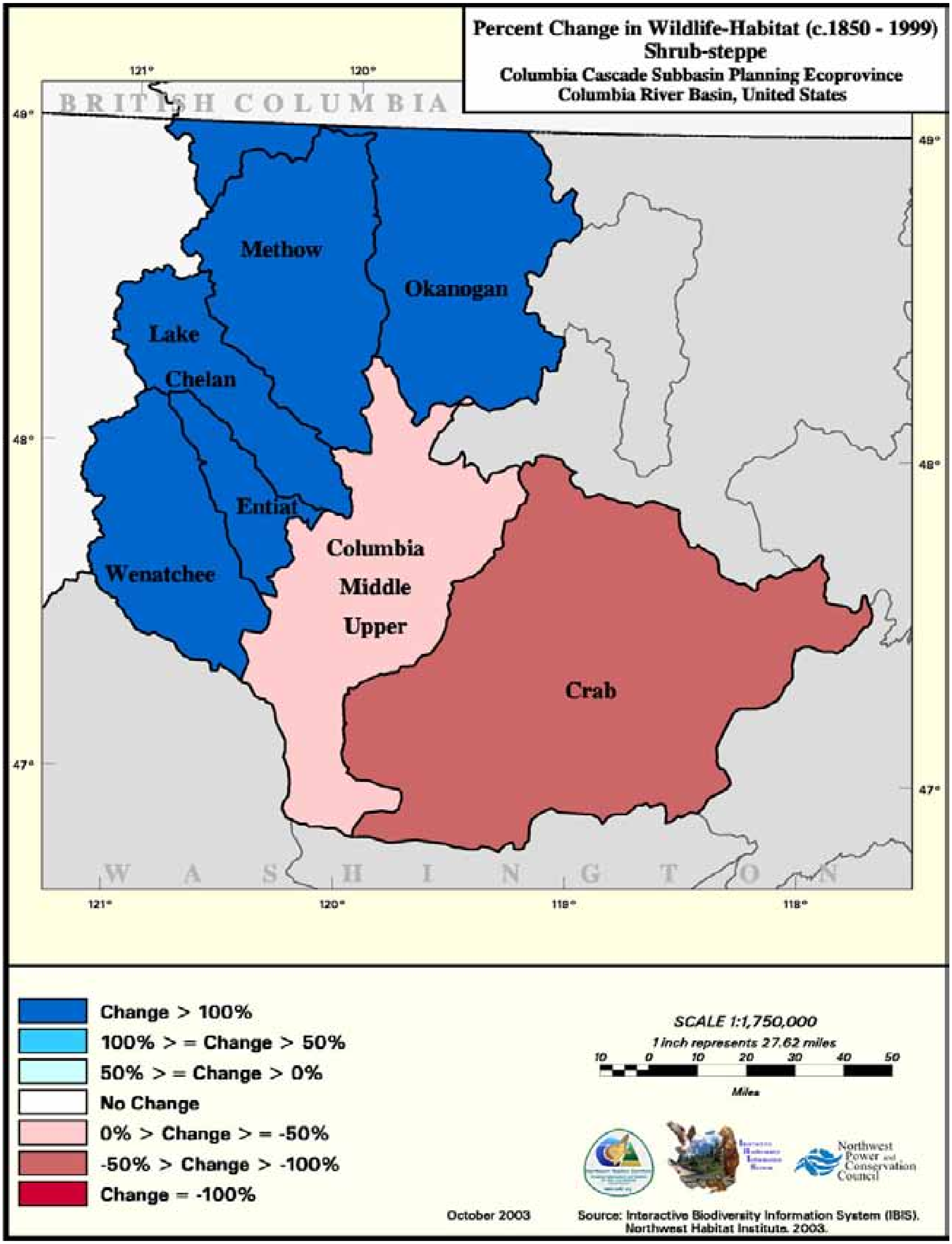

Figure C-10. Percent change in shrubsteppe in the Columbia Cascade Ecoprovince, Washington (NHI 2003).

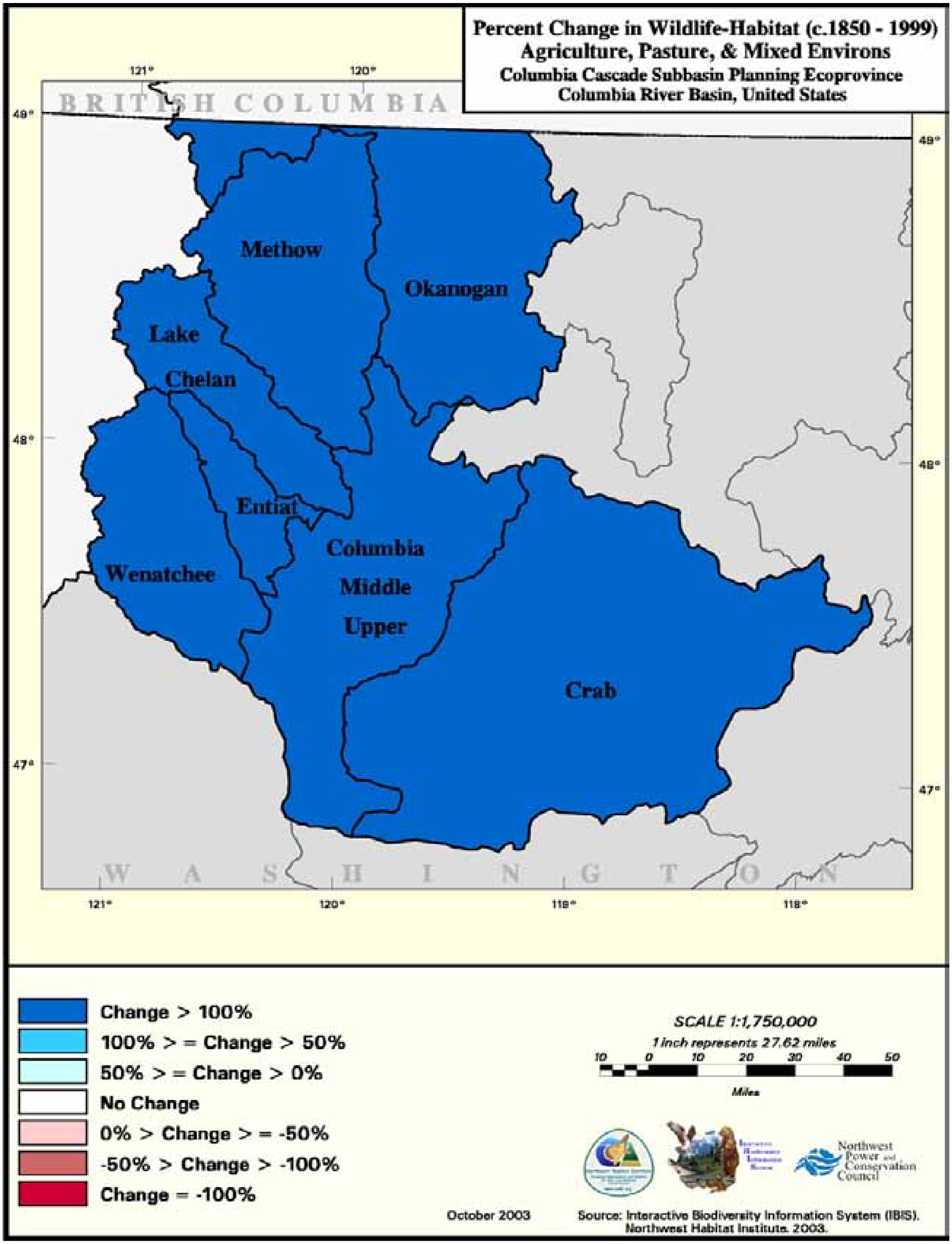

Figure C-11. Percent change in agriculture in the Columbia Cascade Ecoprovince, Washington (NHI 2003).

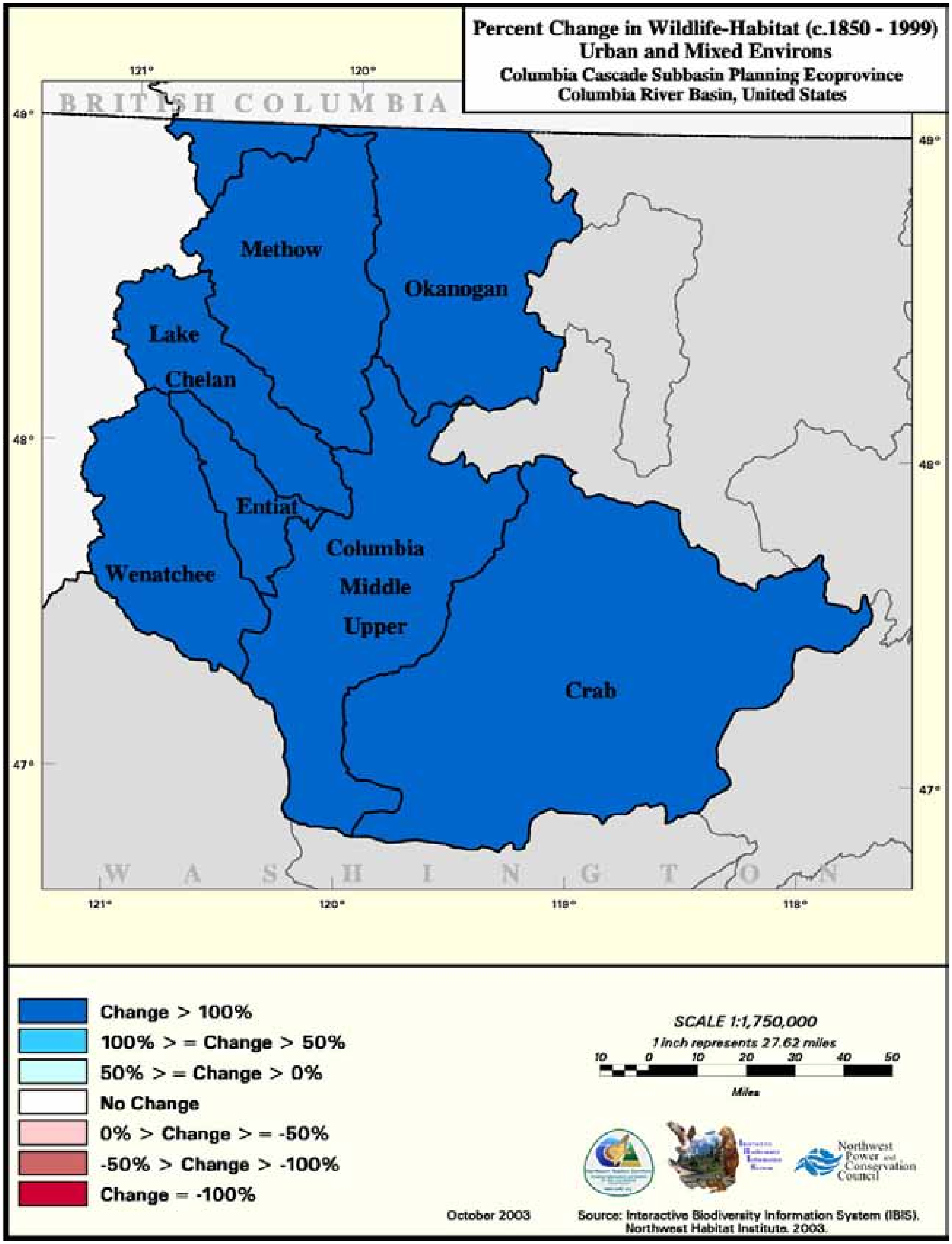

Figure C-12. Percent change in urban and mixed environs in the Columbia Cascade Ecoprovince, Washington (NHI 2003).

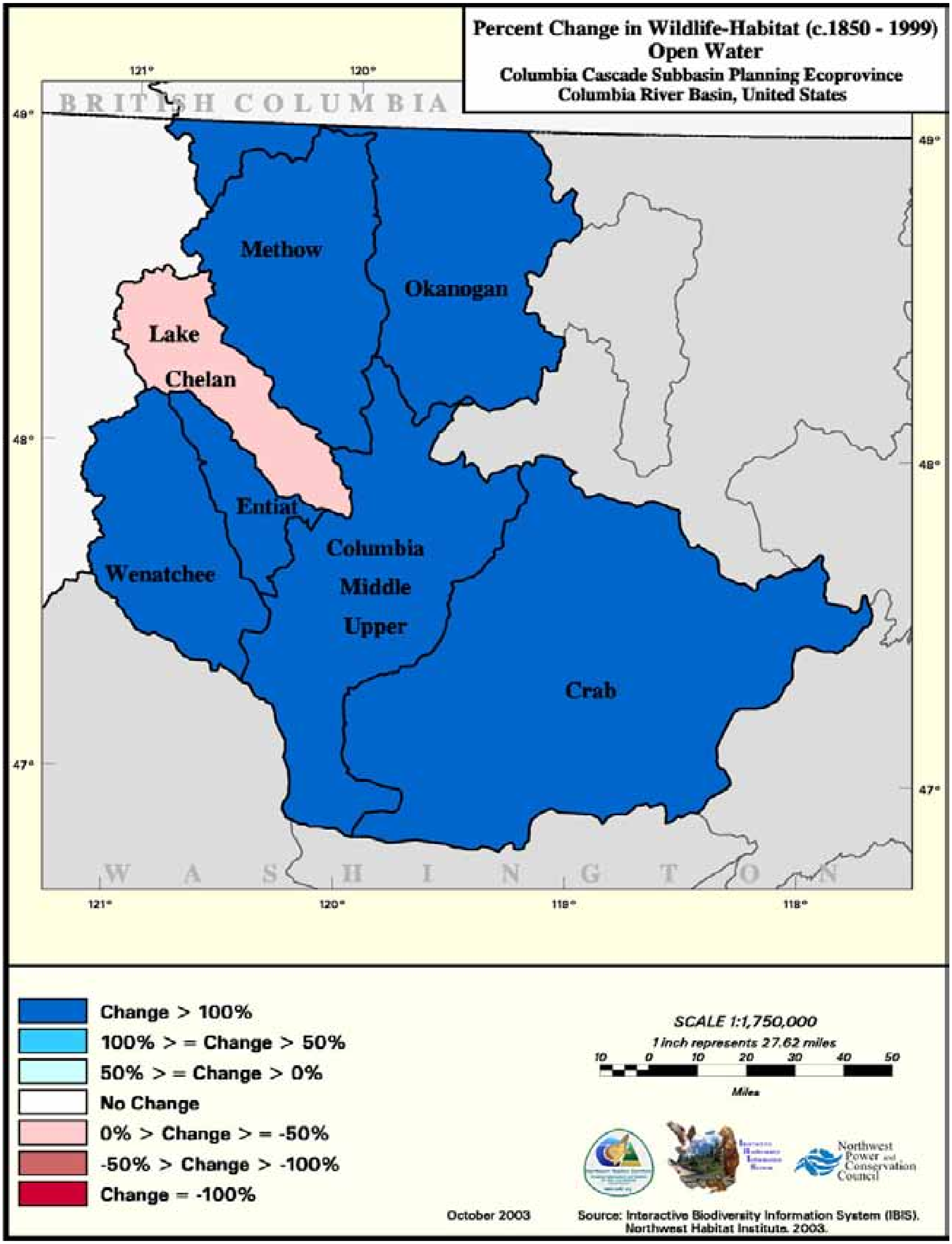

Figure C-13. Percent change in open water in the Columbia Cascade Ecoprovince, Washington (NHI 2003).

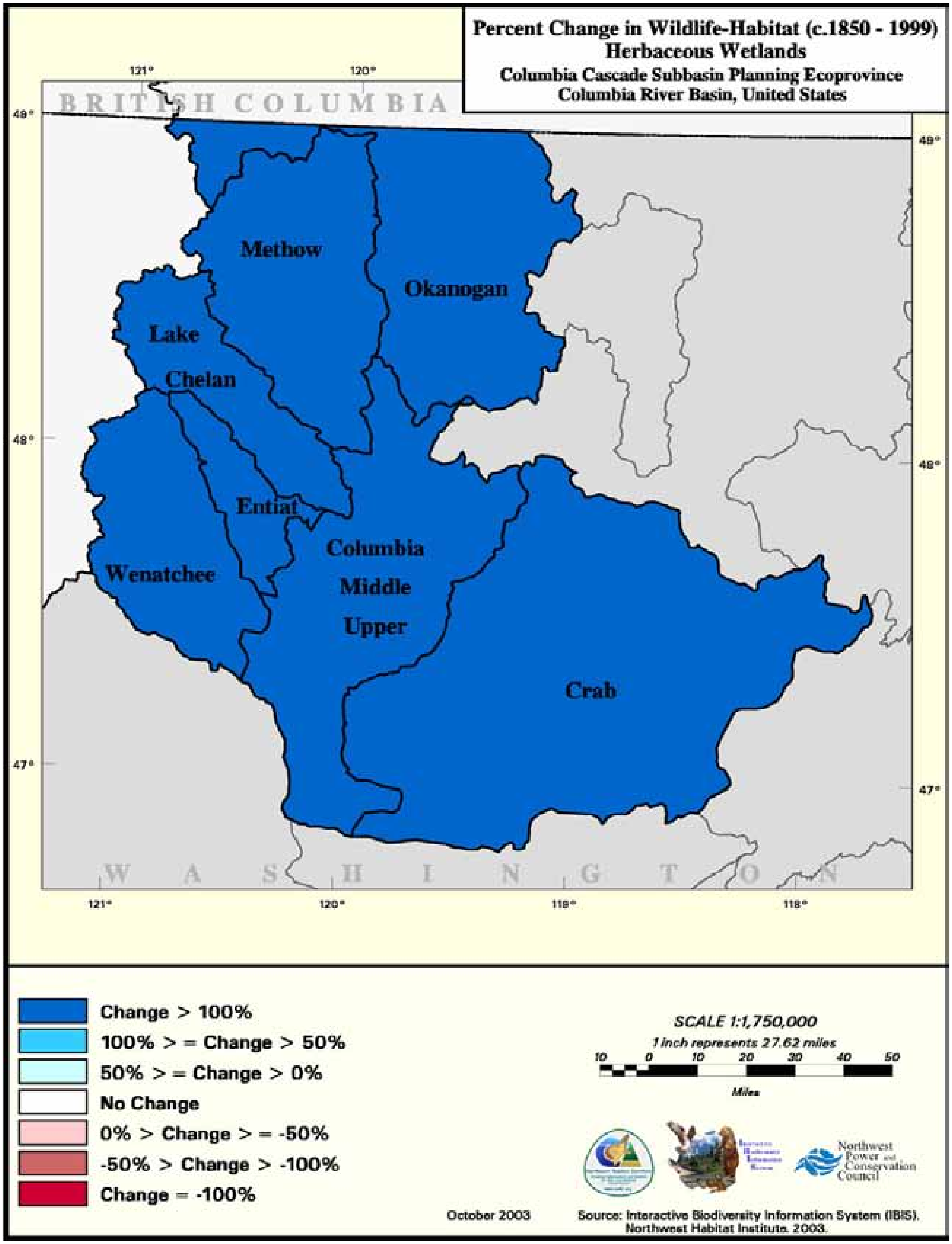

Figure C-14. Percent change in herbaceous wetlands in the Columbia Cascade Ecoprovince, Washington (NHI 2003).

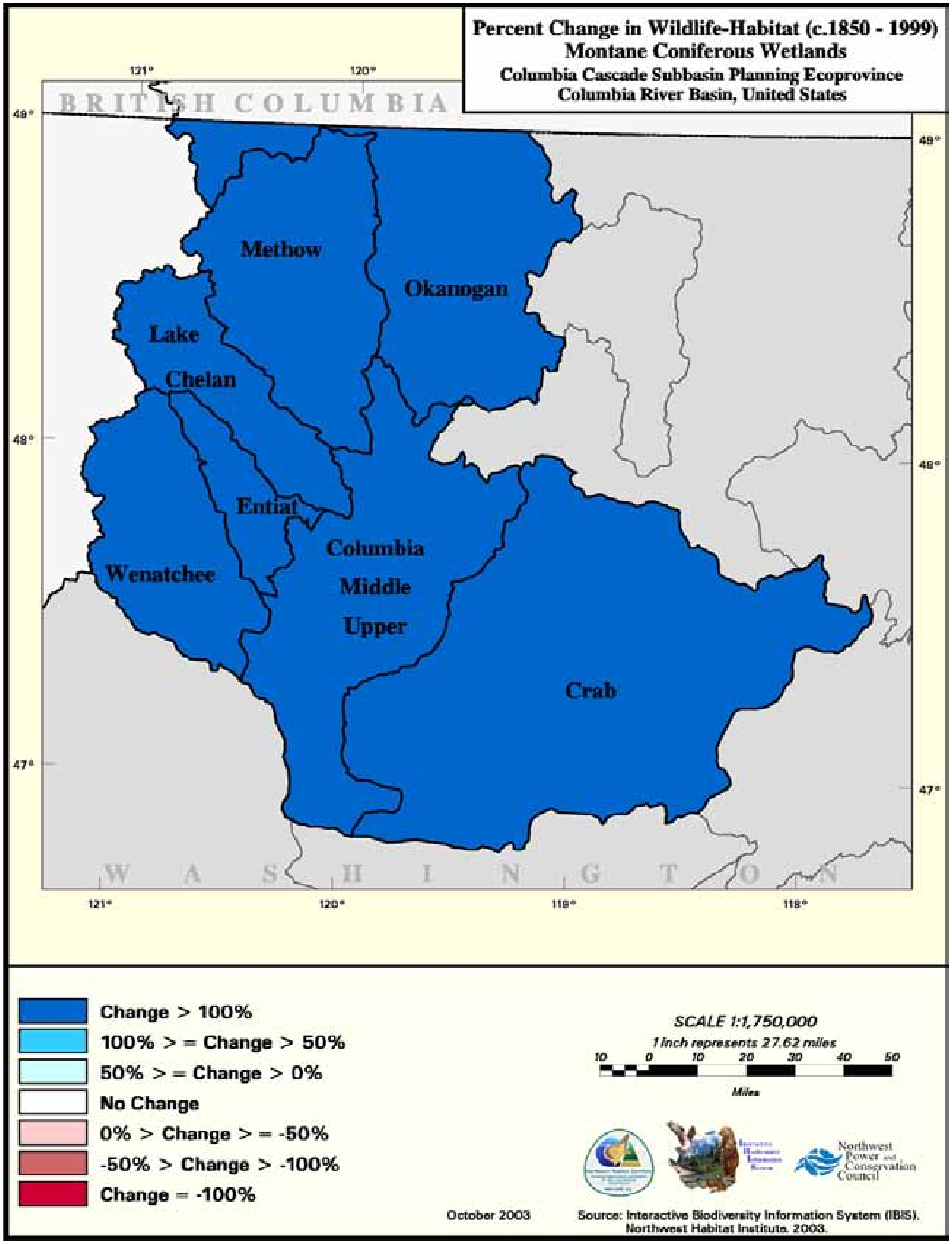

Figure C-15. Percent change in montane coniferous wetlands in the Columbia Cascade Ecoprovince, Washington (NHI 2003).

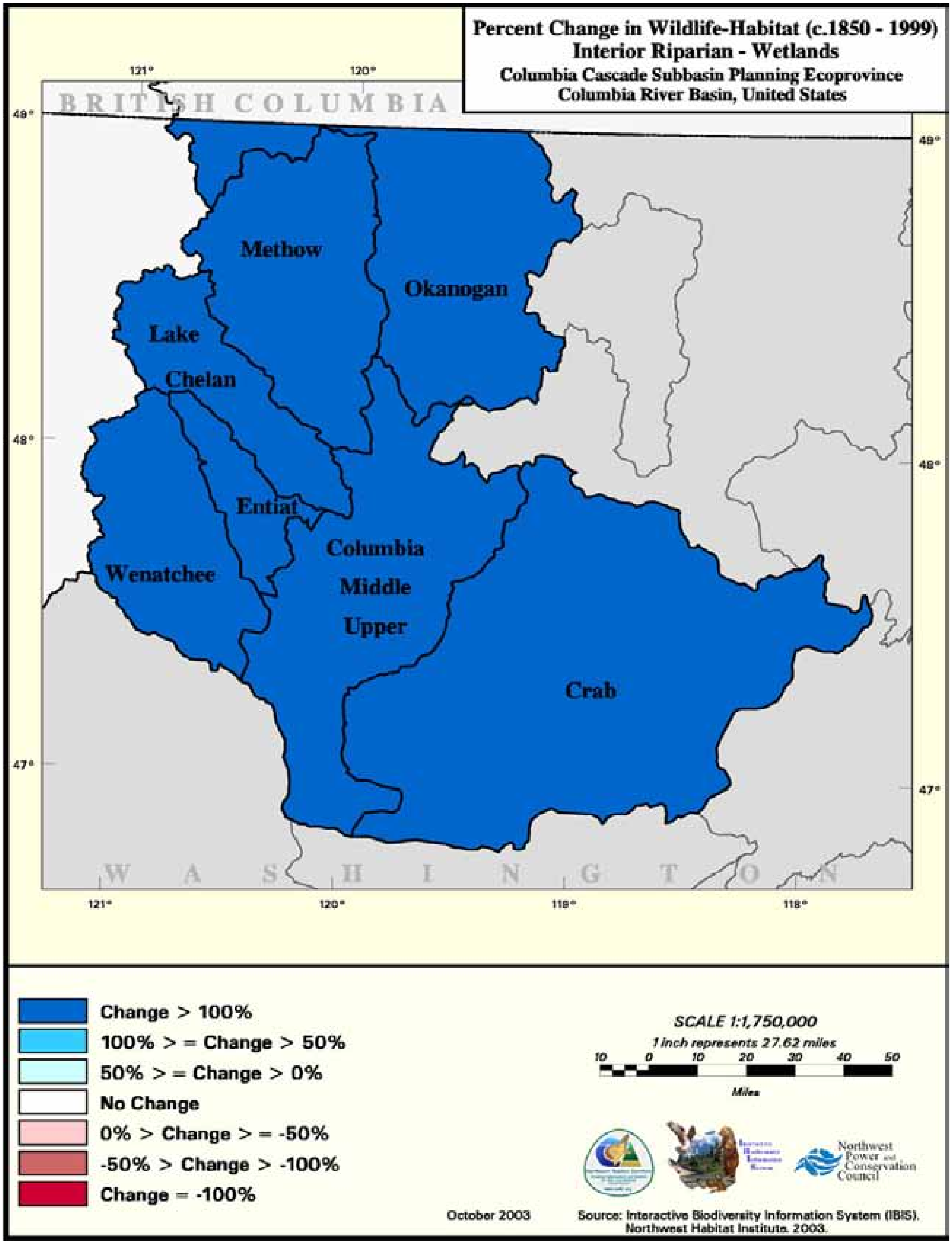

Figure C-16. Percent change in riparian wetlands in the Columbia Cascade Ecoprovince, Washington (NHI 2003).

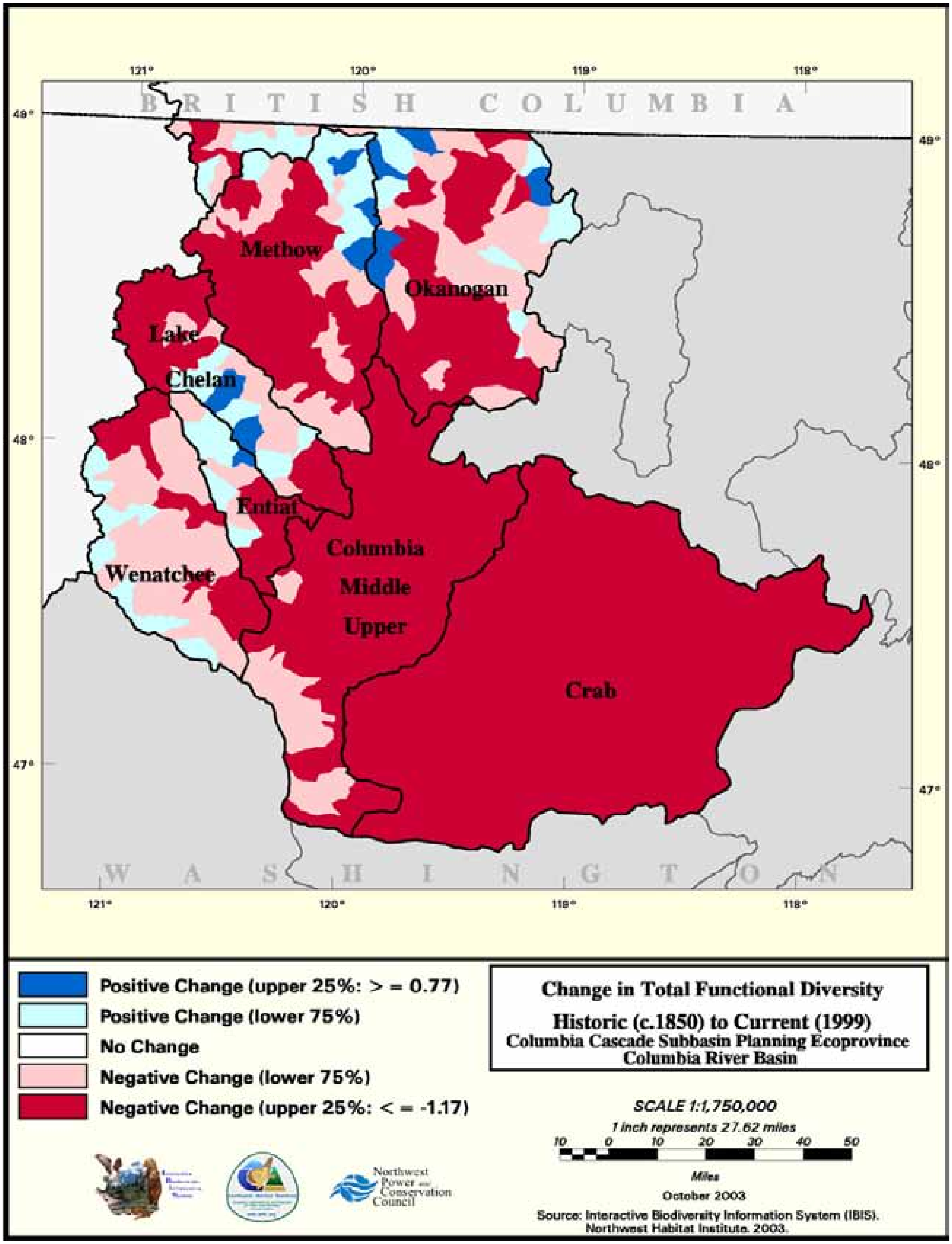

Figure C-17. Percent change in total functional diversity within the Columbia Cascade Ecoprovince, Washington, (NHI 2003).

Appendix D: Rare Plants

Table D-1. List of known occurrences of rare plants in the Columbia Cascade Ecoprovince, Washington (WNHP 2003).

Scientific Name	Common Name	State Status	Federal Status	Historic Record
Agoseris elata	Tall agoseris	Sensitive		
Agrostis borealis	Northern bentgrass	Sensitive		
Allium constrictum	Constricted douglas'	Sensitive		
Ammannia robusta	Grand redstem	Threatened		
Anemone nuttalliana	Pasqueflower	Threatened		
Antennaria parvifolia	Nuttall's pussy-toes	Sensitive		H
Arenaria franklinii var thompsonii	Thompson's sandwort	Review		
Artemisia campestris ssp borealis var wormskioldii	Northern wormwood	Endangered	C	
Aster sibiricus var meritus	Arctic aster	Sensitive		
Astragalus arrectus	Palouse milk-vetch	Sensitive		
Astragalus geyeri	Geyer's milk-vetch	Threatened		
Astragalus microcystis	Least bladdery milk-	Sensitive		
Astragalus sinuatus	Whited's milk-vetch	Endangered	SC	
Astragalus misellus var pauper	Pauper milk-vetch	Sensitive		
Botrychium ascendens	Triangular-lobed	Sensitive	SC	
Botrychium crenulatum	Crenulate moonwort	Sensitive	SC	
Botrychium paradoxum	Two-spiked moonwort	Threatened	SC	
Camissonia pygmaea	Dwarf evening-primrose	Sensitive		
Camissonia minor	Small-flower evening-primrose	Sensitive		
Carex atrosquama	Blackened sedge	Review		
Carex capillaris	Hair-like sedge	Sensitive		
Carex chordorrhiza	Cordroot sedge	Sensitive		
Carex comosa	Bristly sedge	Sensitive		
Carex dioica	Yellow bog sedge	Sensitive		
Carex eleocharis	Narrow-leaved sedge	Sensitive		
Carex flava	Yellow sedge	Sensitive		
Carex heteroneura	Different nerve sedge	Review		
Carex magellanica ssp irrigua	Poor sedge	Sensitive		
Carex norvegica	Scandinavian sedge	Sensitive		
Carex praeceptorum	Teacher's sedge	Review		
Carex proposita	Smoky mountain sedge	Threatened		
Carex scirpoidea var scirpoidea	Canadian single-spike sedge	Sensitive		
Carex sychnocephala	Many-headed sedge	Sensitive		
Carex tenuiflora	Sparse-leaved sedge	Threatened		
Carex vallicola	Valley sedge	Sensitive		
Carex xerantica	White-scaled sedge	Review		
Centunculus minimus	Chaffweed	Review		
Chaenactis thompsonii	Thompson's chaenactis	Sensitive		
Chrysosplenium tetrandrum	Northern golden-carpet	Sensitive		

Scientific Name	Common Name	State Status	Federal Status	Historic Record
Cicuta bulbifera	Bulb-bearing water-hemlock	Sensitive		
Cryptantha leucophaea	Gray cryptantha	Sensitive	SC	
Cryptantha scoparia	Miner's candle	Sensitive		
Cryptantha spiculifera	Snake river cryptantha	Sensitive		
Cryptogramma stelleri	Steller's rockbrake	Sensitive		
Cypripedium fasciculatum	Clustered lady's-slipper	Sensitive	SC	
Cypripedium parviflorum	Yellow lady's-slipper	Threatened		
Cyperus bipartitus	Shining flatsedge	Sensitive		
Delphinium viridescens	Wenatchee larkspur	Threatened	SC	H
Draba aurea	Golden draba	Sensitive		
Draba cana	Lance-leaved draba	Sensitive		
Eatonella nivea	White eatonella	Threatened		
Eleocharis rostellata	Beaked spike-rush	Sensitive		
Erigeron humilis	Arctic-alpine daisy	Review		
Erigeron piperianus	Piper's daisy	Sensitive		
Erigeron salishii	Salish fleabane	Sensitive		
Eriophorum viridicarinatum	Green keeled cotton-	Sensitive		
Eritrichium nanum var elongatum	Pale alpine-forget-me-	Sensitive		
Gentiana glauca	Glaucous gentian	Sensitive		
Gentianella tenella	Slender gentian	Sensitive		
Geum rivale	Water avens	Sensitive		
Geum rossii var depressum	Ross' avens	Endangered		
Gilia leptomeria	Great basin gilia	Sensitive		
Githopsis specularioides	Common blue-cup	Sensitive		
Hackelia cinerea	Gray stickseed	Sensitive		
Hackelia hispida var disjuncta	Sagebrush stickseed	Sensitive		
Hackelia venusta	Showy stickseed	Endangered	E	
Iliamna longisepala	Longsepal globemallow	Sensitive		
Impatiens aurella	Orange balsam	Review		
Isoetes nuttallii	Nuttall's quillwort	Sensitive		H
Juncus tiehmii	Tiehm's rush	Threatened		
Juncus uncialis	Inch-high rush	Sensitive		
Lipocarpha aristulata	Awned halfchaff sedge	Threatened		
Lomatium serpentinum	Snake canyon desert-parsley	Sensitive		H
Lomatium tuberosum	Hoover's desert-parsley	Sensitive	SC	
Loiseleuria procumbens	Alpine azalea	Threatened		H
Lupinus cusickii	Prairie lupine	Review	SC	H
Mimulus pulsiferae	Pulsifer's monkey-flower	Sensitive		
Mimulus suksdorfii	Suksdorf's monkey-	Sensitive		
Mimulus washingtonensis	Washington monkey-	Extirpated		
Minuartia nuttallii ssp fragilis	Nuttall's sandwort	Threatened		
Monolepis pusilla	Red poverty-weed	Threatened		

Scientific Name	Common Name	State Status	Federal Status	Historic Record
Nicotiana attenuata	Coyote tobacco	Sensitive		
Oenothera caespitosa ssp caespitosa	Cespitose evening-primrose	Sensitive		
Ophioglossum pusillum	Adder's-tongue	Threatened		
Opuntia fragilis	Brittle prickly-pear	Review		
Oxytropis campestris var gracilis	Slender crazyweed	Sensitive		
Parnassia kotzebuei	Kotzebue's grass-of-parnassus	Sensitive		
Pediocactus simpsonii var robustior	Hedgehog cactus	Review		
Pellaea brachyptera	Sierra cliff-brake	Sensitive		
Pellaea breweri	Brewer's cliff-brake	Sensitive		
Penstemon eriantherus var whitedii	Fuzzytongue	Sensitive		
Petrophyton cinerascens	Chelan rockmat	Endangered	SC	
Phacelia lenta	Sticky phacelia	Threatened	SC	
Phacelia tetramera	Dwarf phacelia	Sensitive		
Pilularia americana	American pillwort	Sensitive		
Platanthera obtusata	Small northern bog-	Sensitive		
Platanthera sparsiflora	Canyon bog-orchid	Threatened		H
Poa arctica ssp arctica	Gray's bluegrass	Review		
Polemonium pectinatum	Washington	Threatened	SC	
Polemonium viscosum	Skunk polemonium	Sensitive		
Polygonum austiniae	Austin's knotweed	Threatened		
Potentilla diversifolia var perdissecta	Diverse-leaved	Sensitive		
Potentilla nivea	Snow cinquefoil	Sensitive		
Potentilla quinquefolia	Five-leaved cinquefoil	Threatened		
Rorippa columbiae	Persistentsepal yellowcress	Endangered	SC	
Rotala ramosior	Lowland toothcup	Threatened		H
Rubus acaulis	Nagoonberry	Threatened		
Salix glauca	Glaucous willow	Sensitive		
Salix tweedyi	Tweedy's willow	Sensitive		
Salix vestita var erecta	Rock willow	Extirpated		
Saxifraga cernua	Nodding saxifrage	Sensitive		
Saxifraga rivularis	Pygmy saxifrage	Sensitive		
Saxifragopsis fragarioides	Strawberry saxifrage	Threatened		
Schizachyrium scoparium var	Little bluestem	Threatened		
Sidalcea oregana var calva	Wenatchee mountain checker-mallow	Endangered	LE	
Sisyrinchium montanum	Strict blue-eyed-grass	Threatened		
Silene douglasii var monantha	Douglas' silene	Review		H
Silene seelyi	Seely's silene	Sensitive	SC	
Silene spaldingii	Spalding's silene	Threatened	LT	
Sisyrinchium septentrionale	Blue-eyed grass	Sensitive		
Spiranthes diluvialis	Ute ladies' tresses	Endangered	LT	

Scientific Name	Common Name	State Status	Federal Status	Historic Record
Spiranthes porrifolia	Western ladies-tresses	Sensitive		
Swertia perennis	Swertia	Review		
Trifolium thompsonii	Thompson's clover	Threatened	SC	
Trimorpha elata	Tall bitter fleabane	Sensitive		
Utricularia minor	Lesser bladderwort	Review		
Vaccinium myrtilloides	Velvet-leaf blueberry	Sensitive		

State Status of the species is determined by the Washington Department of Fish and Wildlife. Factors considered include abundance, occurrence patterns, vulnerability, threats, existing protection, and taxonomic distinctness.

E =	Endangered. In danger of becoming extinct or extirpated from Washington.
S =	Sensitive. Vulnerable or declining and could become Endangered or Threatened in the state.
C =	Candidate animal. Under review for listing.
M =	Monitor. Taxa of potential concern.
PT =	Part. Used when two portions of a taxon have different state status.

Federal Status under the U.S. Endangered Species Act (USESA) as published in the Federal Register.

LE =	Listed Endangered. In danger of extinction.
LT =	Listed Threatened. Likely to become endangered.
PE =	Proposed Endangered.
PT =	Proposed Threatened.
C =	Candidate species. Sufficient information exists to support listing as Endangered or Threatened.
SC =	Species of Concern. An unofficial status, the species appears to be in jeopardy, but insufficient information to support listing.
NL =	Not Listed. Used when two portions of a taxon have different federal status.

Table D-2. List of known high-quality or rare plant communities and wetland ecosystems of the Columbia Cascade Ecoprovince, Washington (WNHP 2003).

Scientific Name	Common Name	Historic Record
ABIES AMABILIS / ACHLYS TRIPHYLLA FOREST	PACIFIC SILVER FIR / VANILLALEAF	H
ABIES AMABILIS - TSUGA MERTENSIANA COVER TYPE	PACIFIC SILVER FIR - MOUNTAIN HEMLOCK FOREST	H
ABIES AMABILIS COVER TYPE	PACIFIC SILVER FIR FOREST	H
ABIES GRANDIS / ACER CIRCINATUM FOREST	GRAND FIR / VINE MAPLE	
ABIES LASIOCARPA / CALAMAGROSTIS RUBESCENS FOREST	SUBALPINE FIR / PINEGRASS	
ABIES LASIOCARPA / LEDUM GLANDULOSUM FOREST	SUBALPINE FIR / GLANDULAR LABRADOR-TEA	
ABIES LASIOCARPA / RHODODENDRON ALBIFLORUM WOODLAND	SUBALPINE FIR / CASCADE AZALEA	
ABIES LASIOCARPA / VACCINIUM SCOPARIUM FOREST	SUBALPINE FIR / GROUSEBERRY	
ABIES LASIOCARPA COVER TYPE	SUBALPINE FIR FOREST	H
ABIES PROCERA COVER TYPE	NOBLE FIR FOREST	H
ACER CIRCINATUM COVER TYPE	VINE MAPLE SHRUBLAND	
ALNUS INCANA SHRUBLAND (PROVISIONAL)	MOUNTAIN ALDER	
ALNUS VIRIDIS SSP. SINUATA SHRUBLAND (PROVISIONAL)	SITKA ALDER	H
ARTEMISIA TRIDENTATA COVER TYPE	BIG SAGEBRUSH SHRUBLAND	
ARTEMISIA RIGIDA / POA SECUNDA DWARF-SHRUB HERBACEOUS	STIFF SAGEBRUSH / SANDBERG'S BLUEGRASS	
ARTEMISIA TRIDENTATA / FESTUCA IDAHOENSIS SHRUB HERBACEOUS	BIG SAGEBRUSH / IDAHO FESCUE	
ARTEMISIA TRIDENTATA SSP. WYOMINGENSIS / PSEUDOROEGNERIA	WYOMING BIG SAGEBRUSH / BLUEBUNCH WHEATGRASS	
ARTEMISIA TRIDENTATA SSP. WYOMINGENSIS / STIPA COMATA	WYOMING BIG SAGEBRUSH / NEEDLE-AND-THREAD	
ARTEMISIA TRIPARTITA / FESTUCA CAMPESTRIS SHRUB HERBACEOUS	THREETIP SAGEBRUSH / ROUGH FESCUE	
ARTEMISIA TRIPARTITA / FESTUCA IDAHOENSIS SHRUB HERBACEOUS	THREETIP SAGEBRUSH / IDAHO FESCUE	
ARTEMISIA TRIPARTITA / PSEUDOROEGNERIA SPICATA SHRUB	THREETIP SAGEBRUSH / BLUEBUNCH WHEATGRASS	
BETULA OCCIDENTALIS COVER TYPE	WATER BIRCH FOREST	
BETULA OCCIDENTALIS / CORNUS SERICEA SHRUBLAND	WATER BIRCH / RED-OSIER DOGWOOD	
CAREX COVER TYPE	SEDGE SPP. GRASSLAND	
CAREX SCOPULORUM HERBACEOUS VEGETATION	HOLM'S ROCKY MOUNTAIN SEDGE	
CAREX UTRICULATA HERBACEOUS VEGETATION	NORTHWEST TERRITORY SEDGE	
CORNUS SERICEA SHRUBLAND (PROVISIONAL)	RED-OSIER DOGWOOD	

Scientific Name	Common Name	Historic Record
CRATAEGUS DOUGLASII / ROSA WOODSII SHRUBLAND	BLACK HAWTHORN / WOOD'S ROSE	
DANTHONIA INTERMEDIA HERBACEOUS VEGETATION	TIMBER OATGRASS	
DESCHAMPSIA CAESPITOSA HERBACEOUS VEGETATION	TUFTED HAIRGRASS	
DISTICHLIS SPICATA HERBACEOUS VEGETATION	SALTGRASS	
DRYAS OCTOPETALA DWARF-SHRUB HERBACEOUS VEGETATION	EIGHT PETAL MOUNTAIN-AVENS	
ELEOCHARIS PALUSTRIS INTERMITTENTLY FLOODED	CREEPING SPIKERUSH	
ELYMUS LANCEOLATUS - STIPA COMATA HERBACEOUS VEGETATION	STREAMSIDE WILDRYE - NEEDLE-AND-THREAD	
ERIOGONUM COMPOSITUM / POA SECUNDA DWARF-SHRUB	ARROW-LEAF BUCKWHEAT / SANDBERG'S BLUEGRASS	
ERIOGONUM NIVEUM COVER TYPE	SNOW BUCKWHEAT SHRUBLAND	
ERIOGONUM SPHAEROCEPHALUM / POA SECUNDA DWARF-SHRUB	ROCK BUCKWHEAT / SANDBERG'S BLUEGRASS	
ERIOGONUM THYMOIDES / POA SECUNDA DWARF-SHRUB	THYME BUCKWHEAT / SANDBERG'S BLUEGRASS	
FESTUCA IDAHOENSIS - ERIOGONUM HERACLEOIDES HERBACEOUS	IDAHO FESCUE - PARSNIP-FLOWER BUCKWHEAT	
FESTUCA IDAHOENSIS - SYMPHORICARPOS ALBUS	IDAHO FESCUE - COMMON SNOWBERRY	
GRAYIA SPINOSA / POA SECUNDA SHRUBLAND	SPINY HOPSAGE / SANDBERG'S BLUEGRASS	
INLAND SALINE WETLAND CB	INLAND SALINE WETLAND CB	
LARIX LYALLII ASSOCIATION	SUBALPINE LARCH COMMUNITY	H
LARIX OCCIDENTALIS COVER TYPE	WESTERN LARCH FOREST	H
LEYMUS CINEREUS HERBACEOUS VEGETATION (PROVISIONAL)	GREAT BASIN WILDRYE	H
LEYMUS CINEREUS - DISTICHLIS SPICATA HERBACEOUS VEGETATION	GREAT BASIN WILDRYE - SALTGRASS	
LOW ELEVATION FRESHWATER WETLAND CB	LOW ELEVATION FRESHWATER WETLAND CB	
PHILADELPHUS LEWISII INTERMITTENTLY FLOODED	MOCK ORANGE	
PICEA ENGELMANNII - ABIES LASIOCARPA COVER TYPE	ENGELMANN SPRUCE - SUBALPINE FIR FOREST	H
PICEA ENGELMANNII / EQUISETUM ARVENSE FOREST	ENGELMANN SPRUCE / FIELD HORSETAIL	
PINUS ALBICAULIS - ABIES LASIOCARPA COVER TYPE	WHITE-BARK PINE - SUBALPINE FIR FOREST	
PINUS ALBICAULIS COVER TYPE	WHITE-BARK PINE FOREST	
PINUS CONTORTA COVER TYPE	LODGEPOLE PINE FOREST	
PINUS PONDEROSA - PSEUDOTSUGA MENZIESII / PURSHIA TRIDENTATA	PONDEROSA PINE - DOUGLAS-FIR / BITTERBRUSH	
PINUS PONDEROSA - PSEUDOTSUGA MENZIESII / PSEUDOROEGNERIA	PONDEROSA PINE - DOUGLAS-FIR / BLUEBUNCH WHEATGRASS	

Scientific Name	Common Name	Historic Record
PINUS PONDEROSA - PSEUDOTSUGA MENZIESII COVER TYPE	PONDEROSA PINE - DOUGLAS-FIR FOREST	
PINUS PONDEROSA / PURSHIA TRIDENTATA WOODLAND	PONDEROSA PINE / BITTERBRUSH	
PINUS PONDEROSA / SYMPHORICARPOS ALBUS	PONDEROSA PINE - COMMON SNOWBERRY	
PINUS PONDEROSA / CALAMAGROSTIS RUBESCENS FOREST	PONDEROSA PINE / PINEGRASS	
PINUS PONDEROSA COVER TYPE	PONDEROSA PINE FOREST	H
POPULUS TREMULOIDES / CORNUS SERICEA FOREST	QUAKING ASPEN / RED-OSIER DOGWOOD	
POPULUS TREMULOIDES / SYMPHORICARPOS ALBUS FOREST	QUAKING ASPEN / COMMON SNOWBERRY	
POPULUS TREMULOIDES COVER TYPE	QUAKING ASPEN FOREST	
PSEUDOROEGNERIA SPICATA - FESTUCA IDAHOENSIS CANYON	BLUEBUNCH WHEATGRASS - IDAHO FESCUE CANYON	
PSEUDOROEGNERIA SPICATA - FESTUCA IDAHOENSIS PALOUSE	BLUEBUNCH WHEATGRASS - IDAHO FESCUE PALOUSE	
PSEUDOROEGNERIA SPICATA - POA SECUNDA LITHOSOLIC HERBACEOUS	BLUEBUNCH WHEATGRASS - SANDBERG'S BLUEGRASS LITHOSOL	
PSEUDOROEGNERIA SPICATA COVER TYPE	BLUEBUNCH WHEATGRASS GRASSLAND	
PSEUDOTSUGA MENZIESII - ABIES LASIOCARPA COVER TYPE	DOUGLAS-FIR - SUBALPINE FIR FOREST	H
PSEUDOTSUGA MENZIESII - ABIES GRANDIS COVER TYPE	DOUGLAS-FIR - GRAND FIR FOREST	
PSEUDOTSUGA MENZIESII / ACER CIRCINATUM FOREST	DOUGLAS-FIR / VINE MAPLE	H
PSEUDOTSUGA MENZIESII / ARCTOSTAPHYLOS UVA-URSI -	DOUGLAS-FIR / KINIKINNICK - BITTERBRUSH	
PSEUDOTSUGA MENZIESII / ARCTOSTAPHYLOS UVA-URSI	DOUGLAS-FIR / KINIKINNICK CASCADIAN FOREST	
PSEUDOTSUGA MENZIESII / CALAMAGROSTIS RUBESCENS FOREST	DOUGLAS-FIR / PINEGRASS	
PSEUDOTSUGA MENZIESII / PHYSOCARPUS MALVACEUS FOREST	DOUGLAS-FIR / MALLOW-LEAF NINEBARK	
PSEUDOTSUGA MENZIESII COVER TYPE	DOUGLAS-FIR FOREST	
PURSHIA TRIDENTATA / FESTUCA IDAHOENSIS SHRUB HERBACEOUS	BITTERBRUSH / IDAHO FESCUE	
PURSHIA TRIDENTATA / ORYZOPSIS HYMENOIDES SHRUBLAND	BITTERBRUSH / INDIAN RICEGRASS	
PURSHIA TRIDENTATA / PSEUDOROEGNERIA SPICATA SHRUB	BITTERBRUSH / BLUEBUNCH WHEATGRASS	
PURSHIA TRIDENTATA / STIPA COMATA SHRUB HERBACEOUS VEGETATION	BITTERBRUSH / NEEDLE-AND-THREAD	
RHUS GLABRA / PSEUDOROEGNERIA SPICATA SHRUB HERBACEOUS	SMOOTH SUMAC / BLUEBUNCH WHEATGRASS	
SALIX AMYGDALOIDES / SALIX EXIGUA WOODLAND	PEACH-LEAF WILLOW / SANDBAR WILLOW	
SALIX DRUMMONDIANA / CAREX SCOPULORUM VAR. PRIONOPHYLLA	DRUMMOND'S WILLOW / HOLM'S ROCKY MOUNTAIN SEDGE	
SALIX PLANIFOLIA / CAREX SCOPULORUM SHRUBLAND	TEA-LEAF WILLOW / HOLM'S ROCKY MOUNTAIN SEDGE	H

Scientific Name	Common Name	Historic Record
SARCOBATUS VERMICULATUS / DISTICHLIS SPICATA SHRUBLAND	GREASEWOOD / SALTGRASS	
SCIRPUS MARITIMUS HERBACEOUS VEGETATION	SEACOAST BULRUSH	
SPOROBOLUS CRYPTANDRUS - POA SECUNDA HERBACEOUS VEGETATION	SAND DROPSEED - SANDBERG'S BLUEGRASS	
STIPA COMATA COVER TYPE	NEEDLE-AND-THREAD GRASSLAND	
STIPA COMATA - POA SECUNDA HERBACEOUS VEGETATION	NEEDLE-AND-THREAD - SANDBERG'S BLUEGRASS	
SUBALPINE FRESHWATER WETLAND EC	SUBALPINE FRESHWATER WETLAND EC	
SUBALPINE RIPARIAN WETLAND EC	SUBALPINE RIPARIAN WETLAND EC	
THUJA PLICATA - TSUGA HETEROPHYLLA COVER TYPE	WESTERN REDCEDAR - WESTERN HEMLOCK FOREST	
TSUGA HETEROPHYLLA / MAHONIA NERVOSA VAR. NERVOSA FOREST	WESTERN HEMLOCK / DWARF OREGONGRAPE	H
TSUGA MERTENSIANA - ABIES LASIOCARPA COVER TYPE	MOUNTAIN HEMLOCK - SUBALPINE FIR COMMUNITY	H
VERNAL POND CB	VERNAL POND CB	

Appendix E: Wildlife Species of the Columbia Cascades Ecoprovince, Washington

Table E-1. Wildlife species occurrence and breeding status of the Columbia Cascade Ecoprovince, Washington (NHI 2003).

	Common Name	Scientific Name	WA Occurrence	WA Breeding Status
Amphibians				
	Tiger Salamander	*Ambystoma tigrinum*	occurs	breeds
	Northwestern Salamander	*Ambystoma gracile*	occurs	breeds
	Long-toed Salamander	*Ambystoma macrodactylum*	occurs	breeds
	Pacific Giant Salamander	*Dicamptodon tenebrosus*	occurs	breeds
	Rough-skinned Newt	*Taricha granulosa*	occurs	breeds
	Dunn's Salamander	*Plethodon dunni*	occurs	breeds
	Western Red-backed Salamander	*Plethodon vehiculum*	occurs	breeds
	Ensatina	*Ensatina eschscholtzii*	occurs	breeds
	Tailed Frog	*Ascaphus truei*	occurs	breeds
	Great Basin Spadefoot	*Scaphiopus intermontanus*	occurs	breeds
	Western Toad	*Bufo boreas*	occurs	breeds
	Woodhouse's Toad	*Bufo woodhousii*	occurs	breeds
	Pacific Chorus (Tree) Frog	*Pseudacris regilla*	occurs	breeds
	Cascade Frog	*Rana cascadae*	occurs	breeds
	Columbia Spotted Frog	*Rana luteiventris*	occurs	breeds
	Northern Leopard Frog	*Rana pipiens*	occurs	breeds
	Bullfrog	*Rana catesbeiana*	non-native	breeds
	Total Amphibians:	**17**		
Birds				
	Common Loon	*Gavia immer*	occurs	breeds
	Pied-billed Grebe	*Podilymbus podiceps*	occurs	breeds
	Red-necked Grebe	*Podiceps grisegena*	occurs	breeds
	Eared Grebe	*Podiceps nigricollis*	occurs	breeds
	Western Grebe	*Aechmophorus occidentalis*	occurs	breeds
	Clark's Grebe	*Aechmophorus clarkii*	occurs	breeds
	Double-crested Cormorant	*Phalacrocorax auritus*	occurs	breeds
	American Bittern	*Botaurus lentiginosus*	occurs	breeds
	Great Blue Heron	*Ardea herodias*	occurs	breeds
	Great Egret	*Ardea alba*	occurs	breeds
	Black-crowned Night-heron	*Nycticorax nycticorax*	occurs	breeds
	Turkey Vulture	*Cathartes aura*	occurs	breeds
	Canada Goose	*Branta canadensis*	occurs	breeds
	Tundra Swan	*Cygnus columbianus*	occurs	non-breeder
	Wood Duck	*Aix sponsa*	occurs	breeds
	Gadwall	*Anas strepera*	occurs	breeds
	American Wigeon	*Anas americana*	occurs	breeds
	Mallard	*Anas platyrhynchos*	occurs	breeds
	Blue-winged Teal	*Anas discors*	occurs	breeds
	Cinnamon Teal	*Anas cyanoptera*	occurs	breeds
	Northern Shoveler	*Anas clypeata*	occurs	breeds

	Common Name	Scientific Name	WA Occurrence	WA Breeding Status
	Northern Pintail	*Anas acuta*	occurs	breeds
	Green-winged Teal	*Anas crecca*	occurs	breeds
	Canvasback	*Aythya valisineria*	occurs	breeds
	Redhead	*Aythya americana*	occurs	breeds
	Ring-necked Duck	*Aythya collaris*	occurs	breeds
	Greater Scaup	*Aythya marila*	occurs	non-breeder
	Harlequin Duck	*Histrionicus histrionicus*	occurs	breeds
	Barrow's Goldeneye	*Bucephala islandica*	occurs	breeds
	Hooded Merganser	*Lophodytes cucullatus*	occurs	breeds
	Common Merganser	*Mergus merganser*	occurs	breeds
	Ruddy Duck	*Oxyura jamaicensis*	occurs	breeds
	Osprey	*Pandion haliaetus*	occurs	breeds
	Northern Harrier	*Circus cyaneus*	occurs	breeds
	Sharp-shinned Hawk	*Accipiter striatus*	occurs	breeds
	Cooper's Hawk	*Accipiter cooperii*	occurs	breeds
	Northern Goshawk	*Accipiter gentilis*	occurs	breeds
	Swainson's Hawk	*Buteo swainsoni*	occurs	breeds
	Red-tailed Hawk	*Buteo jamaicensis*	occurs	breeds
	Ferruginous Hawk	*Buteo regalis*	occurs	breeds
	Rough-legged Hawk	*Buteo lagopus*	occurs	non-breeder
	Golden Eagle	*Aquila chrysaetos*	occurs	breeds
	American Kestrel	*Falco sparverius*	occurs	breeds
	Gyrfalcon	*Falco rusticolus*	occurs	non-breeder
	Prairie Falcon	*Falco mexicanus*	occurs	breeds
	Chukar	*Alectoris chukar*	non-native	breeds
	Gray Partridge	*Perdix perdix*	non-native	breeds
	Ring-necked Pheasant	*Phasianus colchicus*	non-native	breeds
	Ruffed Grouse	*Bonasa umbellus*	occurs	breeds
	Sage Grouse	*Centrocercus urophasianus*	occurs	breeds
	Spruce Grouse	*Falcipennis canadensis*	occurs	breeds
	White-tailed Ptarmigan	*Lagopus leucurus*	occurs	breeds
	Blue Grouse	*Dendragapus obscurus*	occurs	breeds
	Sharp-tailed Grouse	*Tympanuchus phasianellus*	occurs	breeds
	Wild Turkey	*Meleagris gallopavo*	non-native	breeds
	California Quail	*Callipepla californica*	non-native	breeds
	Virginia Rail	*Rallus limicola*	occurs	breeds
	Sora	*Porzana carolina*	occurs	breeds
	American Coot	*Fulica americana*	occurs	breeds
	Killdeer	*Charadrius vociferus*	occurs	breeds
	Black-necked Stilt	*Himantopus mexicanus*	occurs	breeds
	American Avocet	*Recurvirostra americana*	occurs	breeds
	Greater Yellowlegs	*Tringa melanoleuca*	occurs	non-breeder
	Lesser Yellowlegs	*Tringa flavipes*	occurs	non-breeder
	Solitary Sandpiper	*Tringa solitaria*	occurs	non-breeder
	Spotted Sandpiper	*Actitis macularia*	occurs	breeds

	Common Name	Scientific Name	WA Occurrence	WA Breeding Status
	Long-billed Curlew	*Numenius americanus*	occurs	breeds
	Semipalmated Sandpiper	*Calidris pusilla*	occurs	non-breeder
	Western Sandpiper	*Calidris mauri*	occurs	non-breeder
	Least Sandpiper	*Calidris minutilla*	occurs	non-breeder
	Baird's Sandpiper	*Calidris bairdii*	occurs	non-breeder
	Pectoral Sandpiper	*Calidris melanotos*	occurs	non-breeder
	Stilt Sandpiper	*Calidris himantopus*	occurs	non-breeder
	Long-billed Dowitcher	*Limnodromus scolopaceus*	occurs	non-breeder
	Common Snipe	*Gallinago gallinago*	occurs	breeds
	Wilson's Phalarope	*Phalaropus tricolor*	occurs	breeds
	Red-necked Phalarope	*Phalaropus lobatus*	occurs	non-breeder
	Ring-billed Gull	*Larus delawarensis*	occurs	breeds
	California Gull	*Larus californicus*	occurs	breeds
	Herring Gull	*Larus argentatus*	occurs	non-breeder
	Thayer's Gull	*Larus thayeri*	occurs	non-breeder
	Glaucous Gull	*Larus hyperboreus*	occurs	non-breeder
	Caspian Tern	*Sterna caspia*	occurs	breeds
	Forster's Tern	*Sterna forsteri*	occurs	breeds
	Black Tern	*Chlidonias niger*	occurs	breeds
	Rock Dove	*Columba livia*	non-native	breeds
	Mourning Dove	*Zenaida macroura*	occurs	breeds
	Barn Owl	*Tyto alba*	occurs	breeds
	Flammulated Owl	*Otus flammeolus*	occurs	breeds
	Western Screech-owl	*Otus kennicottii*	occurs	breeds
	Great Horned Owl	*Bubo virginianus*	occurs	breeds
	Snowy Owl	*Nyctea scandiaca*	occurs	non-breeder
	Northern Pygmy-owl	*Glaucidium gnoma*	occurs	breeds
	Burrowing Owl	*Athene cunicularia*	occurs	breeds
	Spotted Owl	*Strix occidentalis*	occurs	breeds
	Barred Owl	*Strix varia*	occurs	breeds
	Great Gray Owl	*Strix nebulosa*	occurs	breeds
	Long-eared Owl	*Asio otus*	occurs	breeds
	Short-eared Owl	*Asio flammeus*	occurs	breeds
	Boreal Owl	*Aegolius funereus*	occurs	breeds
	Northern Saw-whet Owl	*Aegolius acadicus*	occurs	breeds
	Common Nighthawk	*Chordeiles minor*	occurs	breeds
	Common Poorwill	*Phalaenoptilus nuttallii*	occurs	breeds
	Black Swift	*Cypseloides niger*	occurs	breeds
	Vaux's Swift	*Chaetura vauxi*	occurs	breeds
	White-throated Swift	*Aeronautes saxatalis*	occurs	breeds
	Black-chinned Hummingbird	*Archilochus alexandri*	occurs	breeds
	Calliope Hummingbird	*Stellula calliope*	occurs	breeds
	Rufous Hummingbird	*Selasphorus rufus*	occurs	breeds
	Belted Kingfisher	*Ceryle alcyon*	occurs	breeds
	Lewis's Woodpecker	*Melanerpes lewis*	occurs	breeds

	Common Name	Scientific Name	WA Occurrence	WA Breeding Status
	Williamson's Sapsucker	*Sphyrapicus thyroideus*	occurs	breeds
	Red-naped Sapsucker	*Sphyrapicus nuchalis*	occurs	breeds
	Red-breasted Sapsucker	*Sphyrapicus ruber*	occurs	breeds
	Downy Woodpecker	*Picoides pubescens*	occurs	breeds
	Hairy Woodpecker	*Picoides villosus*	occurs	breeds
	White-headed Woodpecker	*Picoides albolarvatus*	occurs	breeds
	Three-toed Woodpecker	*Picoides tridactylus*	occurs	breeds
	Black-backed Woodpecker	*Picoides arcticus*	occurs	breeds
	Northern Flicker	*Colaptes auratus*	occurs	breeds
	Pileated Woodpecker	*Dryocopus pileatus*	occurs	breeds
	Olive-sided Flycatcher	*Contopus cooperi*	occurs	breeds
	Western Wood-pewee	*Contopus sordidulus*	occurs	breeds
	Willow Flycatcher	*Empidonax traillii*	occurs	breeds
	Hammond's Flycatcher	*Empidonax hammondii*	occurs	breeds
	Gray Flycatcher	*Empidonax wrightii*	occurs	breeds
	Dusky Flycatcher	*Empidonax oberholseri*	occurs	breeds
	Pacific-slope Flycatcher	*Empidonax difficilis*	occurs	breeds
	Cordilleran Flycatcher	*Empidonax occidentalis*	occurs	breeds
	Say's Phoebe	*Sayornis saya*	occurs	breeds
	Western Kingbird	*Tyrannus verticalis*	occurs	breeds
	Eastern Kingbird	*Tyrannus tyrannus*	occurs	breeds
	Loggerhead Shrike	*Lanius ludovicianus*	occurs	breeds
	Northern Shrike	*Lanius excubitor*	occurs	non-breeder
	Cassin's Vireo	*Vireo cassinii*	occurs	breeds
	Warbling Vireo	*Vireo gilvus*	occurs	breeds
	Red-eyed Vireo	*Vireo olivaceus*	occurs	breeds
	Gray Jay	*Perisoreus canadensis*	occurs	breeds
	Steller's Jay	*Cyanocitta stelleri*	occurs	breeds
	Clark's Nutcracker	*Nucifraga columbiana*	occurs	breeds
	Black-billed Magpie	*Pica pica*	occurs	breeds
	American Crow	*Corvus brachyrhynchos*	occurs	breeds
	Northwestern Crow	*Corvus caurinus*	occurs	breeds
	Common Raven	*Corvus corax*	occurs	breeds
	Horned Lark	*Eremophila alpestris*	occurs	breeds
	Tree Swallow	*Tachycineta bicolor*	occurs	breeds
	Violet-green Swallow	*Tachycineta thalassina*	occurs	breeds
	Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	occurs	breeds
	Bank Swallow	*Riparia riparia*	occurs	breeds
	Cliff Swallow	*Petrochelidon pyrrhonota*	occurs	breeds
	Barn Swallow	*Hirundo rustica*	occurs	breeds
	Black-capped Chickadee	*Poecile atricapillus*	occurs	breeds
	Mountain Chickadee	*Poecile gambeli*	occurs	breeds
	Chestnut-backed Chickadee	*Poecile rufescens*	occurs	breeds

	Common Name	Scientific Name	WA Occurrence	WA Breeding Status
	Boreal Chickadee	*Poecile hudsonicus*	occurs	breeds
	Red-breasted Nuthatch	*Sitta canadensis*	occurs	breeds
	White-breasted Nuthatch	*Sitta carolinensis*	occurs	breeds
	Pygmy Nuthatch	*Sitta pygmaea*	occurs	breeds
	Brown Creeper	*Certhia americana*	occurs	breeds
	Rock Wren	*Salpinctes obsoletus*	occurs	breeds
	Canyon Wren	*Catherpes mexicanus*	occurs	breeds
	House Wren	*Troglodytes aedon*	occurs	breeds
	Winter Wren	*Troglodytes troglodytes*	occurs	breeds
	Marsh Wren	*Cistothorus palustris*	occurs	breeds
	American Dipper	*Cinclus mexicanus*	occurs	breeds
	Golden-crowned Kinglet	*Regulus satrapa*	occurs	breeds
	Ruby-crowned Kinglet	*Regulus calendula*	occurs	breeds
	Western Bluebird	*Sialia mexicana*	occurs	breeds
	Mountain Bluebird	*Sialia currucoides*	occurs	breeds
	Townsend's Solitaire	*Myadestes townsendi*	occurs	breeds
	Veery	*Catharus fuscescens*	occurs	breeds
	Swainson's Thrush	*Catharus ustulatus*	occurs	breeds
	Hermit Thrush	*Catharus guttatus*	occurs	breeds
	American Robin	*Turdus migratorius*	occurs	breeds
	Varied Thrush	*Ixoreus naevius*	occurs	breeds
	Gray Catbird	*Dumetella carolinensis*	occurs	breeds
	Northern Mockingbird	*Mimus polyglottos*	occurs	breeds
	Sage Thrasher	*Oreoscoptes montanus*	occurs	breeds
	European Starling	*Sturnus vulgaris*	non-native	breeds
	American Pipit	*Anthus rubescens*	occurs	breeds
	Bohemian Waxwing	*Bombycilla garrulus*	occurs	non-breeder
	Cedar Waxwing	*Bombycilla cedrorum*	occurs	breeds
	Orange-crowned Warbler	*Vermivora celata*	occurs	breeds
	Nashville Warbler	*Vermivora ruficapilla*	occurs	breeds
	Yellow Warbler	*Dendroica petechia*	occurs	breeds
	Yellow-rumped Warbler	*Dendroica coronata*	occurs	breeds
	Black-throated Gray Warbler	*Dendroica nigrescens*	occurs	breeds
	Townsend's Warbler	*Dendroica townsendi*	occurs	breeds
	Hermit Warbler	*Dendroica occidentalis*	occurs	breeds
	American Redstart	*Setophaga ruticilla*	occurs	breeds
	Northern Waterthrush	*Seiurus noveboracensis*	occurs	breeds
	Macgillivray's Warbler	*Oporornis tolmiei*	occurs	breeds
	Common Yellowthroat	*Geothlypis trichas*	occurs	breeds
	Wilson's Warbler	*Wilsonia pusilla*	occurs	breeds
	Yellow-breasted Chat	*Icteria virens*	occurs	breeds
	Western Tanager	*Piranga ludoviciana*	occurs	breeds
	Spotted Towhee	*Pipilo maculatus*	occurs	breeds
	American Tree Sparrow	*Spizella arborea*	occurs	non-breeder
	Chipping Sparrow	*Spizella passerina*	occurs	breeds
	Brewer's Sparrow	*Spizella breweri*	occurs	breeds

	Common Name	Scientific Name	WA Occurrence	WA Breeding Status
	Vesper Sparrow	*Pooecetes gramineus*	occurs	breeds
	Lark Sparrow	*Chondestes grammacus*	occurs	breeds
	Black-throated Sparrow	*Amphispiza bilineata*	occurs	breeds
	Sage Sparrow	*Amphispiza belli*	occurs	breeds
	Savannah Sparrow	*Passerculus sandwichensis*	occurs	breeds
	Grasshopper Sparrow	*Ammodramus savannarum*	occurs	breeds
	Fox Sparrow	*Passerella iliaca*	occurs	breeds
	Song Sparrow	*Melospiza melodia*	occurs	breeds
	Lincoln's Sparrow	*Melospiza lincolnii*	occurs	breeds
	White-crowned Sparrow	*Zonotrichia leucophrys*	occurs	breeds
	Dark-eyed Junco	*Junco hyemalis*	occurs	breeds
	Lapland Longspur	*Calcarius lapponicus*	occurs	non-breeder
	Snow Bunting	*Plectrophenax nivalis*	occurs	non-breeder
	Black-headed Grosbeak	*Pheucticus melanocephalus*	occurs	breeds
	Lazuli Bunting	*Passerina amoena*	occurs	breeds
	Bobolink	*Dolichonyx oryzivorus*	occurs	breeds
	Red-winged Blackbird	*Agelaius phoeniceus*	occurs	breeds
	Western Meadowlark	*Sturnella neglecta*	occurs	breeds
	Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	occurs	breeds
	Brewer's Blackbird	*Euphagus cyanocephalus*	occurs	breeds
	Brown-headed Cowbird	*Molothrus ater*	occurs	breeds
	Bullock's Oriole	*Icterus bullockii*	occurs	breeds
	Gray-crowned Rosy-Finch	*Leucosticte tephrocotis*	occurs	breeds
	Pine Grosbeak	*Pinicola enucleator*	occurs	breeds
	Purple Finch	*Carpodacus purpureus*	occurs	breeds
	Cassin's Finch	*Carpodacus cassinii*	occurs	breeds
	House Finch	*Carpodacus mexicanus*	occurs	breeds
	Red Crossbill	*Loxia curvirostra*	occurs	breeds
	White-winged Crossbill	*Loxia leucoptera*	occurs	breeds
	Common Redpoll	*Carduelis flammea*	occurs	non-breeder
	Pine Siskin	*Carduelis pinus*	occurs	breeds
	American Goldfinch	*Carduelis tristis*	occurs	breeds
	Evening Grosbeak	*Coccothraustes vespertinus*	occurs	breeds
	House Sparrow	*Passer domesticus*	non-native	breeds
	Total Birds:	**234**		
Mammals				
	Virginia Opossum	*Didelphis virginiana*	non-native	breeds
	Masked Shrew	*Sorex cinereus*	occurs	breeds
	Vagrant Shrew	*Sorex vagrans*	occurs	breeds
	Montane Shrew	*Sorex monticolus*	occurs	breeds
	Water Shrew	*Sorex palustris*	occurs	breeds
	Pacific Water Shrew	*Sorex bendirii*	occurs	breeds

	Common Name	Scientific Name	WA Occurrence	WA Breeding Status
	Trowbridge's Shrew	*Sorex trowbridgii*	occurs	breeds
	Merriam's Shrew	*Sorex merriami*	occurs	breeds
	Shrew-mole	*Neurotrichus gibbsii*	occurs	breeds
	Coast Mole	*Scapanus orarius*	occurs	breeds
	California Myotis	*Myotis californicus*	occurs	breeds
	Western Small-footed Myotis	*Myotis ciliolabrum*	occurs	breeds
	Yuma Myotis	*Myotis yumanensis*	occurs	breeds
	Little Brown Myotis	*Myotis lucifugus*	occurs	breeds
	Long-legged Myotis	*Myotis volans*	occurs	breeds
	Fringed Myotis	*Myotis thysanodes*	occurs	breeds
	Long-eared Myotis	*Myotis evotis*	occurs	breeds
	Silver-haired Bat	*Lasionycteris noctivagans*	occurs	breeds
	Western Pipistrelle	*Pipistrellus hesperus*	occurs	breeds
	Big Brown Bat	*Eptesicus fuscus*	occurs	breeds
	Hoary Bat	*Lasiurus cinereus*	occurs	non-breeder
	Spotted Bat	*Euderma maculatum*	occurs	breeds
	Townsend's Big-eared Bat	*Corynorhinus townsendii*	occurs	breeds
	Pallid Bat	*Antrozous pallidus*	occurs	breeds
	American Pika	*Ochotona princeps*	occurs	breeds
	Pygmy Rabbit	*Brachylagus idahoensis*	occurs	breeds
	Eastern Cottontail	*Sylvilagus floridanus*	non-native	breeds
	Nuttall's (Mountain) Cottontail	*Sylvilagus nuttallii*	occurs	breeds
	Snowshoe Hare	*Lepus americanus*	occurs	breeds
	White-tailed Jackrabbit	*Lepus townsendii*	occurs	breeds
	Black-tailed Jackrabbit	*Lepus californicus*	occurs	breeds
	Mountain Beaver	*Aplodontia rufa*	occurs	breeds
	Least Chipmunk	*Tamias minimus*	occurs	breeds
	Yellow-pine Chipmunk	*Tamias amoenus*	occurs	breeds
	Townsend's Chipmunk	*Tamias townsendii*	occurs	breeds
	Yellow-bellied Marmot	*Marmota flaviventris*	occurs	breeds
	Hoary Marmot	*Marmota caligata*	occurs	breeds
	Townsend's Ground Squirrel	*Spermophilus townsendii*	occurs	breeds
	Washington Ground Squirrel	*Spermophilus washingtoni*	occurs	breeds
	Columbian Ground Squirrel	*Spermophilus columbianus*	occurs	breeds
	California Ground Squirrel	*Spermophilus beecheyi*	occurs	breeds
	Golden-mantled Ground Squirrel	*Spermophilus lateralis*	occurs	breeds
	Cascade Golden-mantled Ground Squirrel	*Spermophilus saturatus*	occurs	breeds
	Eastern Fox Squirrel	*Sciurus niger*	non-native	breeds
	Western Gray Squirrel	*Sciurus griseus*	occurs	breeds
	Red Squirrel	*Tamiasciurus hudsonicus*	occurs	breeds

	Common Name	Scientific Name	WA Occurrence	WA Breeding Status
	Douglas' Squirrel	*Tamiasciurus douglasii*	occurs	breeds
	Northern Flying Squirrel	*Glaucomys sabrinus*	occurs	breeds
	Northern Pocket Gopher	*Thomomys talpoides*	occurs	breeds
	Great Basin Pocket Mouse	*Perognathus parvus*	occurs	breeds
	American Beaver	*Castor canadensis*	occurs	breeds
	Western Harvest Mouse	*Reithrodontomys megalotis*	occurs	breeds
	Deer Mouse	*Peromyscus maniculatus*	occurs	breeds
	Columbian Mouse	*Peromyscus keeni*	occurs	breeds
	Northern Grasshopper Mouse	*Onychomys leucogaster*	occurs	breeds
	Bushy-tailed Woodrat	*Neotoma cinerea*	occurs	breeds
	Southern Red-backed Vole	*Clethrionomys gapperi*	occurs	breeds
	Heather Vole	*Phenacomys intermedius*	occurs	breeds
	Meadow Vole	*Microtus pennsylvanicus*	occurs	breeds
	Montane Vole	*Microtus montanus*	occurs	breeds
	Long-tailed Vole	*Microtus longicaudus*	occurs	breeds
	Creeping Vole	*Microtus oregoni*	occurs	breeds
	Water Vole	*Microtus richardsoni*	occurs	breeds
	Sagebrush Vole	*Lemmiscus curtatus*	occurs	breeds
	Muskrat	*Ondatra zibethicus*	occurs	breeds
	Northern Bog Lemming	*Synaptomys borealis*	occurs	breeds
	Black Rat	*Rattus rattus*	non-native	breeds
	Norway Rat	*Rattus norvegicus*	non-native	breeds
	House Mouse	*Mus musculus*	non-native	breeds
	Western Jumping Mouse	*Zapus princeps*	occurs	breeds
	Pacific Jumping Mouse	*Zapus trinotatus*	occurs	breeds
	Common Porcupine	*Erethizon dorsatum*	occurs	breeds
	Nutria	*Myocastor coypus*	non-native	breeds
	Coyote	*Canis latrans*	occurs	breeds
	Gray Wolf	*Canis lupus*	occurs	breeds
	Red Fox	*Vulpes vulpes*	occurs	breeds
	Black Bear	*Ursus americanus*	occurs	breeds
	Grizzly Bear	*Ursus arctos*	occurs	breeds
	Raccoon	*Procyon lotor*	occurs	breeds
	American Marten	*Martes americana*	occurs	breeds
	Fisher	*Martes pennanti*	occurs	breeds
	Ermine	*Mustela erminea*	occurs	breeds
	Long-tailed Weasel	*Mustela frenata*	occurs	breeds
	Mink	*Mustela vison*	occurs	breeds
	Wolverine	*Gulo gulo*	occurs	breeds
	American Badger	*Taxidea taxus*	occurs	breeds
	Striped Skunk	*Mephitis mephitis*	occurs	breeds
	Northern River Otter	*Lutra canadensis*	occurs	breeds
	Mountain Lion	*Puma concolor*	occurs	breeds

	Common Name	Scientific Name	WA Occurrence	WA Breeding Status
	Lynx	*Lynx canadensis*	occurs	breeds
	Bobcat	*Lynx rufus*	occurs	breeds
	Rocky Mountain Elk	*Cervus elaphus nelsoni*	occurs	breeds
	Mule Deer	*Odocoileus hemionus*	occurs	breeds
	White-tailed Deer	*Odocoileus virginianus*	occurs	breeds
	Moose	*Alces alces*	occurs	breeds
	Mountain Goat	*Oreamnos americanus*	occurs	breeds
	Bighorn Sheep	*Ovis canadensis*	reintroduced	breeds
	Total Mammals:	**97**		
Reptiles				
	Painted Turtle	*Chrysemys picta*	occurs	breeds
	Northern Alligator Lizard	*Elgaria coerulea*	occurs	breeds
	Southern Alligator Lizard	*Elgaria multicarinata*	occurs	breeds
	Short-horned Lizard	*Phrynosoma douglassii*	occurs	breeds
	Sagebrush Lizard	*Sceloporus graciosus*	occurs	breeds
	Western Fence Lizard	*Sceloporus occidentalis*	occurs	breeds
	Side-blotched Lizard	*Uta stansburiana*	occurs	breeds
	Western Skink	*Eumeces skiltonianus*	occurs	breeds
	Rubber Boa	*Charina bottae*	occurs	breeds
	Racer	*Coluber constrictor*	occurs	breeds
	Sharptail Snake	*Contia tenuis*	occurs	breeds
	Ringneck Snake	*Diadophis punctatus*	occurs	breeds
	Night Snake	*Hypsiglena torquata*	occurs	breeds
	Striped Whipsnake	*Masticophis taeniatus*	occurs	breeds
	Gopher Snake	*Pituophis catenifer*	occurs	breeds
	Western Terrestrial Garter Snake	*Thamnophis elegans*	occurs	breeds
	Northwestern Garter Snake	*Thamnophis ordinoides*	occurs	breeds
	Common Garter Snake	*Thamnophis sirtalis*	occurs	breeds
	Western Rattlesnake	*Crotalus viridis*	occurs	breeds
	Total Reptiles:	**19**		
	Total Species:	**367**		

Table E-2. Threatened and endangered species of the Columbia Cascade Ecoprovince, Washington (NHI 2003).

	Common Name	Scientific Name	State Status		Federal Status
Amphibians					
	Dunn's Salamander	*Plethodon dunni*	WA	Candidate Species	
	Western Toad	*Bufo boreas*	WA	Candidate Species	
	Columbia Spotted Frog	*Rana luteiventris*	WA	Candidate Species	
	Northern Leopard Frog	*Rana pipiens*	WA	Endangered	
	Total Listed Amphibians:	**4**			
Birds					
	Common Loon	*Gavia immer*	WA	Sensitive	
	Western Grebe	*Aechmophorus occidentalis*	WA	Candidate Species	
	Northern Goshawk	*Accipiter gentilis*	WA	Candidate Species	
	Ferruginous Hawk	*Buteo regalis*	WA	Threatened	
	Golden Eagle	*Aquila chrysaetos*	WA	Candidate Species	
	Sage Grouse	*Centrocercus urophasianus*	WA	Threatened	Anticipated Candidate
	Sharp-tailed Grouse	*Tympanuchus phasianellus*	WA	Threatened	
	Marbled Murrelet	*Brachyramphus marmoratus*	WA	Threatened	Threatened
	Flammulated Owl	*Otus flammeolus*	WA	Candidate Species	
	Burrowing Owl	*Athene cunicularia*	WA	Candidate Species	
	Spotted Owl	*Strix occidentalis*	WA	Endangered	Threatened
	Vaux's Swift	*Chaetura vauxi*	WA	Candidate Species	
	Lewis's Woodpecker	*Melanerpes lewis*	WA	Candidate Species	
	White-headed Woodpecker	*Picoides albolarvatus*	WA	Candidate Species	
	Black-backed Woodpecker	*Picoides arcticus*	WA	Candidate Species	
	Pileated Woodpecker	*Dryocopus pileatus*	WA	Candidate Species	
	Loggerhead Shrike	*Lanius ludovicianus*	WA	Candidate Species	
	Horned Lark	*Eremophila alpestris*	WA	Candidate Species	Candidate
	White-breasted Nuthatch	*Sitta carolinensis*	WA	Candidate Species	
	Sage Thrasher	*Oreoscoptes montanus*	WA	Candidate Species	
	Vesper Sparrow	*Pooecetes gramineus*	WA	Candidate Species	

	Common Name	Scientific Name	State Status		Federal Status
	Sage Sparrow	*Amphispiza belli*	WA	Candidate Species	
	Total Listed Birds:	**22**			
Mammals					
	Merriam's Shrew	*Sorex merriami*	WA	Candidate Species	
	Townsend's Big-eared Bat	*Corynorhinus townsendii*	WA	Candidate Species	
	Pygmy Rabbit	*Brachylagus idahoensis*	WA	Endangered	Endangered
	White-tailed Jackrabbit	*Lepus townsendii*	WA	Candidate Species	
	Black-tailed Jackrabbit	*Lepus californicus*	WA	Candidate Species	
	Washington Ground Squirrel	*Spermophilus washingtoni*	WA	Candidate Species	Anticipated Candidate
	Western Gray Squirrel	*Sciurus griseus*	WA	Threatened	
	Northern Pocket Gopher	*Thomomys talpoides*	WA	Candidate Species	
	Gray Wolf	*Canis lupus*	WA	Endangered	Endangered
	Grizzly Bear	*Ursus arctos*	WA	Endangered	Threatened
	Fisher	*Martes pennanti*	WA	Endangered	
	Wolverine	*Gulo gulo*	WA	Candidate Species	
	Lynx	*Lynx canadensis*	WA	Threatened	Threatened
	White-tailed Deer	*Odocoileus virginianus*	WA	Endangered	Endangered
	Total Listed Mammals:	**14**			
Reptiles					
	Sharptail Snake	*Contia tenuis*	WA	Candidate Species	
	Striped Whipsnake	*Masticophis taeniatus*	WA	Candidate Species	
	Total Listed Reptiles:	**2**			
Total Listed Species:		**42**			

Table E-3. Partners in Flight species of the Columbia Cascade Ecoprovince, Washington (NHI 2003).

Common Name	Scientific Name	PIF 1998-1999 Continental	PIF Ranking by Super Region Draft 2002	WA PIF Priority & Focal Species
Northern Harrier	*Circus cyaneus*			Yes
Swainson's Hawk	*Buteo swainsoni*		MO (Intermountain West, Prairies)	Yes
Ferruginous Hawk	*Buteo regalis*			Yes
Rough-legged Hawk	*Buteo lagopus*		PR (Arctic)	
American Kestrel	*Falco sparverius*			Yes
Gyrfalcon	*Falco rusticolus*		PR (Arctic)	
Sage Grouse	*Centrocercus urophasianus*		MA (Intermountain West, Prairies)	
Spruce Grouse	*Falcipennis canadensis*		PR (Northern Forests)	
White-tailed Ptarmigan	*Lagopus leucurus*		MO (Arctic)	
Blue Grouse	*Dendragapus obscurus*		MA (Pacific, Intermountain West)	
Sharp-tailed Grouse	*Tympanuchus phasianellus*		MO (Prairies)	Yes
Long-billed Curlew	*Numenius americanus*	Yes		
Stilt Sandpiper	*Calidris himantopus*	Yes		
Flammulated Owl	*Otus flammeolus*		MO (Pacific, Intermountain West, Southwest)	Yes
Snowy Owl	*Nyctea scandiaca*		PR (Arctic)	
Northern Pygmy-owl	*Glaucidium gnoma*		PR (Pacific)	
Burrowing Owl	*Athene cunicularia*			Yes
Spotted Owl	*Strix occidentalis*		IM (Pacific, Intermountain West, Southwest)	
Great Gray Owl	*Strix nebulosa*			Yes
Short-eared Owl	*Asio flammeus*	Yes	MA (Arctic, Northern Forests, Intermountain West, Prairies)	Yes
Common Poorwill	*Phalaenoptilus nuttallii*			Yes
Black Swift	*Cypseloides niger*	Yes	IM (Pacific, Intermountain West)	Yes
Vaux's Swift	*Chaetura vauxi*			Yes
White-throated Swift	*Aeronautes saxatalis*		MA (Intermountain West, Southwest)	Yes
Calliope Hummingbird	*Stellula calliope*		MO (Intermountain West)	Yes
Rufous Hummingbird	*Selasphorus rufus*	Yes	MA (Pacific, Intermountain West)	Yes
Lewis's Woodpecker	*Melanerpes lewis*	Yes	MO (Intermountain West, Prairies)	Yes

Common Name	Scientific Name	PIF 1998-1999 Continental	PIF Ranking by Super Region Draft 2002	WA PIF Priority & Focal Species
Williamson's Sapsucker	*Sphyrapicus thyroideus*		MO (Intermountain West)	Yes
Red-naped Sapsucker	*Sphyrapicus nuchalis*		MO (Intermountain West)	Yes
Red-breasted Sapsucker	*Sphyrapicus ruber*		MO (Pacific)	Yes
Downy Woodpecker	*Picoides pubescens*			Yes
White-headed Woodpecker	*Picoides albolarvatus*	Yes	PR (Pacific, Intermountain West)	Yes
Three-toed Woodpecker	*Picoides tridactylus*		PR (Northern Forests)	
Black-backed Woodpecker	*Picoides arcticus*		PR (Northern Forests)	Yes
Pileated Woodpecker	*Dryocopus pileatus*			Yes
Olive-sided Flycatcher	*Contopus cooperi*		MA (Pacific, Northern Forests, Intermountain West)	Yes
Western Wood-pewee	*Contopus sordidulus*			Yes
Willow Flycatcher	*Empidonax traillii*		MA (Prairies, East)	Yes
Hammond's Flycatcher	*Empidonax hammondii*			Yes
Gray Flycatcher	*Empidonax wrightii*		PR (Intermountain West)	Yes
Dusky Flycatcher	*Empidonax oberholseri*		MA (Intermountain West)	Yes
Pacific-slope Flycatcher	*Empidonax difficilis*		PR (Pacific)	Yes
Loggerhead Shrike	*Lanius ludovicianus*			Yes
Northern Shrike	*Lanius excubitor*		PR (Northern Forests)	
Warbling Vireo	*Vireo gilvus*			Yes
Red-eyed Vireo	*Vireo olivaceus*			Yes
Gray Jay	*Perisoreus canadensis*		PR (Northern Forests)	
Clark's Nutcracker	*Nucifraga columbiana*		PR (Intermountain West)	Yes
Horned Lark	*Eremophila alpestris*			Yes
Bank Swallow	*Riparia riparia*			Yes
Chestnut-backed Chickadee	*Poecile rufescens*		PR (Pacific)	
Boreal Chickadee	*Poecile hudsonicus*		MA (Northern Forests)	
White-breasted Nuthatch	*Sitta carolinensis*			Yes
Brown Creeper	*Certhia americana*			Yes
House Wren	*Troglodytes aedon*			Yes

Common Name	Scientific Name	PIF 1998-1999 Continental	PIF Ranking by Super Region Draft 2002	WA PIF Priority & Focal Species
Winter Wren	*Troglodytes troglodytes*			Yes
American Dipper	*Cinclus mexicanus*			Yes
Western Bluebird	*Sialia mexicana*			Yes
Mountain Bluebird	*Sialia currucoides*		PR (Intermountain West)	
Townsend's Solitaire	*Myadestes townsendi*			Yes
Veery	*Catharus fuscescens*			Yes
Swainson's Thrush	*Catharus ustulatus*			Yes
Hermit Thrush	*Catharus guttatus*			Yes
Varied Thrush	*Ixoreus naevius*			Yes
Sage Thrasher	*Oreoscoptes montanus*		PR (Intermountain West)	Yes
American Pipit	*Anthus rubescens*		PR (Arctic)	Yes
Bohemian Waxwing	*Bombycilla garrulus*		MA (Northern Forests)	
Orange-crowned Warbler	*Vermivora celata*			Yes
Nashville Warbler	*Vermivora ruficapilla*		PR (Northern Forests)	Yes
Yellow Warbler	*Dendroica petechia*			Yes
Yellow-rumped Warbler	*Dendroica coronata*			Yes
Black-throated Gray Warbler	*Dendroica nigrescens*		MO (Pacific)	Yes
Townsend's Warbler	*Dendroica townsendi*			Yes
Hermit Warbler	*Dendroica occidentalis*	Yes	MO (Pacific)	Yes
Macgillivray's Warbler	*Oporornis tolmiei*			Yes
Wilson's Warbler	*Wilsonia pusilla*			Yes
Yellow-breasted Chat	*Icteria virens*			Yes
Western Tanager	*Piranga ludoviciana*			Yes
Chipping Sparrow	*Spizella passerina*			Yes
Brewer's Sparrow	*Spizella breweri*	Yes	MA (Intermountain West)	Yes
Vesper Sparrow	*Pooecetes gramineus*			Yes
Lark Sparrow	*Chondestes grammacus*			Yes
Black-throated Sparrow	*Amphispiza bilineata*			Yes
Sage Sparrow	*Amphispiza belli*	Yes	PR (Intermountain West)	Yes
Grasshopper Sparrow	*Ammodramus savannarum*		MA (Prairies)	Yes
Fox Sparrow	*Passerella iliaca*			Yes
Lincoln's Sparrow	*Melospiza lincolnii*		PR (Northern Forests)	Yes
Lapland Longspur	*Calcarius lapponicus*		PR (Arctic)	
Snow Bunting	*Plectrophenax nivalis*		PR (Arctic)	

Common Name	Scientific Name	PIF 1998-1999 Continental	PIF Ranking by Super Region Draft 2002	WA PIF Priority & Focal Species
Black-headed Grosbeak	*Pheucticus melanocephalus*			Yes
Bobolink	*Dolichonyx oryzivorus*	Yes		
Western Meadowlark	*Sturnella neglecta*			Yes
Bullock's Oriole	*Icterus bullockii*			Yes
Pine Grosbeak	*Pinicola enucleator*		MO (Northern Forests)	
Purple Finch	*Carpodacus purpureus*			Yes
Cassin's Finch	*Carpodacus cassinii*		MA (Intermountain West)	
Red Crossbill	*Loxia curvirostra*			Yes
White-winged Crossbill	*Loxia leucoptera*		PR (Northern Forests)	
Total Species:	**98**			

Table E-4. Wildlife game species of the Columbia Cascade Ecoprovince, Washington (NHI 2003).

	Common Name	Scientific Name	WA
Amphibians			
	Bullfrog	*Rana catesbeiana*	Game Species
	Total Game Amphibians:	**1**	
Birds			
	Canada Goose	*Branta canadensis*	Game Bird
	Wood Duck	*Aix sponsa*	Game Bird
	Gadwall	*Anas strepera*	Game Bird
	American Wigeon	*Anas americana*	Game Bird
	Mallard	*Anas platyrhynchos*	Game Bird
	Blue-winged Teal	*Anas discors*	Game Bird
	Cinnamon Teal	*Anas cyanoptera*	Game Bird
	Northern Shoveler	*Anas clypeata*	Game Bird
	Northern Pintail	*Anas acuta*	Game Bird
	Green-winged Teal	*Anas crecca*	Game Bird
	Canvasback	*Aythya valisineria*	Game Bird
	Redhead	*Aythya americana*	Game Bird
	Ring-necked Duck	*Aythya collaris*	Game Bird
	Greater Scaup	*Aythya marila*	Game Bird
	Harlequin Duck	*Histrionicus histrionicus*	Game Bird
	Barrow's Goldeneye	*Bucephala islandica*	Game Bird
	Hooded Merganser	*Lophodytes cucullatus*	Game Bird
	Common Merganser	*Mergus merganser*	Game Bird
	Ruddy Duck	*Oxyura jamaicensis*	Game Bird
	Chukar	*Alectoris chukar*	Game Bird
	Gray Partridge	*Perdix perdix*	Game Bird
	Ring-necked Pheasant	*Phasianus colchicus*	Game Bird
	Ruffed Grouse	*Bonasa umbellus*	Game Bird
	Spruce Grouse	*Falcipennis canadensis*	Game Bird
	White-tailed Ptarmigan	*Lagopus leucurus*	Game Bird
	Blue Grouse	*Dendragapus obscurus*	Game Bird
	Wild Turkey	*Meleagris gallopavo*	Game Bird
	California Quail	*Callipepla californica*	Game Bird
	American Coot	*Fulica americana*	Game Bird
	Common Snipe	*Gallinago gallinago*	Game Bird
	Mourning Dove	*Zenaida macroura*	Game Bird
	Total Game Birds:	**31**	
Mammals			
	Eastern Cottontail	*Sylvilagus floridanus*	Game Mammal
	Nuttall's (Mountain) Cottontail	*Sylvilagus nuttallii*	Game Mammal
	Snowshoe Hare	*Lepus americanus*	Game Mammal
	White-tailed Jackrabbit	*Lepus townsendii*	Game Mammal
	Black-tailed Jackrabbit	*Lepus californicus*	Game Mammal
	American Beaver	*Castor canadensis*	Game Mammal
	Muskrat	*Ondatra zibethicus*	Game Mammal
	Red Fox	*Vulpes vulpes*	Game Mammal

	Common Name	Scientific Name	WA
	Black Bear	*Ursus americanus*	Game Mammal
	Raccoon	*Procyon lotor*	Game Mammal
	American Marten	*Martes americana*	Game Mammal
	Ermine	*Mustela erminea*	Game Mammal
	Long-tailed Weasel	*Mustela frenata*	Game Mammal
	Mink	*Mustela vison*	Game Mammal
	American Badger	*Taxidea taxus*	Game Mammal
	Northern River Otter	*Lutra canadensis*	Game Mammal
	Mountain Lion	*Puma concolor*	Game Mammal
	Bobcat	*Lynx rufus*	Game Mammal
	Elk	*Cervus elaphus*	Game Mammal
	Rocky Mountain Elk	*Cervus elaphus nelsoni*	Game Mammal
	Mule Deer	*Odocoileus hemionus*	Game Mammal
	Black-tailed Deer (westside)	*Odocoileus hemionus columbianus*	Game Mammal
	Moose	*Alces alces*	Game Mammal
	Mountain Goat	*Oreamnos americanus*	Game Mammal
	Bighorn Sheep	*Ovis canadensis*	Game Mammal
	Total Game Mammals:	**25**	
	Total Game Species:	**57**	

Table E-5. Wildlife species in the Columbia Cascade Ecoprovince that eat salmonids (NHI 2003).

	Common Name	Scientific Name	Relationship Type	Salmonid Stage
Amphibians				
	Pacific Giant Salamander	*Dicamptodon tenebrosus*	Recurrent	Incubation - eggs and alevin
	Pacific Giant Salamander	*Dicamptodon tenebrosus*	Recurrent	Freshwater rearing - fry, fingerling, and parr
	Total Amphibians:	**1**		
Birds				
	Common Loon	*Gavia immer*	Recurrent	Freshwater rearing - fry, fingerling, and parr
	Common Loon	*Gavia immer*	Rare	Carcasses
	Common Loon	*Gavia immer*	Recurrent	Saltwater - smolts, immature adults, and adults
	Pied-billed Grebe	*Podilymbus podiceps*	Recurrent	Freshwater rearing - fry, fingerling, and parr
	Red-necked Grebe	*Podiceps grisegena*	Rare	Carcasses
	Red-necked Grebe	*Podiceps grisegena*	Rare	Saltwater - smolts, immature adults, and adults
	Western Grebe	*Aechmophorus occidentalis*	Rare	Carcasses
	Western Grebe	*Aechmophorus occidentalis*	Recurrent	Freshwater rearing - fry, fingerling, and parr
	Western Grebe	*Aechmophorus occidentalis*	Recurrent	Saltwater - smolts, immature adults, and adults
	Clark's Grebe	*Aechmophorus clarkii*	Recurrent	Saltwater - smolts, immature adults, and adults
	Double-crested Cormorant	*Phalacrocorax auritus*	Recurrent	Freshwater rearing - fry, fingerling, and parr
	Double-crested Cormorant	*Phalacrocorax auritus*	Recurrent	Saltwater - smolts, immature adults, and adults
	Great Blue Heron	*Ardea herodias*	Recurrent	Freshwater rearing - fry, fingerling, and parr
	Great Blue Heron	*Ardea herodias*	Recurrent	Saltwater - smolts, immature adults, and adults
	Great Egret	*Ardea alba*	Rare	Freshwater rearing - fry, fingerling, and parr
	Great Egret	*Ardea alba*	Rare	Saltwater - smolts, immature adults, and

	Common Name	Scientific Name	Relationship Type	Salmonid Stage
				adults
	Black-crowned Night-heron	*Nycticorax nycticorax*	Recurrent	Freshwater rearing - fry, fingerling, and parr
	Black-crowned Night-heron	*Nycticorax nycticorax*	Recurrent	Saltwater - smolts, immature adults, and adults
	Turkey Vulture	*Cathartes aura*	Recurrent	Carcasses
	Mallard	*Anas platyrhynchos*	Rare	Incubation - eggs and alevin
	Mallard	*Anas platyrhynchos*	Rare	Carcasses
	Green-winged Teal	*Anas crecca*	Rare	Incubation - eggs and alevin
	Canvasback	*Aythya valisineria*	Rare	Carcasses
	Greater Scaup	*Aythya marila*	Rare	Incubation - eggs and alevin
	Greater Scaup	*Aythya marila*	Rare	Carcasses
	Harlequin Duck	*Histrionicus histrionicus*	Strong, consistent	Saltwater - smolts, immature adults, and adults
	Harlequin Duck	*Histrionicus histrionicus*	Strong, consistent	Incubation - eggs and alevin
	Harlequin Duck	*Histrionicus histrionicus*	Indirect	Carcasses
	Barrow's Goldeneye	*Bucephala islandica*	Recurrent	Carcasses
	Barrow's Goldeneye	*Bucephala islandica*	Recurrent	Incubation - eggs and alevin
	Barrow's Goldeneye	*Bucephala islandica*	Rare	Saltwater - smolts, immature adults, and adults
	Barrow's Goldeneye	*Bucephala islandica*	Recurrent	Freshwater rearing - fry, fingerling, and parr
	Hooded Merganser	*Lophodytes cucullatus*	Rare	Freshwater rearing - fry, fingerling, and parr
	Hooded Merganser	*Lophodytes cucullatus*	Rare	Carcasses
	Hooded Merganser	*Lophodytes cucullatus*	Rare	Incubation - eggs and alevin
	Common Merganser	*Mergus merganser*	Recurrent	Carcasses
	Common Merganser	*Mergus merganser*	Strong, consistent	Incubation - eggs and alevin
	Common Merganser	*Mergus merganser*	Strong, consistent	Freshwater rearing - fry, fingerling, and parr
	Common Merganser	*Mergus merganser*	Strong, consistent	Saltwater - smolts, immature adults, and adults

	Common Name	Scientific Name	Relationship Type	Salmonid Stage
	Osprey	*Pandion haliaetus*	Strong, consistent	Freshwater rearing - fry, fingerling, and parr
	Osprey	*Pandion haliaetus*	Strong, consistent	Spawning - freshwater
	Osprey	*Pandion haliaetus*	Strong, consistent	Saltwater - smolts, immature adults, and adults
	Red-tailed Hawk	*Buteo jamaicensis*	Rare	Carcasses
	Golden Eagle	*Aquila chrysaetos*	Recurrent	Spawning - freshwater
	Golden Eagle	*Aquila chrysaetos*	Recurrent	Carcasses
	Gyrfalcon	*Falco rusticolus*	Indirect	Freshwater rearing - fry, fingerling, and parr
	Gyrfalcon	*Falco rusticolus*	Indirect	Carcasses
	Gyrfalcon	*Falco rusticolus*	Indirect	Saltwater - smolts, immature adults, and adults
	Killdeer	*Charadrius vociferus*	Indirect	Carcasses
	Greater Yellowlegs	*Tringa melanoleuca*	Rare	Incubation - eggs and alevin
	Spotted Sandpiper	*Actitis macularia*	Indirect	Carcasses
	Ring-billed Gull	*Larus delawarensis*	Recurrent	Carcasses
	Ring-billed Gull	*Larus delawarensis*	Recurrent	Saltwater - smolts, immature adults, and adults
	Ring-billed Gull	*Larus delawarensis*	Recurrent	Freshwater rearing - fry, fingerling, and parr
	California Gull	*Larus californicus*	Recurrent	Carcasses
	California Gull	*Larus californicus*	Recurrent	Saltwater - smolts, immature adults, and adults
	Herring Gull	*Larus argentatus*	Recurrent	Freshwater rearing - fry, fingerling, and parr
	Herring Gull	*Larus argentatus*	Recurrent	Saltwater - smolts, immature adults, and adults
	Herring Gull	*Larus argentatus*	Recurrent	Carcasses
	Thayer's Gull	*Larus thayeri*	Recurrent	Saltwater - smolts, immature adults, and adults
	Glaucous Gull	*Larus hyperboreus*	Recurrent	Saltwater - smolts, immature adults, and adults
	Glaucous Gull	*Larus hyperboreus*	Recurrent	Carcasses
	Caspian Tern	*Sterna caspia*	Strong, consistent	Freshwater rearing - fry, fingerling, and parr

	Common Name	Scientific Name	Relationship Type	Salmonid Stage
	Caspian Tern	*Sterna caspia*	Strong, consistent	Saltwater - smolts, immature adults, and adults
	Forster's Tern	*Sterna forsteri*	Recurrent	Saltwater - smolts, immature adults, and adults
	Forster's Tern	*Sterna forsteri*	Recurrent	Freshwater rearing - fry, fingerling, and parr
	Marbled Murrelet	*Brachyramphus marmoratus*	Recurrent	Freshwater rearing - fry, fingerling, and parr
	Marbled Murrelet	*Brachyramphus marmoratus*	Recurrent	Saltwater - smolts, immature adults, and adults
	Snowy Owl	*Nyctea scandiaca*	Indirect	Freshwater rearing - fry, fingerling, and parr
	Belted Kingfisher	*Ceryle alcyon*	Recurrent	Spawning - freshwater
	Belted Kingfisher	*Ceryle alcyon*	Recurrent	Freshwater rearing - fry, fingerling, and parr
	Belted Kingfisher	*Ceryle alcyon*	Recurrent	Saltwater - smolts, immature adults, and adults
	Willow Flycatcher	*Empidonax traillii*	Indirect	Carcasses
	Gray Jay	*Perisoreus canadensis*	Rare	Carcasses
	Steller's Jay	*Cyanocitta stelleri*	Recurrent	Carcasses
	Black-billed Magpie	*Pica pica*	Recurrent	Freshwater rearing - fry, fingerling, and parr
	Black-billed Magpie	*Pica pica*	Recurrent	Carcasses
	American Crow	*Corvus brachyrhynchos*	Recurrent	Carcasses
	American Crow	*Corvus brachyrhynchos*	Recurrent	Freshwater rearing - fry, fingerling, and parr
	Northwestern Crow	*Corvus caurinus*	Recurrent	Saltwater - smolts, immature adults, and adults
	Northwestern Crow	*Corvus caurinus*	Recurrent	Carcasses
	Northwestern Crow	*Corvus caurinus*	Recurrent	Freshwater rearing - fry, fingerling, and parr
	Common Raven	*Corvus corax*	Recurrent	Carcasses
	Common Raven	*Corvus corax*	Recurrent	Freshwater rearing - fry, fingerling, and parr
	Common Raven	*Corvus corax*	Recurrent	Spawning - freshwater

	Common Name	Scientific Name	Relationship Type	Salmonid Stage
	Tree Swallow	*Tachycineta bicolor*	Indirect	Carcasses
	Violet-green Swallow	*Tachycineta thalassina*	Indirect	Carcasses
	Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	Indirect	Carcasses
	Bank Swallow	*Riparia riparia*	Indirect	Carcasses
	Cliff Swallow	*Petrochelidon pyrrhonota*	Indirect	Carcasses
	Barn Swallow	*Hirundo rustica*	Indirect	Carcasses
	Winter Wren	*Troglodytes troglodytes*	Rare	Carcasses
	American Dipper	*Cinclus mexicanus*	Recurrent	Incubation - eggs and alevin
	American Dipper	*Cinclus mexicanus*	Recurrent	Freshwater rearing - fry, fingerling, and parr
	American Dipper	*Cinclus mexicanus*	Recurrent	Carcasses
	American Dipper	*Cinclus mexicanus*	Indirect	Carcasses
	American Robin	*Turdus migratorius*	Rare	Incubation - eggs and alevin
	Varied Thrush	*Ixoreus naevius*	Rare	Incubation - eggs and alevin
	Varied Thrush	*Ixoreus naevius*	Rare	Carcasses
	Spotted Towhee	*Pipilo maculatus*	Rare	Carcasses
	Song Sparrow	*Melospiza melodia*	Rare	Carcasses
	Total Birds:	**54**		
Mammals				
	Virginia Opossum	*Didelphis virginiana*	Recurrent	Carcasses
	Masked Shrew	*Sorex cinereus*	Rare	Carcasses
	Masked Shrew	*Sorex cinereus*	Indirect	Carcasses
	Vagrant Shrew	*Sorex vagrans*	Indirect	Carcasses
	Vagrant Shrew	*Sorex vagrans*	Rare	Carcasses
	Montane Shrew	*Sorex monticolus*	Rare	Carcasses
	Montane Shrew	*Sorex monticolus*	Indirect	Carcasses
	Water Shrew	*Sorex palustris*	Recurrent	Carcasses
	Water Shrew	*Sorex palustris*	Recurrent	Incubation - eggs and alevin
	Water Shrew	*Sorex palustris*	Recurrent	Freshwater rearing - fry, fingerling, and parr
	Water Shrew	*Sorex palustris*	Indirect	Carcasses
	Pacific Water Shrew	*Sorex bendirii*	Indirect	Carcasses
	Pacific Water Shrew	*Sorex bendirii*	Rare	Carcasses
	Trowbridge's Shrew	*Sorex trowbridgii*	Indirect	Carcasses
	Trowbridge's Shrew	*Sorex trowbridgii*	Rare	Carcasses
	Douglas' Squirrel	*Tamiasciurus douglasii*	Rare	Carcasses
	Northern Flying Squirrel	*Glaucomys sabrinus*	Rare	Carcasses

	Common Name	Scientific Name	Relationship Type	Salmonid Stage
	Deer Mouse	*Peromyscus maniculatus*	Rare	Carcasses
	Coyote	*Canis latrans*	Recurrent	Carcasses
	Gray Wolf	*Canis lupus*	Recurrent	Spawning - freshwater
	Gray Wolf	*Canis lupus*	Recurrent	Carcasses
	Red Fox	*Vulpes vulpes*	Rare	Carcasses
	Black Bear	*Ursus americanus*	Strong, consistent	Carcasses
	Black Bear	*Ursus americanus*	Strong, consistent	Spawning - freshwater
	Grizzly Bear	*Ursus arctos*	Strong, consistent	Spawning - freshwater
	Grizzly Bear	*Ursus arctos*	Strong, consistent	Carcasses
	Raccoon	*Procyon lotor*	Recurrent	Carcasses
	Raccoon	*Procyon lotor*	Recurrent	Freshwater rearing - fry, fingerling, and parr
	American Marten	*Martes americana*	Rare	Carcasses
	Fisher	*Martes pennanti*	Rare	Carcasses
	Long-tailed Weasel	*Mustela frenata*	Rare	Carcasses
	Mink	*Mustela vison*	Recurrent	Spawning - freshwater
	Mink	*Mustela vison*	Recurrent	Freshwater rearing - fry, fingerling, and parr
	Mink	*Mustela vison*	Recurrent	Carcasses
	Wolverine	*Gulo gulo*	Rare	Carcasses
	Striped Skunk	*Mephitis mephitis*	Rare	Carcasses
	Northern River Otter	*Lutra canadensis*	Strong, consistent	Carcasses
	Northern River Otter	*Lutra canadensis*	Strong, consistent	Freshwater rearing - fry, fingerling, and parr
	Northern River Otter	*Lutra canadensis*	Strong, consistent	Spawning - freshwater
	Mountain Lion	*Puma concolor*	Rare	Spawning - freshwater
	Bobcat	*Lynx rufus*	Recurrent	Spawning - freshwater
	Bobcat	*Lynx rufus*	Recurrent	Carcasses
	Total Mammals:	**25**		
Reptiles				
	Western Terrestrial Garter Snake	*Thamnophis elegans*	Rare	Freshwater rearing - fry, fingerling, and parr
	Common Garter Snake	*Thamnophis sirtalis*	Rare	Freshwater rearing - fry, fingerling, and parr
	Total Reptiles:	**2**		

	Common Name	Scientific Name	Relationship Type	Salmonid Stage
	Total Species:	**82**		

Table E-6. Wildlife species occurrence in ponderosa pine habitat in the Columbia Cascade Ecoprovince, Washington (NHI 2003).

Entiat	Lake Chelan	Wenatchee	Methow	Okanogan	Columbia Upper Middle	Crab
American Badger	American Badger	American Badger	American Badger	American Badger	American Badger	American Badger
American Beaver	American Beaver	American Beaver	American Beaver	American Beaver	American Beaver	American Beaver
American Crow	American Crow	American Crow	American Crow	American Crow	American Crow	American Crow
American Goldfinch	American Goldfinch	American Goldfinch	American Goldfinch	American Goldfinch	American Goldfinch	American Goldfinch
American Kestrel	American Kestrel	American Kestrel	American Kestrel	American Kestrel	American Kestrel	American Kestrel
American Marten	American Marten	American Marten	American Marten	American Marten	American Marten	American Robin
American Robin	American Robin	American Robin	American Robin	American Robin	American Robin	Bank Swallow
Bank Swallow	Bank Swallow	Bank Swallow	Bank Swallow	Bank Swallow	Bank Swallow	Barn Swallow
Barn Swallow	Barn Swallow	Barn Swallow	Barn Swallow	Barn Swallow	Barn Swallow	Barred Owl
Barred Owl	Barred Owl	Barred Owl	Barred Owl	Barred Owl	Barred Owl	Big Brown Bat
Big Brown Bat	Big Brown Bat	Big Brown Bat	Big Brown Bat	Big Brown Bat	Big Brown Bat	Black Bear
Black Bear	Black Bear	Black Bear	Black Bear	Black Bear	Black Bear	Black-backed Woodpecker
Black Swift	Black Swift	Black Swift	Black Swift	Black Swift	Black Swift	Black-billed Magpie
Black-backed Woodpecker	Black-backed Woodpecker	Black-backed Woodpecker	Black-backed Woodpecker	Black-backed Woodpecker	Black-backed Woodpecker	Black-capped Chickadee
Black-billed Magpie	Black-billed Magpie	Black-billed Magpie	Black-billed Magpie	Black-billed Magpie	Black-billed Magpie	Black-chinned Hummingbird
Black-capped Chickadee	Black-capped Chickadee	Black-capped Chickadee	Black-capped Chickadee	Black-capped Chickadee	Black-capped Chickadee	Black-headed Grosbeak
Black-chinned Hummingbird	Black-chinned Hummingbird	Black-chinned Hummingbird	Black-chinned Hummingbird	Black-chinned Hummingbird	Black-chinned Hummingbird	Blue Grouse
Black-headed Grosbeak	Black-headed Grosbeak	Black-headed Grosbeak	Black-headed Grosbeak	Black-headed Grosbeak	Black-headed Grosbeak	Bobcat
Black-throated Gray Warbler	Black-throated Gray Warbler	Black-throated Gray Warbler	Black-throated Gray Warbler	Blue Grouse	Black-tailed Deer	Brewer's Blackbird
Blue Grouse	Blue Grouse	Blue Grouse	Blue Grouse	Bobcat	Black-throated Gray Warbler	Brewer's Sparrow
Bobcat	Bobcat	Bobcat	Bobcat	Brewer's Blackbird	Blue Grouse	Brown Creeper

Entiat	Lake Chelan	Wenatchee	Methow	Okanogan	Columbia Upper Middle	Crab
Brewer's Blackbird	Brewer's Blackbird	Brewer's Blackbird	Brewer's Blackbird	Brewer's Sparrow	Bobcat	Brown-headed Cowbird
Brewer's Sparrow	Brewer's Sparrow	Brewer's Sparrow	Brewer's Sparrow	Brown Creeper	Brewer's Blackbird	Bullfrog
Brown Creeper	Brown Creeper	Brown Creeper	Brown Creeper	Brown-headed Cowbird	Brewer's Sparrow	Bushy-tailed Woodrat
Brown-headed Cowbird	Brown-headed Cowbird	Brown-headed Cowbird	Brown-headed Cowbird	Bullfrog	Brown Creeper	California Ground Squirrel
Bullfrog	Bullfrog	Bullfrog	Bullfrog	Bushy-tailed Woodrat	Brown-headed Cowbird	California Myotis
Bushy-tailed Woodrat	Bushy-tailed Woodrat	Bushy-tailed Woodrat	Bushy-tailed Woodrat	California Myotis	Bullfrog	California Quail
California Myotis	California Myotis	California Ground Squirrel	California Myotis	California Quail	Bushy-tailed Woodrat	Calliope Hummingbird
California Quail	California Quail	California Myotis	California Quail	Calliope Hummingbird	California Ground Squirrel	Canyon Wren
Calliope Hummingbird	Calliope Hummingbird	California Quail	Calliope Hummingbird	Canyon Wren	California Myotis	Cassin's Finch
Canyon Wren	Canyon Wren	Calliope Hummingbird	Canyon Wren	Cascade Golden-mantled Ground Squirrel	California Quail	Cassin's Vireo
Cascade Golden-mantled Ground Squirrel	Cascade Golden-mantled Ground Squirrel	Canyon Wren	Cascade Golden-mantled Ground Squirrel	Cassin's Finch	Calliope Hummingbir d	Cedar Waxwing
Cassin's Finch	Cassin's Finch	Cascade Golden-mantled Ground Squirrel	Cassin's Finch	Cassin's Vireo	Canyon Wren	Chipping Sparrow
Cassin's Vireo	Cassin's Vireo	Cassin's Finch	Cassin's Vireo	Cedar Waxwing	Cascade Golden-mantled Ground Squirrel	Clark's Nutcracker
Cedar Waxwing	Cedar Waxwing	Cassin's Vireo	Cedar Waxwing	Chipping Sparrow	Cassin's Finch	Cliff Swallow
Chipping Sparrow	Chipping Sparrow	Cedar Waxwing	Chipping Sparrow	Clark's Nutcracker	Cassin's Vireo	Coast Mole
Clark's Nutcracker	Clark's Nutcracker	Chipping Sparrow	Clark's Nutcracker	Cliff Swallow	Cedar Waxwing	Columbia Spotted Frog
Cliff Swallow	Cliff Swallow	Clark's Nutcracker	Cliff Swallow	Coast Mole	Chipping Sparrow	Columbian Ground Squirrel
Coast Mole	Coast Mole	Cliff Swallow	Coast Mole	Columbia Spotted Frog	Clark's Nutcracker	Common Garter Snake

Entiat	Lake Chelan	Wenatchee	Methow	Okanogan	Columbia Upper Middle	Crab
Columbia Spotted Frog	Columbia Spotted Frog	Coast Mole	Columbia Spotted Frog	Columbian Ground Squirrel	Cliff Swallow	Common Nighthawk
Columbian Ground Squirrel	Columbian Ground Squirrel	Columbia Spotted Frog	Columbian Ground Squirrel	Common Garter Snake	Coast Mole	Common Poorwill
Common Garter Snake	Common Garter Snake	Columbian Ground Squirrel	Common Garter Snake	Common Nighthawk	Columbia Spotted Frog	Common Porcupine
Common Nighthawk	Common Nighthawk	Common Garter Snake	Common Nighthawk	Common Poorwill	Columbian Ground Squirrel	Common Raven
Common Poorwill	Common Poorwill	Common Nighthawk	Common Poorwill	Common Porcupine	Common Garter Snake	Cooper's Hawk
Common Porcupine	Common Porcupine	Common Poorwill	Common Porcupine	Common Raven	Common Nighthawk	Coyote
Common Raven	Common Raven	Common Porcupine	Common Raven	Cooper's Hawk	Common Poorwill	Dark-eyed Junco
Cooper's Hawk	Cooper's Hawk	Common Raven	Cooper's Hawk	Coyote	Common Porcupine	Deer Mouse
Coyote	Coyote	Cooper's Hawk	Coyote	Dark-eyed Junco	Common Raven	Douglas' Squirrel
Dark-eyed Junco	Dark-eyed Junco	Coyote	Dark-eyed Junco	Deer Mouse	Cooper's Hawk	Downy Woodpecker
Deer Mouse	Deer Mouse	Dark-eyed Junco	Deer Mouse	Downy Woodpecker	Coyote	Dusky Flycatcher
Douglas' Squirrel	Douglas' Squirrel	Deer Mouse	Douglas' Squirrel	Dusky Flycatcher	Dark-eyed Junco	Eastern Kingbird
Downy Woodpecker	Downy Woodpecker	Douglas' Squirrel	Downy Woodpecker	Eastern Kingbird	Deer Mouse	Ermine
Dusky Flycatcher	Dusky Flycatcher	Downy Woodpecker	Dusky Flycatcher	Ermine	Douglas' Squirrel	European Starling
Eastern Kingbird	Eastern Kingbird	Dusky Flycatcher	Eastern Kingbird	European Starling	Downy Woodpecker	Evening Grosbeak
Ermine	Ermine	Eastern Kingbird	Ermine	Evening Grosbeak	Dusky Flycatcher	Flammulated Owl
European Starling	European Starling	Ensatina	European Starling	Fisher	Eastern Kingbird	Fox Sparrow
Evening Grosbeak	Evening Grosbeak	Ermine	Evening Grosbeak	Flammulated Owl	Ensatina	Fringed Myotis
Fisher	Fisher	European Starling	Fisher	Fox Sparrow	Ermine	Golden Eagle
Flammulated Owl	Flammulated Owl	Evening Grosbeak	Flammulated Owl	Fringed Myotis	European Starling	Golden-crowned Kinglet
Fox Sparrow	Fox Sparrow	Fisher	Fox Sparrow	Golden Eagle	Evening Grosbeak	Golden-mantled Ground Squirrel
Fringed Myotis	Fringed Myotis	Flammulated Owl	Fringed Myotis	Golden-crowned Kinglet	Fisher	Gopher Snake
Golden Eagle	Golden Eagle	Fox Sparrow	Golden Eagle	Golden-	Flammulate	Gray

Entiat	Lake Chelan	Wenatchee	Methow	Okanogan	Columbia Upper Middle	Crab
				mantled Ground Squirrel	d Owl	Flycatcher
Golden-crowned Kinglet	Golden-crowned Kinglet	Fringed Myotis	Golden-crowned Kinglet	Gopher Snake	Fox Sparrow	Gray Jay
Gopher Snake	Golden-mantled Ground Squirrel	Golden Eagle	Golden-mantled Ground Squirrel	Gray Flycatcher	Fringed Myotis	Great Basin Spadefoot
Gray Flycatcher	Gopher Snake	Golden-crowned Kinglet	Gopher Snake	Gray Jay	Golden Eagle	Great Horned Owl
Gray Jay	Gray Flycatcher	Gopher Snake	Gray Flycatcher	Gray Wolf	Golden-crowned Kinglet	Hairy Woodpecker
Gray Wolf	Gray Jay	Gray Flycatcher	Gray Jay	Great Basin Spadefoot	Golden-mantled Ground Squirrel	Hammond's Flycatcher
Great Basin Spadefoot	Gray Wolf	Gray Jay	Gray Wolf	Great Gray Owl	Gopher Snake	Hermit Thrush
Great Horned Owl	Great Basin Spadefoot	Gray Wolf	Great Basin Spadefoot	Great Horned Owl	Gray Flycatcher	Hoary Bat
Grizzly Bear	Great Gray Owl	Great Basin Spadefoot	Great Gray Owl	Grizzly Bear	Gray Jay	House Finch
Hairy Woodpecker	Great Horned Owl	Great Horned Owl	Great Horned Owl	Hairy Woodpecker	Gray Wolf	House Wren
Hammond's Flycatcher	Grizzly Bear	Grizzly Bear	Grizzly Bear	Hammond's Flycatcher	Great Basin Spadefoot	Killdeer
Hermit Thrush	Hairy Woodpecker	Hairy Woodpecker	Hairy Woodpecker	Hermit Thrush	Great Gray Owl	Lark Sparrow
Hoary Bat	Hammond's Flycatcher	Hammond's Flycatcher	Hammond's Flycatcher	Hoary Bat	Great Horned Owl	Lazuli Bunting
House Finch	Hermit Thrush	Hermit Thrush	Hermit Thrush	House Finch	Grizzly Bear	Least Chipmunk
House Wren	Hoary Bat	Hoary Bat	Hoary Bat	House Wren	Hairy Woodpecker	Lewis's Woodpecker
Killdeer	House Finch	House Finch	House Finch	Killdeer	Hammond's Flycatcher	Little Brown Myotis
Lark Sparrow	House Wren	House Wren	House Wren	Lark Sparrow	Hermit Thrush	Long-eared Myotis
Lazuli Bunting	Killdeer	Killdeer	Killdeer	Lazuli Bunting	Hoary Bat	Long-eared Owl
Least Chipmunk	Lark Sparrow	Lark Sparrow	Lark Sparrow	Least Chipmunk	House Finch	Long-legged Myotis
Lewis's Woodpecker	Lazuli Bunting	Lazuli Bunting	Lazuli Bunting	Lewis's Woodpecker	House Wren	Long-tailed Vole
Little Brown Myotis	Least Chipmunk	Least Chipmunk	Least Chipmunk	Little Brown Myotis	Killdeer	Long-tailed Weasel
Long-eared Myotis	Lewis's Woodpecker	Lewis's Woodpecker	Lewis's Woodpecker	Long-eared Myotis	Lark Sparrow	Long-toed Salamander
Long-eared Owl	Little Brown Myotis	Little Brown Myotis	Little Brown Myotis	Long-eared Owl	Lazuli Bunting	Macgillivray's Warbler

Entiat	Lake Chelan	Wenatchee	Methow	Okanogan	Columbia Upper Middle	Crab
Long-legged Myotis	Long-eared Myotis	Long-eared Myotis	Long-eared Myotis	Long-legged Myotis	Least Chipmunk	Masked Shrew
Long-tailed Vole	Long-eared Owl	Long-eared Owl	Long-eared Owl	Long-tailed Vole	Lewis's Woodpecker	Mink
Long-tailed Weasel	Long-legged Myotis	Long-legged Myotis	Long-legged Myotis	Long-tailed Weasel	Little Brown Myotis	Montane Vole
Long-toed Salamander	Long-tailed Vole	Long-tailed Vole	Long-tailed Vole	Long-toed Salamander	Long-eared Myotis	Mountain Bluebird
Macgillivray's Warbler	Long-tailed Weasel	Long-tailed Weasel	Long-tailed Weasel	Macgillivray's Warbler	Long-eared Owl	Mountain Chickadee
Masked Shrew	Long-toed Salamander	Long-toed Salamander	Long-toed Salamander	Masked Shrew	Long-legged Myotis	Mountain Lion
Mink	Macgillivray's Warbler	Macgillivray's Warbler	Macgillivray's Warbler	Mink	Long-tailed Vole	Mourning Dove
Montane Vole	Masked Shrew	Masked Shrew	Masked Shrew	Montane Vole	Long-tailed Weasel	Mule Deer
Mountain Bluebird	Mink	Mink	Mink	Mountain Bluebird	Long-toed Salamander	Nashville Warbler
Mountain Chickadee	Montane Vole	Montane Vole	Montane Vole	Mountain Chickadee	Macgillivray's Warbler	Night Snake
Mountain Lion	Mountain Bluebird	Mountain Bluebird	Mountain Bluebird	Mountain Lion	Masked Shrew	Northern Alligator Lizard
Mourning Dove	Mountain Chickadee	Mountain Chickadee	Mountain Chickadee	Mourning Dove	Mink	Northern Flicker
Mule Deer	Mountain Lion	Mountain Lion	Mountain Lion	Mule Deer	Montane Vole	Northern Flying Squirrel
Nashville Warbler	Mourning Dove	Mourning Dove	Mourning Dove	Nashville Warbler	Mountain Bluebird	Northern Goshawk
Night Snake	Mule Deer	Mule Deer	Mule Deer	Night Snake	Mountain Chickadee	Northern Pocket Gopher
Northern Alligator Lizard	Nashville Warbler	Nashville Warbler	Nashville Warbler	Northern Alligator Lizard	Mountain Lion	Northern Pygmy-owl
Northern Flicker	Night Snake	Night Snake	Night Snake	Northern Flicker	Mourning Dove	Northern Rough-winged Swallow
Northern Flying Squirrel	Northern Alligator Lizard	Northern Alligator Lizard	Northern Alligator Lizard	Northern Flying Squirrel	Nashville Warbler	Northern Saw-whet Owl
Northern Goshawk	Northern Flicker	Northern Flicker	Northern Flicker	Northern Goshawk	Night Snake	Olive-sided Flycatcher
Northern Pocket Gopher	Northern Flying Squirrel	Northern Flying Squirrel	Northern Flying Squirrel	Northern Pocket Gopher	Northern Alligator Lizard	Orange-crowned Warbler
Northern Pygmy-owl	Northern Goshawk	Northern Goshawk	Northern Goshawk	Northern Pygmy-owl	Northern Flicker	Osprey
Northern Rough-winged Swallow	Northern Pocket Gopher	Northern Pocket Gopher	Northern Pocket Gopher	Northern Rough-winged Swallow	Northern Flying Squirrel	Pacific Chorus (Tree) Frog

Entiat	Lake Chelan	Wenatchee	Methow	Okanogan	Columbia Upper Middle	Crab
Northern Saw-whet Owl	Northern Pygmy-owl	Northern Pygmy-owl	Northern Pygmy-owl	Northern Saw-whet Owl	Northern Goshawk	Painted Turtle
Olive-sided Flycatcher	Northern Rough-winged Swallow	Northern Rough-winged Swallow	Northern Rough-winged Swallow	Olive-sided Flycatcher	Northern Pocket Gopher	Pallid Bat
Orange-crowned Warbler	Northern Saw-whet Owl	Northern Saw-whet Owl	Northern Saw-whet Owl	Orange-crowned Warbler	Northern Pygmy-owl	Pileated Woodpecker
Osprey	Olive-sided Flycatcher	Northwestern Garter Snake	Olive-sided Flycatcher	Osprey	Northern Rough-winged Swallow	Pine Siskin
Pacific Chorus (Tree) Frog	Orange-crowned Warbler	Olive-sided Flycatcher	Orange-crowned Warbler	Pacific Chorus (Tree) Frog	Northern Saw-whet Owl	Prairie Falcon
Pacific Jumping Mouse	Osprey	Orange-crowned Warbler	Osprey	Pacific Jumping Mouse	Northwestern Garter Snake	Pygmy Nuthatch
Painted Turtle	Pacific Chorus (Tree) Frog	Osprey	Pacific Chorus (Tree) Frog	Painted Turtle	Olive-sided Flycatcher	Pygmy Shrew
Pallid Bat	Pacific Jumping Mouse	Pacific Chorus (Tree) Frog	Pacific Jumping Mouse	Pallid Bat	Orange-crowned Warbler	Racer
Pileated Woodpecker	Painted Turtle	Pacific Jumping Mouse	Painted Turtle	Pileated Woodpecker	Osprey	Red Crossbill
Pine Siskin	Pallid Bat	Painted Turtle	Pallid Bat	Pine Siskin	Pacific Chorus (Tree) Frog	Red fox
Prairie Falcon	Pileated Woodpecker	Pallid Bat	Pileated Woodpecker	Prairie Falcon	Pacific Jumping Mouse	Red Squirrel
Pygmy Nuthatch	Pine Siskin	Pileated Woodpecker	Pine Siskin	Pygmy Nuthatch	Painted Turtle	Red-breasted Nuthatch
Racer	Prairie Falcon	Pine Siskin	Prairie Falcon	Racer	Pallid Bat	Red-naped Sapsucker
Red Crossbill	Pygmy Nuthatch	Prairie Falcon	Pygmy Nuthatch	Red Crossbill	Pileated Woodpecker	Red-tailed Hawk
Red Fox	Racer	Purple Finch	Racer	Red Fox	Pine Siskin	Ringneck Snake
Red Squirrel	Red Crossbill	Pygmy Nuthatch	Red Crossbill	Red Squirrel	Prairie Falcon	Ring-necked Pheasant
Red-breasted Nuthatch	Red Fox	Racer	Red Fox	Red-breasted Nuthatch	Purple Finch	Rock Wren
Red-breasted Sapsucker	Red Squirrel	Red Crossbill	Red Squirrel	Red-breasted Sapsucker	Pygmy Nuthatch	Rocky Mountain Elk
Red-naped Sapsucker	Red-breasted Nuthatch	Red Fox	Red-breasted Nuthatch	Red-naped Sapsucker	Racer	Rough-legged Hawk
Red-tailed Hawk	Red-breasted Sapsucker	Red Squirrel	Red-breasted Sapsucker	Red-tailed Hawk	Red Crossbill	Rubber Boa

Entiat	Lake Chelan	Wenatchee	Methow	Okanogan	Columbia Upper Middle	Crab
Ring-necked Pheasant	Red-naped Sapsucker	Red-breasted Nuthatch	Red-naped Sapsucker	Ring-necked Pheasant	Red Fox	Ruby-crowned Kinglet
Rock Wren	Red-tailed Hawk	Red-breasted Sapsucker	Red-tailed Hawk	Rock Wren	Red Squirrel	Ruffed Grouse
Rocky Mountain Elk	Ring-necked Pheasant	Red-naped Sapsucker	Ring-necked Pheasant	Rocky Mountain Elk	Red-breasted Nuthatch	Rufous Hummingbird
Rough-legged Hawk	Rock Wren	Red-tailed Hawk	Rock Wren	Rough-legged Hawk	Red-breasted Sapsucker	Sagebrush Lizard
Rough-skinned Newt	Rocky Mountain Elk	Ringneck Snake	Rocky Mountain Elk	Rubber Boa	Red-naped Sapsucker	Say's Phoebe
Rubber Boa	Rough-legged Hawk	Ring-necked Pheasant	Rough-legged Hawk	Ruby-crowned Kinglet	Red-tailed Hawk	Sharp-shinned Hawk
Ruby-crowned Kinglet	Rough-skinned Newt	Rock Wren	Rough-skinned Newt	Ruffed Grouse	Ringneck Snake	Sharptail Snake
Ruffed Grouse	Rubber Boa	Rocky Mountain Elk	Rubber Boa	Rufous Hummingbird	Ring-necked Pheasant	Short-horned Lizard
Rufous Hummingbird	Ruby-crowned Kinglet	Rough-legged Hawk	Ruby-crowned Kinglet	Sagebrush Lizard	Rock Wren	Silver-haired Bat
Sagebrush Lizard	Ruffed Grouse	Rough-skinned Newt	Ruffed Grouse	Say's Phoebe	Rough-legged Hawk	Snowshoe Hare
Say's Phoebe	Rufous Hummingbird	Rubber Boa	Rufous Hummingbird	Sharp-shinned Hawk	Rough-skinned Newt	Song Sparrow
Sharp-shinned Hawk	Sagebrush Lizard	Ruby-crowned Kinglet	Sagebrush Lizard	Short-horned Lizard	Rubber Boa	Spotted Bat
Sharptail Snake	Say's Phoebe	Ruffed Grouse	Say's Phoebe	Silver-haired Bat	Ruby-crowned Kinglet	Spotted Towhee
Short-horned Lizard	Sharp-shinned Hawk	Rufous Hummingbird	Sharp-shinned Hawk	Snowshoe Hare	Ruffed Grouse	Steller's Jay
Silver-haired Bat	Sharptail Snake	Sagebrush Lizard	Sharptail Snake	Song Sparrow	Rufous Hummingbir d	Striped Skunk
Snowshoe Hare	Short-horned Lizard	Say's Phoebe	Short-horned Lizard	Spotted Bat	Sagebrush Lizard	Striped Whipsnake
Song Sparrow	Silver-haired Bat	Sharp-shinned Hawk	Silver-haired Bat	Spotted Owl	Say's Phoebe	Tiger Salamander
Spotted Bat	Snowshoe Hare	Sharptail Snake	Snowshoe Hare	Spotted Towhee	Sharp-shinned Hawk	Townsend's Big-eared Bat
Spotted Owl	Song Sparrow	Short-horned Lizard	Song Sparrow	Steller's Jay	Sharptail Snake	Townsend's Solitaire
Spotted Towhee	Spotted Bat	Silver-haired Bat	Spotted Bat	Striped Skunk	Short-horned	Townsend's Warbler

Entiat	Lake Chelan	Wenatchee	Methow	Okanogan	Columbia Upper Middle	Crab
					Lizard	
Steller's Jay	Spotted Owl	Snowshoe Hare	Spotted Owl	Tailed Frog	Silver-haired Bat	Tree Swallow
Striped Skunk	Spotted Towhee	Song Sparrow	Spotted Towhee	Three-toed Woodpecker	Snowshoe Hare	Turkey Vulture
Striped Whipsnake	Steller's Jay	Southern Alligator Lizard	Steller's Jay	Tiger Salamander	Song Sparrow	Vagrant Shrew
Tailed Frog	Striped Skunk	Spotted Bat	Striped Skunk	Townsend's Big-eared Bat	Southern Alligator Lizard	Varied Thrush
Three-toed Woodpecker	Striped Whipsnake	Spotted Owl	Striped Whipsnake	Townsend's Solitaire	Spotted Bat	Vaux's Swift
Tiger Salamander	Tailed Frog	Spotted Towhee	Tailed Frog	Townsend's Warbler	Spotted Owl	Violet-green Swallow
Townsend's Big-eared Bat	Three-toed Woodpecker	Steller's Jay	Three-toed Woodpecker	Tree Swallow	Spotted Towhee	Warbling Vireo
Townsend's Solitaire	Tiger Salamander	Striped Skunk	Tiger Salamander	Trowbridge's Shrew	Steller's Jay	Western Bluebird
Townsend's Warbler	Townsend's Big-eared Bat	Striped Whipsnake	Townsend's Big-eared Bat	Turkey Vulture	Striped Skunk	Western Jumping Mouse
Tree Swallow	Townsend's Solitaire	Tailed Frog	Townsend's Solitaire	Vagrant Shrew	Striped Whipsnake	Western Kingbird
Trowbridge's Shrew	Townsend's Warbler	Three-toed Woodpecker	Townsend's Warbler	Varied Thrush	Tailed Frog	Western Pipistrelle
Turkey Vulture	Tree Swallow	Tiger Salamander	Tree Swallow	Vaux's Swift	Three-toed Woodpecker	Western Rattlesnake
Vagrant Shrew	Trowbridge's Shrew	Townsend's Big-eared Bat	Trowbridge's Shrew	Violet-green Swallow	Tiger Salamander	Western Screech-owl
Varied Thrush	Turkey Vulture	Townsend's Solitaire	Turkey Vulture	Warbling Vireo	Townsend's Big-eared Bat	Western Skink
Vaux's Swift	Vagrant Shrew	Townsend's Warbler	Vagrant Shrew	Western Bluebird	Townsend's Solitaire	Western Small-footed Myotis
Violet-green Swallow	Varied Thrush	Tree Swallow	Varied Thrush	Western Fence Lizard	Townsend's Warbler	Western Tanager
Warbling Vireo	Vaux's Swift	Trowbridge's Shrew	Vaux's Swift	Western Gray Squirrel	Tree Swallow	Western Terrestrial Garter Snake
Western Bluebird	Violet-green Swallow	Turkey Vulture	Violet-green Swallow	Western Jumping Mouse	Trowbridge's Shrew	Western Toad
Western Fence Lizard	Warbling Vireo	Vagrant Shrew	Warbling Vireo	Western Kingbird	Turkey Vulture	Western Wood-pewee
Western Gray Squirrel	Western Bluebird	Varied Thrush	Western Bluebird	Western Pipistrelle	Vagrant Shrew	White-breasted Nuthatch
Western Jumping Mouse	Western Fence Lizard	Vaux's Swift	Western Fence Lizard	Western Rattlesnake	Varied Thrush	White-headed Woodpecker
Western	Western Gray	Violet-green	Western	Western	Vaux's Swift	White-

Entiat	Lake Chelan	Wenatchee	Methow	Okanogan	Columbia Upper Middle	Crab
Kingbird	Squirrel	Swallow	Gray Squirrel	Screech-owl		throated Swift
Western Pipistrelle	Western Jumping Mouse	Warbling Vireo	Western Jumping Mouse	Western Skink	Violet-green Swallow	Wild Turkey
Western Rattlesnake	Western Kingbird	Western Bluebird	Western Kingbird	Western Small-footed Myotis	Warbling Vireo	Willow Flycatcher
Western Screech-owl	Western Pipistrelle	Western Fence Lizard	Western Pipistrelle	Western Tanager	Western Bluebird	Wilson's Warbler
Western Skink	Western Rattlesnake	Western Gray Squirrel	Western Rattlesnake	Western Terrestrial Garter Snake	Western Fence Lizard	Yellow-bellied Marmot
Western Small-footed Myotis	Western Screech-owl	Western Jumping Mouse	Western Screech-owl	Western Toad	Western Gray Squirrel	Yellow-pine Chipmunk
Western Tanager	Western Skink	Western Kingbird	Western Skink	Western Wood-pewee	Western Jumping Mouse	Yellow-rumped Warbler
Western Terrestrial Garter Snake	Western Small-footed Myotis	Western Pipistrelle	Western Small-footed Myotis	White-breasted Nuthatch	Western Kingbird	Yuma Myotis
Western Toad	Western Tanager	Western Rattlesnake	Western Tanager	White-crowned Sparrow	Western Pipistrelle	
Western Wood-pewee	Western Terrestrial Garter Snake	Western Screech-owl	Western Terrestrial Garter Snake	White-headed Woodpecker	Western Rattlesnake	
White-breasted Nuthatch	Western Toad	Western Skink	Western Toad	White-throated Swift	Western Screech-owl	
White-crowned Sparrow	Western Wood-pewee	Western Small-footed Myotis	Western Wood-pewee	Wild Turkey	Western Skink	
White-headed Woodpecker	White-breasted Nuthatch	Western Tanager	White-breasted Nuthatch	Williamson's Sapsucker	Western Small-footed Myotis	
White-throated Swift	White-crowned Sparrow	Western Terrestrial Garter Snake	White-crowned Sparrow	Willow Flycatcher	Western Tanager	
Wild Turkey	White-headed Woodpecker	Western Toad	White-headed Woodpecker	Wilson's Warbler	Western Terrestrial Garter Snake	
Williamson's Sapsucker	White-throated Swift	Western Wood-pewee	White-throated Swift	Yellow-bellied Marmot	Western Toad	
Willow Flycatcher	Wild Turkey	White-breasted Nuthatch	Wild Turkey	Yellow-pine Chipmunk	Western Wood-pewee	
Wilson's Warbler	Williamson's Sapsucker	White-crowned Sparrow	Williamson's Sapsucker	Yellow-rumped Warbler	White-breasted Nuthatch	
Yellow-bellied Marmot	Willow Flycatcher	White-headed	Willow Flycatcher	Yuma Myotis	White-crowned	

Entiat	Lake Chelan	Wenatchee	Methow	Okanogan	Columbia Upper Middle	Crab
		Woodpecker			Sparrow	
Yellow-pine Chipmunk	Wilson's Warbler	White-throated Swift	Wilson's Warbler		White-headed Woodpecker	
Yellow-rumped Warbler	Yellow-bellied Marmot	Wild Turkey	Yellow-bellied Marmot		White-throated Swift	
Yuma Myotis	Yellow-pine Chipmunk	Williamson's Sapsucker	Yellow-pine Chipmunk		Wild Turkey	
	Yellow-rumped Warbler	Willow Flycatcher	Yellow-rumped Warbler		Williamson's Sapsucker	
	Yuma Myotis	Wilson's Warbler	Yuma Myotis		Willow Flycatcher	
		Yellow-bellied Marmot			Wilson's Warbler	
		Yellow-pine Chipmunk			Yellow-bellied Marmot	
		Yellow-rumped Warbler			Yellow-pine Chipmunk	
		Yuma Myotis			Yellow-rumped Warbler	
					Yuma Myotis	

Table E-7. Wildlife species occurrence in shrubsteppe habitat in the Columbia Cascade Ecoprovince, Washington (NHI 2003).

Entiat	Lake Chelan	Wenatchee	Methow	Okanogan	Columbia Upper Middle	Crab
American Avocet	American Avocet	American Crow	American Avocet	American Avocet	American Avocet	American Avocet
American Badger	American Badger	American Goldfinch	American Badger	American Badger	American Badger	American Badger
American Crow	American Crow	American Kestrel	American Crow	American Crow	American Crow	American Crow
American Goldfinch	American Goldfinch	American Robin	American Goldfinch	American Goldfinch	American Goldfinch	American Goldfinch
American Kestrel	American Kestrel	Bank Swallow	American Kestrel	American Kestrel	American Kestrel	American Kestrel
American Robin	American Robin	Barn Owl	American Robin	American Robin	American Robin	American Robin
Bank Swallow	Bank Swallow	Barn Swallow	Bank Swallow	Bank Swallow	Bank Swallow	Bank Swallow
Barn Owl	Barn Owl	Barrow's Goldeneye	Barn Owl	Barn Owl	Barn Owl	Barn Owl
Barn Swallow	Barn Swallow	Big Brown Bat	Barn Swallow	Barn Swallow	Barn Swallow	Barn Swallow
Barrow's Goldeneye	Barrow's Goldeneye	Black Bear	Barrow's Goldeneye	Barrow's Goldeneye	Barrow's Goldeneye	Barrow's Goldeneye
Big Brown Bat	Big Brown Bat	Black-billed Magpie	Big Brown Bat	Big Brown Bat	Big Brown Bat	Big Brown Bat
Black Bear	Black Bear	Black-chinned Hummingbird	Black Bear	Black Bear	Black Bear	Black Bear
Black-billed Magpie	Black-billed Magpie	Black-tailed Jackrabbit	Black-billed Magpie	Black-billed Magpie	Black-billed Magpie	Black-billed Magpie
Black-chinned Hummingbird	Black-chinned Hummingbird	Black-throated Sparrow	Black-chinned Hummingbird	Black-chinned Hummingbird	Black-chinned Hummingbird	Black-chinned Hummingbird
Black-tailed Jackrabbit	Black-tailed Jackrabbit	Blue Grouse	Black-tailed Jackrabbit	Black-tailed Jackrabbit	Black-necked Stilt	Black-necked Stilt
Black-throated Sparrow	Black-throated Sparrow	Bobcat	Black-throated Sparrow	Blue Grouse	Black-tailed Jackrabbit	Black-tailed Jackrabbit
Blue Grouse	Blue Grouse	Brewer's Blackbird	Blue Grouse	Bobcat	Black-throated Sparrow	Black-throated Sparrow
Bobcat	Bobcat	Brewer's Sparrow	Bobcat	Brewer's Blackbird	Blue Grouse	Blue Grouse
Brewer's Blackbird	Brewer's Blackbird	Brown-headed Cowbird	Brewer's Blackbird	Brewer's Sparrow	Bobcat	Bobcat
Brewer's Sparrow	Brewer's Sparrow	Bullfrog	Brewer's Sparrow	Brown-headed Cowbird	Brewer's Blackbird	Brewer's Blackbird
Brown-headed Cowbird	Brown-headed Cowbird	Burrowing Owl	Brown-headed Cowbird	Bullfrog	Brewer's Sparrow	Brewer's Sparrow
Bullfrog	Bullfrog	Bushy-tailed Woodrat	Bullfrog	Burrowing Owl	Brown-headed	Brown-headed

Entiat	Lake Chelan	Wenatchee	Methow	Okanogan	Columbia Upper Middle	Crab
					Cowbird	Cowbird
Burrowing Owl	Burrowing Owl	California Myotis	Burrowing Owl	Bushy-tailed Woodrat	Bullfrog	Bullfrog
Bushy-tailed Woodrat	Bushy-tailed Woodrat	California Quail	Bushy-tailed Woodrat	California Myotis	Burrowing Owl	Burrowing Owl
California Myotis	California Myotis	Canada Goose	California Myotis	California Quail	Bushy-tailed Woodrat	Bushy-tailed Woodrat
California Quail	California Quail	Canyon Wren	California Quail	Canada Goose	California Myotis	California Myotis
Canada Goose	Canada Goose	Chipping Sparrow	Canada Goose	Canyon Wren	California Quail	California Quail
Canyon Wren	Canyon Wren	Chukar	Canyon Wren	Chipping Sparrow	Canada Goose	Canada Goose
Chipping Sparrow	Chipping Sparrow	Cliff Swallow	Chipping Sparrow	Chukar	Canyon Wren	Canyon Wren
Chukar	Chukar	Columbia Spotted Frog	Chukar	Cliff Swallow	Chipping Sparrow	Chipping Sparrow
Cliff Swallow	Cliff Swallow	Columbian Ground Squirrel	Cliff Swallow	Columbia Spotted Frog	Chukar	Chukar
Columbia Spotted Frog	Columbia Spotted Frog	Common Garter Snake	Columbia Spotted Frog	Columbian Ground Squirrel	Cliff Swallow	Cliff Swallow
Columbian Ground Squirrel	Columbian Ground Squirrel	Common Nighthawk	Columbian Ground Squirrel	Common Garter Snake	Columbia Spotted Frog	Columbia Spotted Frog
Common Garter Snake	Common Garter Snake	Common Poorwill	Common Garter Snake	Common Nighthawk	Columbian Ground Squirrel	Columbian Ground Squirrel
Common Nighthawk	Common Nighthawk	Common Porcupine	Common Nighthawk	Common Poorwill	Common Garter Snake	Common Garter Snake
Common Poorwill	Common Poorwill	Common Raven	Common Poorwill	Common Porcupine	Common Nighthawk	Common Nighthawk
Common Porcupine	Common Porcupine	Cooper's Hawk	Common Porcupine	Common Raven	Common Poorwill	Common Poorwill
Common Raven	Common Raven	Coyote	Common Raven	Cooper's Hawk	Common Porcupine	Common Porcupine
Cooper's Hawk	Cooper's Hawk	Deer Mouse	Cooper's Hawk	Coyote	Common Raven	Common Raven
Coyote	Coyote	Eastern Kingbird	Coyote	Deer Mouse	Cooper's Hawk	Cooper's Hawk
Deer Mouse	Deer Mouse	European Starling	Deer Mouse	Eastern Kingbird	Coyote	Coyote
Eastern Kingbird	Eastern Kingbird	Ferruginous Hawk	Eastern Kingbird	European Starling	Deer Mouse	Deer Mouse
European Starling	European Starling	Fringed Myotis	European Starling	Fringed Myotis	Eastern Kingbird	Eastern Kingbird
Ferruginous Hawk	Fringed Myotis	Golden Eagle	Fringed Myotis	Golden Eagle	European Starling	European Starling
Fringed Myotis	Golden Eagle	Gopher Snake	Golden Eagle	Golden-mantled Ground Squirrel	Ferruginous Hawk	Ferruginous Hawk

Entiat	Lake Chelan	Wenatchee	Methow	Okanogan	Columbia Upper Middle	Crab
Golden Eagle	Golden-mantled Ground Squirrel	Grasshopper Sparrow	Golden-mantled Ground Squirrel	Gopher Snake	Fringed Myotis	Fringed Myotis
Gopher Snake	Gopher Snake	Gray Flycatcher	Gopher Snake	Grasshopper Sparrow	Golden Eagle	Golden Eagle
Grasshopper Sparrow	Grasshopper Sparrow	Gray Partridge	Grasshopper Sparrow	Gray Flycatcher	Golden-mantled Ground Squirrel	Golden-mantled Ground Squirrel
Gray Flycatcher	Gray Flycatcher	Great Basin Pocket Mouse	Gray Flycatcher	Gray Partridge	Gopher Snake	Gopher Snake
Gray Partridge	Gray Partridge	Great Basin Spadefoot	Gray Partridge	Great Basin Pocket Mouse	Grasshopper Sparrow	Grasshoppe r Sparrow
Great Basin Pocket Mouse	Great Basin Pocket Mouse	Great Horned Owl	Great Basin Pocket Mouse	Great Basin Spadefoot	Gray Flycatcher	Gray Flycatcher
Great Basin Spadefoot	Great Basin Spadefoot	Greater Yellowlegs	Great Basin Spadefoot	Great Horned Owl	Gray Partridge	Gray Partridge
Great Horned Owl	Great Horned Owl	Hoary Bat	Great Horned Owl	Greater Yellowlegs	Great Basin Pocket Mouse	Great Basin Pocket Mouse
Greater Yellowlegs	Greater Yellowlegs	Horned Lark	Greater Yellowlegs	Hoary Bat	Great Basin Spadefoot	Great Basin Spadefoot
Hoary Bat	Hoary Bat	Killdeer	Hoary Bat	Horned Lark	Great Horned Owl	Great Horned Owl
Horned Lark	Horned Lark	Lark Sparrow	Horned Lark	Killdeer	Greater Yellowlegs	Greater Yellowlegs
Killdeer	Killdeer	Least Chipmunk	Killdeer	Lark Sparrow	Hoary Bat	Hoary Bat
Lark Sparrow	Lark Sparrow	Lesser Yellowlegs	Lark Sparrow	Least Chipmunk	Horned Lark	Horned Lark
Least Chipmunk	Least Chipmunk	Little Brown Myotis	Least Chipmunk	Lesser Yellowlegs	Killdeer	Killdeer
Lesser Yellowlegs	Lesser Yellowlegs	Loggerhead Shrike	Lesser Yellowlegs	Little Brown Myotis	Lark Sparrow	Lark Sparrow
Little Brown Myotis	Little Brown Myotis	Long-billed Curlew	Little Brown Myotis	Loggerhead Shrike	Least Chipmunk	Least Chipmunk
Loggerhead Shrike	Loggerhead Shrike	Long-eared Myotis	Loggerhead Shrike	Long-billed Curlew	Lesser Yellowlegs	Lesser Yellowlegs
Long-billed Curlew	Long-billed Curlew	Long-eared Owl	Long-billed Curlew	Long-eared Myotis	Little Brown Myotis	Little Brown Myotis
Long-eared Myotis	Long-eared Myotis	Long-legged Myotis	Long-eared Myotis	Long-eared Owl	Loggerhead Shrike	Loggerhead Shrike
Long-eared Owl	Long-eared Owl	Long-tailed Vole	Long-eared Owl	Long-legged Myotis	Long-billed Curlew	Long-billed Curlew
Long-legged Myotis	Long-legged Myotis	Long-tailed Weasel	Long-legged Myotis	Long-tailed Vole	Long-eared Myotis	Long-eared Myotis
Long-tailed Vole	Long-tailed Vole	Long-toed Salamander	Long-tailed Vole	Long-tailed Weasel	Long-eared Owl	Long-eared Owl
Long-tailed Weasel	Long-tailed Weasel	Mallard	Long-tailed Weasel	Long-toed Salamander	Long-legged Myotis	Long-legged Myotis

Entiat	Lake Chelan	Wenatchee	Methow	Okanogan	Columbia Upper Middle	Crab
Long-toed Salamander	Long-toed Salamander	Merriam's Shrew	Long-toed Salamander	Mallard	Long-tailed Vole	Long-tailed Vole
Mallard	Mallard	Mink	Mallard	Merriam's Shrew	Long-tailed Weasel	Long-tailed Weasel
Merriam's Shrew	Merriam's Shrew	Montane Vole	Merriam's Shrew	Mink	Long-toed Salamander	Long-toed Salamander
Mink	Mink	Mountain Bluebird	Mink	Montane Vole	Mallard	Mallard
Montane Vole	Montane Vole	Mourning Dove	Montane Vole	Mountain Bluebird	Merriam's Shrew	Merriam's Shrew
Mountain Bluebird	Mountain Bluebird	Mule Deer	Mountain Bluebird	Mourning Dove	Mink	Mink
Mourning Dove	Mourning Dove	Nashville Warbler	Mourning Dove	Mule Deer	Montane Vole	Montane Vole
Mule Deer	Mule Deer	Night Snake	Mule Deer	Nashville Warbler	Mountain Bluebird	Mountain Bluebird
Nashville Warbler	Nashville Warbler	Northern Flicker	Nashville Warbler	Night Snake	Mourning Dove	Mourning Dove
Night Snake	Night Snake	Northern Goshawk	Night Snake	Northern Flicker	Nashville Warbler	Mule Deer
Northern Flicker	Northern Flicker	Northern Grasshopper Mouse	Northern Flicker	Northern Goshawk	Night Snake	Nashville Warbler
Northern Goshawk	Northern Goshawk	Northern Harrier	Northern Goshawk	Northern Grasshopper Mouse	Northern Flicker	Night Snake
Northern Grasshopper Mouse	Northern Grasshopper Mouse	Northern Pocket Gopher	Northern Grasshopper Mouse	Northern Harrier	Northern Goshawk	Northern Flicker
Northern Harrier	Northern Harrier	Northern Rough-winged Swallow	Northern Harrier	Northern Pocket Gopher	Northern Grasshopper Mouse	Northern Goshawk
Northern Pocket Gopher	Northern Pocket Gopher	Northern Shrike	Northern Pocket Gopher	Northern Rough-winged Swallow	Northern Harrier	Northern Grasshoppe r Mouse
Northern Rough-winged Swallow	Northern Rough-winged Swallow	Nuttall's (Mountain) Cottontail	Northern Rough-winged Swallow	Northern Shrike	Northern Leopard Frog	Northern Harrier
Northern Shrike	Northern Shrike	Orange-crowned Warbler	Northern Shrike	Nuttall's (Mountain) Cottontail	Northern Pocket Gopher	Northern Leopard Frog
Nuttall's (Mountain) Cottontail	Nuttall's (Mountain) Cottontail	Osprey	Nuttall's (Mountain) Cottontail	Orange-crowned Warbler	Northern Rough-winged Swallow	Northern Pocket Gopher
Orange-crowned Warbler	Orange-crowned Warbler	Pacific Chorus (Tree) Frog	Orange-crowned Warbler	Osprey	Northern Shrike	Northern Rough-winged Swallow
Osprey	Osprey	Painted Turtle	Osprey	Pacific Chorus	Nuttall's (Mountain)	Northern Shrike

Entiat	Lake Chelan	Wenatchee	Methow	Okanogan	Columbia Upper Middle	Crab
				(Tree) Frog	Cottontail	
Pacific Chorus (Tree) Frog	Pacific Chorus (Tree) Frog	Pallid Bat	Pacific Chorus (Tree) Frog	Painted Turtle	Orange-crowned Warbler	Nuttall's (Mountain) Cottontail
Painted Turtle	Painted Turtle	Prairie Falcon	Painted Turtle	Pallid Bat	Osprey	Orange-crowned Warbler
Pallid Bat	Pallid Bat	Racer	Pallid Bat	Prairie Falcon	Pacific Chorus (Tree) Frog	Osprey
Prairie Falcon	Prairie Falcon	Red-tailed Hawk	Prairie Falcon	Racer	Painted Turtle	Pacific Chorus (Tree) Frog
Pygmy Rabbit	Racer	Ringneck Snake	Racer	Red-tailed Hawk	Pallid Bat	Painted Turtle
Racer	Red-tailed Hawk	Ring-necked Pheasant	Red-tailed Hawk	Ring-necked Pheasant	Prairie Falcon	Pallid Bat
Red-tailed Hawk	Ring-necked Pheasant	Rock Dove	Ring-necked Pheasant	Rock Dove	Pygmy Rabbit	Prairie Falcon
Ring-necked Pheasant	Rock Dove	Rock Wren	Rock Dove	Rock Wren	Racer	Pygmy Rabbit
Rock Dove	Rock Wren	Rocky Mountain Elk	Rock Wren	Rocky Mountain Elk	Red-tailed Hawk	Racer
Rock Wren	Rocky Mountain Elk	Rough-legged Hawk	Rocky Mountain Elk	Rough-legged Hawk	Ringneck Snake	Red-tailed Hawk
Rocky Mountain Elk	Rough-legged Hawk	Rough-skinned Newt	Rough-legged Hawk	Rubber Boa	Ring-necked Pheasant	Ringneck Snake
Rough-legged Hawk	Rough-skinned Newt	Rubber Boa	Rough-skinned Newt	Sage Sparrow	Rock Dove	Ring-necked Pheasant
Rough-skinned Newt	Rubber Boa	Sage Grouse	Rubber Boa	Sage Thrasher	Rock Wren	Rock Dove
Rubber Boa	Sage Sparrow	Sage Sparrow	Sage Sparrow	Sagebrush Lizard	Rough-legged Hawk	Rock Wren
Sage Grouse	Sage Thrasher	Sage Thrasher	Sage Thrasher	Sagebrush Vole	Rough-skinned Newt	Rocky Mountain Elk
Sage Sparrow	Sagebrush Lizard	Sagebrush Lizard	Sagebrush Lizard	Savannah Sparrow	Rubber Boa	Rough-legged Hawk
Sage Thrasher	Sagebrush Vole	Sagebrush Vole	Sagebrush Vole	Say's Phoebe	Sage Grouse	Rubber Boa
Sagebrush Lizard	Savannah Sparrow	Savannah Sparrow	Savannah Sparrow	Sharp-shinned Hawk	Sage Sparrow	Sage Grouse
Sagebrush Vole	Say's Phoebe	Say's Phoebe	Say's Phoebe	Sharp-tailed Grouse	Sage Thrasher	Sage Sparrow
Savannah Sparrow	Sharp-shinned Hawk	Sharp-shinned Hawk	Sharp-shinned Hawk	Short-eared Owl	Sagebrush Lizard	Sage Thrasher
Say's	Sharp-tailed	Short-eared	Sharp-tailed	Short-horned	Sagebrush	Sagebrush

Entiat	Lake Chelan	Wenatchee	Methow	Okanogan	Columbia Upper Middle	Crab
Phoebe	Grouse	Owl	Grouse	Lizard	Vole	Lizard
Sharp-shinned Hawk	Short-eared Owl	Short-horned Lizard	Short-eared Owl	Snow Bunting	Savannah Sparrow	Sagebrush Vole
Sharp-tailed Grouse	Short-horned Lizard	Side-blotched Lizard	Short-horned Lizard	Solitary Sandpiper	Say's Phoebe	Savannah Sparrow
Short-eared Owl	Side-blotched Lizard	Snow Bunting	Side-blotched Lizard	Spotted Bat	Sharp-shinned Hawk	Say's Phoebe
Short-horned Lizard	Snow Bunting	Solitary Sandpiper	Snow Bunting	Spotted Sandpiper	Sharp-tailed Grouse	Sharp-shinned Hawk
Side-blotched Lizard	Solitary Sandpiper	Spotted Bat	Solitary Sandpiper	Swainson's Hawk	Short-eared Owl	Sharp-tailed Grouse
Snow Bunting	Spotted Bat	Spotted Sandpiper	Spotted Bat	Tiger Salamander	Short-horned Lizard	Short-eared Owl
Solitary Sandpiper	Spotted Sandpiper	Striped Whipsnake	Spotted Sandpiper	Townsend's Big-eared Bat	Side-blotched Lizard	Short-horned Lizard
Spotted Bat	Striped Whipsnake	Swainson's Hawk	Striped Whipsnake	Townsend's Solitaire	Snow Bunting	Side-blotched Lizard
Spotted Sandpiper	Swainson's Hawk	Tiger Salamander	Swainson's Hawk	Turkey Vulture	Solitary Sandpiper	Snow Bunting
Striped Whipsnake	Tiger Salamander	Townsend's Big-eared Bat	Tiger Salamander	Vagrant Shrew	Spotted Bat	Solitary Sandpiper
Swainson's Hawk	Townsend's Big-eared Bat	Townsend's Ground Squirrel	Townsend's Big-eared Bat	Vesper Sparrow	Spotted Sandpiper	Spotted Bat
Tiger Salamander	Townsend's Solitaire	Townsend's Solitaire	Townsend's Solitaire	Western Fence Lizard	Striped Whipsnake	Spotted Sandpiper
Townsend's Big-eared Bat	Turkey Vulture	Turkey Vulture	Turkey Vulture	Western Harvest Mouse	Swainson's Hawk	Striped Whipsnake
Townsend's Solitaire	Vagrant Shrew	Vagrant Shrew	Vagrant Shrew	Western Kingbird	Tiger Salamander	Swainson's Hawk
Turkey Vulture	Vesper Sparrow	Vesper Sparrow	Vesper Sparrow	Western Meadowlark	Townsend's Big-eared Bat	Tiger Salamander
Vagrant Shrew	Washington Ground Squirrel	Washington Ground Squirrel	Washington Ground Squirrel	Western Pipistrelle	Townsend's Ground Squirrel	Townsend's Big-eared Bat
Vesper Sparrow	Western Fence Lizard	Western Fence Lizard	Western Fence Lizard	Western Rattlesnake	Townsend's Solitaire	Townsend's Ground Squirrel
Washington Ground Squirrel	Western Harvest Mouse	Western Harvest Mouse	Western Harvest Mouse	Western Skink	Turkey Vulture	Townsend's Solitaire
Western Fence Lizard	Western Kingbird	Western Kingbird	Western Kingbird	Western Small-footed Myotis	Vagrant Shrew	Turkey Vulture

Entiat	Lake Chelan	Wenatchee	Methow	Okanogan	Columbia Upper Middle	Crab
Western Harvest Mouse	Western Meadowlark	Western Meadowlark	Western Meadowlark	Western Terrestrial Garter Snake	Vesper Sparrow	Vagrant Shrew
Western Kingbird	Western Pipistrelle	Western Pipistrelle	Western Pipistrelle	Western Toad	Washington Ground Squirrel	Vesper Sparrow
Western Meadowlark	Western Rattlesnake	Western Rattlesnake	Western Rattlesnake	White-crowned Sparrow	Western Fence Lizard	Washington Ground Squirrel
Western Pipistrelle	Western Skink	Western Skink	Western Skink	White-tailed Jackrabbit	Western Harvest Mouse	Western Harvest Mouse
Western Rattlesnake	Western Small-footed Myotis	Western Small-footed Myotis	Western Small-footed Myotis	White-throated Swift	Western Kingbird	Western Kingbird
Western Skink	Western Terrestrial Garter Snake	Western Terrestrial Garter Snake	Western Terrestrial Garter Snake	Yellow-bellied Marmot	Western Meadowlark	Western Meadowlark
Western Small-footed Myotis	Western Toad	Western Toad	Western Toad	Yuma Myotis	Western Pipistrelle	Western Pipistrelle
Western Terrestrial Garter Snake	White-crowned Sparrow	White-crowned Sparrow	White-crowned Sparrow		Western Rattlesnake	Western Rattlesnake
Western Toad	White-tailed Jackrabbit	White-tailed Jackrabbit	White-tailed Jackrabbit		Western Skink	Western Skink
White-crowned Sparrow	White-throated Swift	White-throated Swift	White-throated Swift		Western Small-footed Myotis	Western Small-footed Myotis
White-tailed Jackrabbit	Yellow-bellied Marmot	Woodhouse's Toad	Yellow-bellied Marmot		Western Terrestrial Garter Snake	Western Terrestrial Garter Snake
White-throated Swift	Yuma Myotis	Yellow-bellied Marmot	Yuma Myotis		Western Toad	Western Toad
Yellow-bellied Marmot		Yuma Myotis			White-crowned Sparrow	White-tailed Jackrabbit
Yuma Myotis					White-tailed Jackrabbit	White-throated Swift
					White-throated Swift	Woodhouse's Toad
					Woodhouse's Toad	Yellow-bellied Marmot
					Yellow-bellied Marmot	Yuma Myotis

Entiat	Lake Chelan	Wenatchee	Methow	Okanogan	Columbia Upper Middle	Crab
					Yuma Myotis	

Table E-8. Wildlife species occurrence in riparian wetland habitat in the Columbia Cascade Ecoprovince, Washington (NHI 2003).

Entiat	Lake Chelan	Wenatchee	Methow	Okanogan	Columbia Upper Middle	Crab
American Badger	American Badger	American Badger	American Badger	American Badger	American Badger	American Badger
American Beaver	American Beaver	American Beaver	American Beaver	American Beaver	American Beaver	American Beaver
American Crow	American Crow	American Crow	American Crow	American Crow	American Crow	American Crow
American Dipper	American Dipper	American Dipper	American Dipper	American Dipper	American Dipper	American Dipper
American Goldfinch	American Goldfinch	American Goldfinch	American Goldfinch	American Goldfinch	American Goldfinch	American Goldfinch
American Kestrel	American Kestrel	American Kestrel	American Kestrel	American Kestrel	American Kestrel	American Kestrel
American Marten	American Marten	American Marten	American Marten	American Marten	American Marten	American Redstart
American Robin	American Redstart	American Robin	American Redstart	American Redstart	American Redstart	American Robin
American Tree Sparrow	American Robin	American Tree Sparrow	American Robin	American Robin	American Robin	American Tree Sparrow
American Wigeon	American Tree Sparrow	Bank Swallow	American Tree Sparrow	American Tree Sparrow	American Tree Sparrow	American Wigeon
Bank Swallow	American Wigeon	Barn Owl	American Wigeon	American Wigeon	American Wigeon	Bank Swallow
Barn Owl	Bank Swallow	Barn Swallow	Bank Swallow	Bank Swallow	Bank Swallow	Barn Owl
Barn Swallow	Barn Owl	Barred Owl	Barn Owl	Barn Owl	Barn Owl	Barn Swallow
Barred Owl	Barn Swallow	Belted Kingfisher	Barn Swallow	Barn Swallow	Barn Swallow	Barred Owl
Belted Kingfisher	Barred Owl	Big Brown Bat	Barred Owl	Barred Owl	Barred Owl	Belted Kingfisher
Big Brown Bat	Belted Kingfisher	Black Bear	Belted Kingfisher	Belted Kingfisher	Belted Kingfisher	Big Brown Bat
Black Bear	Big Brown Bat	Black Swift	Big Brown Bat	Big Brown Bat	Big Brown Bat	Black Bear
Black Swift	Black Bear	Black-backed Woodpecker	Black Bear	Black Bear	Black Bear	Black-backed Woodpecker
Black-backed Woodpecker	Black Swift	Black-billed Magpie	Black Swift	Black Swift	Black Swift	Black-billed Magpie
Black-billed Magpie	Black-backed Woodpecker	Black-capped Chickadee	Black-backed Woodpecker	Black-backed Woodpecker	Black-backed Woodpecker	Black-capped Chickadee
Black-capped Chickadee	Black-billed Magpie	Black-chinned Hummingbird	Black-billed Magpie	Black-billed Magpie	Black-billed Magpie	Black-chinned Hummingbird
Black-chinned Hummingbird	Black-capped Chickadee	Black-crowned Night-heron	Black-capped Chickadee	Black-capped Chickadee	Black-capped Chickadee	Black-crowned Night-heron
Black-crowned	Black-chinned	Black-headed	Black-chinned	Black-chinned	Black-chinned	Black-headed

Entiat	Lake Chelan	Wenatchee	Methow	Okanogan	Columbia Upper Middle	Crab
Night-heron	Hummingbird	Grosbeak	Hummingbird	Hummingbird	Hummingbir d	Grosbeak
Black-headed Grosbeak	Black-crowned Night-heron	Black-throated Gray Warbler	Black-crowned Night-heron	Black-crowned Night-heron	Black-crowned Night-heron	Blue Grouse
Black-throated Gray Warbler	Black-headed Grosbeak	Blue Grouse	Black-headed Grosbeak	Black-headed Grosbeak	Black-headed Grosbeak	Bobcat
Blue Grouse	Black-throated Gray Warbler	Bobcat	Black-throated Gray Warbler	Blue Grouse	Black-tailed Deer	Bobolink
Bobcat	Blue Grouse	Bohemian Waxwing	Blue Grouse	Bobcat	Black-throated Gray Warbler	Bohemian Waxwing
Bohemian Waxwing	Bobcat	Brewer's Blackbird	Bobcat	Bobolink	Blue Grouse	Brewer's Blackbird
Brewer's Blackbird	Bobolink	Brown Creeper	Bobolink	Bohemian Waxwing	Bobcat	Brown Creeper
Brown Creeper	Bohemian Waxwing	Brown-headed Cowbird	Bohemian Waxwing	Brewer's Blackbird	Bobolink	Brown-headed Cowbird
Brown-headed Cowbird	Brewer's Blackbird	Bullfrog	Brewer's Blackbird	Brown Creeper	Bohemian Waxwing	Bullfrog
Bullfrog	Brown Creeper	Bullock's Oriole	Brown Creeper	Brown-headed Cowbird	Brewer's Blackbird	Bullock's Oriole
Bullock's Oriole	Brown-headed Cowbird	Bushy-tailed Woodrat	Brown-headed Cowbird	Bullfrog	Brown Creeper	Bushy-tailed Woodrat
Bushy-tailed Woodrat	Bullfrog	California Myotis	Bullfrog	Bullock's Oriole	Brown-headed Cowbird	California Myotis
California Myotis	Bullock's Oriole	California Quail	Bullock's Oriole	Bushy-tailed Woodrat	Bullfrog	California Quail
California Quail	Bushy-tailed Woodrat	Calliope Hummingbird	Bushy-tailed Woodrat	California Myotis	Bullock's Oriole	Calliope Hummingbird
Calliope Hummingbird	California Myotis	Canada Goose	California Myotis	California Quail	Bushy-tailed Woodrat	Canada Goose
Canada Goose	California Quail	Canyon Wren	California Quail	Calliope Hummingbird	California Myotis	Canyon Wren
Canyon Wren	Calliope Hummingbird	Cascade Frog	Calliope Hummingbird	Canada Goose	California Quail	Cassin's Finch
Cascade Frog	Canada Goose	Cassin's Finch	Canada Goose	Canyon Wren	Calliope Hummingbir d	Cassin's Vireo
Cassin's Finch	Canyon Wren	Cassin's Vireo	Canyon Wren	Cascade Frog	Canada Goose	Cedar Waxwing
Cassin's Vireo	Cascade Frog	Cedar Waxwing	Cascade Frog	Cassin's Finch	Canyon Wren	Chipping Sparrow
Cedar Waxwing	Cassin's Finch	Chipping Sparrow	Cassin's Finch	Cassin's Vireo	Cascade Frog	Chukar
Chipping	Cassin's	Chukar	Cassin's	Cedar	Cassin's	Cliff Swallow

Entiat	Lake Chelan	Wenatchee	Methow	Okanogan	Columbia Upper Middle	Crab
Sparrow	Vireo		Vireo	Waxwing	Finch	
Chukar	Cedar Waxwing	Cliff Swallow	Cedar Waxwing	Chipping Sparrow	Cassin's Vireo	Coast Mole
Cliff Swallow	Chipping Sparrow	Coast Mole	Chipping Sparrow	Chukar	Cedar Waxwing	Columbia Spotted Frog
Coast Mole	Chukar	Columbia Spotted Frog	Chukar	Cliff Swallow	Chipping Sparrow	Columbian Ground Squirrel
Columbia Spotted Frog	Cliff Swallow	Columbian Ground Squirrel	Cliff Swallow	Coast Mole	Chukar	Common Garter Snake
Columbian Ground Squirrel	Coast Mole	Columbian Mouse	Coast Mole	Columbia Spotted Frog	Cliff Swallow	Common Merganser
Columbian Mouse	Columbia Spotted Frog	Common Garter Snake	Columbia Spotted Frog	Columbian Ground Squirrel	Coast Mole	Common Nighthawk
Common Garter Snake	Columbian Ground Squirrel	Common Merganser	Columbian Ground Squirrel	Columbian Mouse	Columbia Spotted Frog	Common Porcupine
Common Merganser	Columbian Mouse	Common Nighthawk	Columbian Mouse	Common Garter Snake	Columbian Ground Squirrel	Common Raven
Common Nighthawk	Common Garter Snake	Common Porcupine	Common Garter Snake	Common Merganser	Columbian Mouse	Common Redpoll
Common Porcupine	Common Merganser	Common Raven	Common Merganser	Common Nighthawk	Common Garter Snake	Common Yellowthroat
Common Raven	Common Nighthawk	Common Redpoll	Common Nighthawk	Common Porcupine	Common Merganser	Cooper's Hawk
Common Redpoll	Common Porcupine	Common Yellowthroat	Common Porcupine	Common Raven	Common Nighthawk	Cordilleran Flycatcher
Common Yellowthroat	Common Raven	Cooper's Hawk	Common Raven	Common Redpoll	Common Porcupine	Coyote
Cooper's Hawk	Common Redpoll	Cordilleran Flycatcher	Common Redpoll	Common Yellowthroat	Common Raven	Dark-eyed Junco
Cordilleran Flycatcher	Common Yellowthroat	Coyote	Common Yellowthroat	Cooper's Hawk	Common Redpoll	Deer Mouse
Coyote	Cooper's Hawk	Creeping Vole	Cooper's Hawk	Cordilleran Flycatcher	Common Yellowthroat	Double-crested Cormorant
Creeping Vole	Cordilleran Flycatcher	Dark-eyed Junco	Cordilleran Flycatcher	Coyote	Cooper's Hawk	Downy Woodpecker
Dark-eyed Junco	Coyote	Deer Mouse	Coyote	Creeping Vole	Cordilleran Flycatcher	Dusky Flycatcher
Deer Mouse	Creeping Vole	Downy Woodpecker	Creeping Vole	Dark-eyed Junco	Coyote	Eastern Cottontail
Downy Woodpecker	Dark-eyed Junco	Dusky Flycatcher	Dark-eyed Junco	Deer Mouse	Creeping Vole	Eastern Kingbird
Dusky Flycatcher	Deer Mouse	Eastern Cottontail	Deer Mouse	Downy Woodpecker	Dark-eyed Junco	Ermine
Eastern Kingbird	Downy Woodpecker	Eastern Kingbird	Downy Woodpecker	Dusky Flycatcher	Deer Mouse	European Starling
Ermine	Dusky	Ermine	Dusky	Eastern Fox	Double-	Evening

Entiat	Lake Chelan	Wenatchee	Methow	Okanogan	Columbia Upper Middle	Crab
	Flycatcher		Flycatcher	Squirrel	crested Cormorant	Grosbeak
European Starling	Eastern Fox Squirrel	European Starling	Eastern Fox Squirrel	Eastern Kingbird	Downy Woodpecker	Flammulated Owl
Evening Grosbeak	Eastern Kingbird	Evening Grosbeak	Eastern Kingbird	Ermine	Dusky Flycatcher	Fox Sparrow
Fisher	Ermine	Fisher	Ermine	European Starling	Eastern Cottontail	Fringed Myotis
Flammulated Owl	European Starling	Flammulated Owl	European Starling	Evening Grosbeak	Eastern Fox Squirrel	Golden Eagle
Fox Sparrow	Evening Grosbeak	Fox Sparrow	Evening Grosbeak	Fisher	Eastern Kingbird	Golden-crowned Kinglet
Fringed Myotis	Fisher	Fringed Myotis	Fisher	Flammulated Owl	Ermine	Golden-mantled Ground Squirrel
Golden Eagle	Flammulated Owl	Golden Eagle	Flammulated Owl	Fox Sparrow	European Starling	Gopher Snake
Golden-crowned Kinglet	Fox Sparrow	Golden-crowned Kinglet	Fox Sparrow	Fringed Myotis	Evening Grosbeak	Gray Catbird
Gopher Snake	Fringed Myotis	Gopher Snake	Fringed Myotis	Golden Eagle	Fisher	Gray Jay
Gray Catbird	Golden Eagle	Gray Catbird	Golden Eagle	Golden-crowned Kinglet	Flammulated Owl	Great Basin Spadefoot
Gray Jay	Golden-crowned Kinglet	Gray Jay	Golden-crowned Kinglet	Golden-mantled Ground Squirrel	Fox Sparrow	Great Blue Heron
Great Basin Spadefoot	Golden-mantled Ground Squirrel	Great Basin Spadefoot	Golden-mantled Ground Squirrel	Gopher Snake	Fringed Myotis	Great Egret
Great Blue Heron	Gopher Snake	Great Blue Heron	Gopher Snake	Gray Catbird	Golden Eagle	Great Horned Owl
Great Horned Owl	Gray Catbird	Great Horned Owl	Gray Catbird	Gray Jay	Golden-crowned Kinglet	Greater Yellowlegs
Greater Yellowlegs	Gray Jay	Greater Yellowlegs	Gray Jay	Great Basin Spadefoot	Golden-mantled Ground Squirrel	Green-winged Teal
Green-winged Teal	Great Basin Spadefoot	Green-winged Teal	Great Basin Spadefoot	Great Blue Heron	Gopher Snake	Hairy Woodpecker
Grizzly Bear	Great Blue Heron	Grizzly Bear	Great Blue Heron	Great Horned Owl	Gray Catbird	Heather Vole
Hairy Woodpecker	Great Horned Owl	Hairy Woodpecker	Great Horned Owl	Greater Yellowlegs	Gray Jay	Hermit Thrush
Harlequin Duck	Greater Yellowlegs	Harlequin Duck	Greater Yellowlegs	Green-winged Teal	Great Basin Spadefoot	Hoary Bat
Heather Vole	Green-winged Teal	Heather Vole	Green-winged Teal	Grizzly Bear	Great Blue Heron	Hooded Merganser

Entiat	Lake Chelan	Wenatchee	Methow	Okanogan	Columbia Upper Middle	Crab
Hermit Thrush	Grizzly Bear	Hermit Thrush	Grizzly Bear	Hairy Woodpecker	Great Egret	House Finch
Hoary Bat	Hairy Woodpecker	Hoary Bat	Hairy Woodpecker	Harlequin Duck	Great Horned Owl	House Wren
Hooded Merganser	Harlequin Duck	Hooded Merganser	Harlequin Duck	Heather Vole	Greater Yellowlegs	Killdeer
House Finch	Heather Vole	House Finch	Heather Vole	Hermit Thrush	Green-winged Teal	Lazuli Bunting
House Wren	Hermit Thrush	House Wren	Hermit Thrush	Hoary Bat	Grizzly Bear	Least Chipmunk
Killdeer	Hoary Bat	Killdeer	Hoary Bat	Hooded Merganser	Hairy Woodpecker	Lesser Yellowlegs
Lazuli Bunting	Hooded Merganser	Lazuli Bunting	Hooded Merganser	House Finch	Harlequin Duck	Lewis's Woodpecker
Least Chipmunk	House Finch	Least Chipmunk	House Finch	House Wren	Heather Vole	Lincoln's Sparrow
Lesser Yellowlegs	House Wren	Lesser Yellowlegs	House Wren	Killdeer	Hermit Thrush	Little Brown Myotis
Lewis's Woodpecker	Killdeer	Lewis's Woodpecker	Killdeer	Lazuli Bunting	Hoary Bat	Long-eared Myotis
Lincoln's Sparrow	Lazuli Bunting	Lincoln's Sparrow	Lazuli Bunting	Least Chipmunk	Hooded Merganser	Long-eared Owl
Little Brown Myotis	Least Chipmunk	Little Brown Myotis	Least Chipmunk	Lesser Yellowlegs	House Finch	Long-legged Myotis
Long-eared Myotis	Lesser Yellowlegs	Long-eared Myotis	Lesser Yellowlegs	Lewis's Woodpecker	House Wren	Long-tailed Vole
Long-eared Owl	Lewis's Woodpecker	Long-eared Owl	Lewis's Woodpecker	Lincoln's Sparrow	Killdeer	Long-tailed Weasel
Long-legged Myotis	Lincoln's Sparrow	Long-legged Myotis	Lincoln's Sparrow	Little Brown Myotis	Lazuli Bunting	Long-toed Salamander
Long-tailed Vole	Little Brown Myotis	Long-tailed Vole	Little Brown Myotis	Long-eared Myotis	Least Chipmunk	Macgillivray's Warbler
Long-tailed Weasel	Long-eared Myotis	Long-tailed Weasel	Long-eared Myotis	Long-eared Owl	Lesser Yellowlegs	Mallard
Long-toed Salamander	Long-eared Owl	Long-toed Salamander	Long-eared Owl	Long-legged Myotis	Lewis's Woodpecker	Masked Shrew
Macgillivray's Warbler	Long-legged Myotis	Macgillivray's Warbler	Long-legged Myotis	Long-tailed Vole	Lincoln's Sparrow	Meadow Vole
Mallard	Long-tailed Vole	Mallard	Long-tailed Vole	Long-tailed Weasel	Little Brown Myotis	Mink
Masked Shrew	Long-tailed Weasel	Masked Shrew	Long-tailed Weasel	Long-toed Salamander	Long-eared Myotis	Montane Shrew
Meadow Vole	Long-toed Salamander	Mink	Long-toed Salamander	Macgillivray's Warbler	Long-eared Owl	Montane Vole
Mink	Macgillivray's Warbler	Montane Shrew	Macgillivray's Warbler	Mallard	Long-legged Myotis	Moose
Montane Shrew	Mallard	Montane Vole	Mallard	Masked Shrew	Long-tailed Vole	Mountain Bluebird
Montane Vole	Masked Shrew	Mountain Bluebird	Masked Shrew	Meadow Vole	Long-tailed Weasel	Mountain Chickadee
Mountain Bluebird	Meadow Vole	Mountain Chickadee	Meadow Vole	Mink	Long-toed Salamander	Mountain Lion
Mountain Chickadee	Mink	Mountain Lion	Mink	Montane Shrew	Macgillivray's Warbler	Mourning Dove

Entiat	Lake Chelan	Wenatchee	Methow	Okanogan	Columbia Upper Middle	Crab
Mountain Lion	Montane Shrew	Mourning Dove	Montane Shrew	Montane Vole	Mallard	Mule Deer
Mourning Dove	Montane Vole	Mule Deer	Montane Vole	Moose	Masked Shrew	Muskrat
Mule Deer	Moose	Muskrat	Moose	Mountain Bluebird	Meadow Vole	Nashville Warbler
Muskrat	Mountain Bluebird	Nashville Warbler	Mountain Bluebird	Mountain Chickadee	Mink	Northern Alligator Lizard
Nashville Warbler	Mountain Chickadee	Northern Alligator Lizard	Mountain Chickadee	Mountain Lion	Montane Shrew	Northern Flicker
Northern Alligator Lizard	Mountain Lion	Northern Flicker	Mountain Lion	Mourning Dove	Montane Vole	Northern Flying Squirrel
Northern Flicker	Mourning Dove	Northern Flying Squirrel	Mourning Dove	Mule Deer	Moose	Northern Goshawk
Northern Flying Squirrel	Mule Deer	Northern Goshawk	Mule Deer	Muskrat	Mountain Bluebird	Northern Harrier
Northern Goshawk	Muskrat	Northern Harrier	Muskrat	Nashville Warbler	Mountain Chickadee	Northern Leopard Frog
Northern Harrier	Nashville Warbler	Northern Pocket Gopher	Nashville Warbler	Northern Alligator Lizard	Mountain Lion	Northern Pocket Gopher
Northern Pocket Gopher	Northern Alligator Lizard	Northern Pygmy-owl	Northern Alligator Lizard	Northern Flicker	Mourning Dove	Northern Pygmy-owl
Northern Pygmy-owl	Northern Flicker	Northern River Otter	Northern Flicker	Northern Flying Squirrel	Muskrat	Northern River Otter
Northern River Otter	Northern Flying Squirrel	Northern Rough-winged Swallow	Northern Flying Squirrel	Northern Goshawk	Nashville Warbler	Northern Rough-winged Swallow
Northern Rough-winged Swallow	Northern Goshawk	Northern Saw-whet Owl	Northern Goshawk	Northern Harrier	Northern Alligator Lizard	Northern Saw-whet Owl
Northern Saw-whet Owl	Northern Harrier	Northwestern Salamander	Northern Harrier	Northern Pocket Gopher	Northern Flicker	Northern Waterthrush
Olive-sided Flycatcher	Northern Pocket Gopher	Olive-sided Flycatcher	Northern Pocket Gopher	Northern Pygmy-owl	Northern Flying Squirrel	Olive-sided Flycatcher
Orange-crowned Warbler	Northern Pygmy-owl	Orange-crowned Warbler	Northern Pygmy-owl	Northern River Otter	Northern Goshawk	Orange-crowned Warbler
Osprey	Northern River Otter	Osprey	Northern River Otter	Northern Rough-winged Swallow	Northern Harrier	Osprey

Entiat	Lake Chelan	Wenatchee	Methow	Okanogan	Columbia Upper Middle	Crab
Pacific Chorus (Tree) Frog	Northern Rough-winged Swallow	Pacific Chorus (Tree) Frog	Northern Rough-winged Swallow	Northern Saw-whet Owl	Northern Leopard Frog	Pacific Chorus (Tree) Frog
Pacific Jumping Mouse	Northern Saw-whet Owl	Pacific Jumping Mouse	Northern Saw-whet Owl	Northern Waterthrush	Northern Pocket Gopher	Painted Turtle
Pacific Water Shrew	Northern Waterthrush	Pacific Water Shrew	Northern Waterthrush	Olive-sided Flycatcher	Northern Pygmy-owl	Pallid Bat
Painted Turtle	Olive-sided Flycatcher	Painted Turtle	Olive-sided Flycatcher	Orange-crowned Warbler	Northern River Otter	Pied-billed Grebe
Pallid Bat	Orange-crowned Warbler	Pallid Bat	Orange-crowned Warbler	Osprey	Northern Rough-winged Swallow	Pileated Woodpecker
Pied-billed Grebe	Osprey	Pied-billed Grebe	Osprey	Pacific Chorus (Tree) Frog	Northern Saw-whet Owl	Pine Siskin
Pileated Woodpecker	Pacific Chorus (Tree) Frog	Pileated Woodpecker	Pacific Chorus (Tree) Frog	Pacific Jumping Mouse	Northern Waterthrush	Prairie Falcon
Pine Siskin	Pacific Jumping Mouse	Pine Siskin	Pacific Jumping Mouse	Painted Turtle	Northwester n Salamander	Pygmy Nuthatch
Prairie Falcon	Pacific Water Shrew	Prairie Falcon	Pacific Water Shrew	Pallid Bat	Olive-sided Flycatcher	Raccoon
Pygmy Nuthatch	Painted Turtle	Pygmy Nuthatch	Painted Turtle	Pied-billed Grebe	Orange-crowned Warbler	Racer
Raccoon	Pallid Bat	Raccoon	Pallid Bat	Pileated Woodpecker	Osprey	Red Crossbill
Racer	Pied-billed Grebe	Racer	Pied-billed Grebe	Pine Siskin	Pacific Chorus (Tree) Frog	Red fox
Red Crossbill	Pileated Woodpecker	Red Crossbill	Pileated Woodpecker	Prairie Falcon	Pacific Jumping Mouse	Red-breasted Nuthatch
Red Fox	Pine Siskin	Red Fox	Pine Siskin	Pygmy Nuthatch	Pacific Water Shrew	Red-eyed Vireo
Red-breasted Nuthatch	Prairie Falcon	Red-breasted Nuthatch	Prairie Falcon	Raccoon	Painted Turtle	Red-naped Sapsucker
Red-breasted Sapsucker	Pygmy Nuthatch	Red-breasted Sapsucker	Pygmy Nuthatch	Racer	Pallid Bat	Red-tailed Hawk
Red-eyed Vireo	Raccoon	Red-eyed Vireo	Raccoon	Red Crossbill	Pied-billed Grebe	Red-winged Blackbird
Red-naped Sapsucker	Racer	Red-naped Sapsucker	Racer	Red Fox	Pileated Woodpecker	Ring-necked Duck
Red-tailed Hawk	Red Crossbill	Red-tailed Hawk	Red Crossbill	Red-breasted Nuthatch	Pine Siskin	Ring-necked Pheasant
Red-winged	Red Fox	Red-winged	Red Fox	Red-	Prairie	Rocky

Entiat	Lake Chelan	Wenatchee	Methow	Okanogan	Columbia Upper Middle	Crab
Blackbird		Blackbird		breasted Sapsucker	Falcon	Mountain Elk
Ring-necked Duck	Red-breasted Nuthatch	Ring-necked Duck	Red-breasted Nuthatch	Red-eyed Vireo	Pygmy Nuthatch	Rough-legged Hawk
Ring-necked Pheasant	Red-breasted Sapsucker	Ring-necked Pheasant	Red-breasted Sapsucker	Red-naped Sapsucker	Raccoon	Rubber Boa
Rocky Mountain Elk	Red-eyed Vireo	Rocky Mountain Elk	Red-eyed Vireo	Red-tailed Hawk	Racer	Ruby-crowned Kinglet
Rough-legged Hawk	Red-naped Sapsucker	Rough-legged Hawk	Red-naped Sapsucker	Red-winged Blackbird	Red Crossbill	Ruffed Grouse
Rough-skinned Newt	Red-tailed Hawk	Rough-skinned Newt	Red-tailed Hawk	Ring-necked Duck	Red Fox	Rufous Hummingbird
Rubber Boa	Red-winged Blackbird	Rubber Boa	Red-winged Blackbird	Ring-necked Pheasant	Red-breasted Nuthatch	Savannah Sparrow
Ruby-crowned Kinglet	Ring-necked Duck	Ruby-crowned Kinglet	Ring-necked Duck	Rocky Mountain Elk	Red-breasted Sapsucker	Say's Phoebe
Ruffed Grouse	Ring-necked Pheasant	Ruffed Grouse	Ring-necked Pheasant	Rough-legged Hawk	Red-eyed Vireo	Sharptail Snake
Rufous Hummingbird	Rocky Mountain Elk	Rufous Hummingbird	Rocky Mountain Elk	Rubber Boa	Red-naped Sapsucker	Sharp-tailed Grouse
Savannah Sparrow	Rough-legged Hawk	Savannah Sparrow	Rough-legged Hawk	Ruby-crowned Kinglet	Red-tailed Hawk	Silver-haired Bat
Say's Phoebe	Rough-skinned Newt	Say's Phoebe	Rough-skinned Newt	Ruffed Grouse	Red-winged Blackbird	Snowshoe Hare
Sharptail Snake	Rubber Boa	Sharptail Snake	Rubber Boa	Rufous Hummingbird	Ring-necked Duck	Solitary Sandpiper
Sharp-tailed Grouse	Ruby-crowned Kinglet	Shrew-mole	Ruby-crowned Kinglet	Savannah Sparrow	Ring-necked Pheasant	Song Sparrow
Shrew-mole	Ruffed Grouse	Silver-haired Bat	Ruffed Grouse	Say's Phoebe	Rough-legged Hawk	Southern Red-backed Vole
Silver-haired Bat	Rufous Hummingbird	Snowshoe Hare	Rufous Hummingbird	Sharp-tailed Grouse	Rough-skinned Newt	Spotted Bat
Snowshoe Hare	Savannah Sparrow	Solitary Sandpiper	Savannah Sparrow	Silver-haired Bat	Rubber Boa	Spotted Sandpiper
Solitary Sandpiper	Say's Phoebe	Song Sparrow	Say's Phoebe	Snowshoe Hare	Ruby-crowned Kinglet	Spotted Towhee
Song Sparrow	Sharptail Snake	Southern Alligator Lizard	Sharptail Snake	Solitary Sandpiper	Ruffed Grouse	Steller's Jay
Southern Red-backed Vole	Sharp-tailed Grouse	Southern Red-backed Vole	Sharp-tailed Grouse	Song Sparrow	Rufous Hummingbir d	Striped Skunk

Entiat	Lake Chelan	Wenatchee	Methow	Okanogan	Columbia Upper Middle	Crab
Spotted Bat	Shrew-mole	Spotted Bat	Shrew-mole	Southern Red-backed Vole	Savannah Sparrow	Swainson's Hawk
Spotted Sandpiper	Silver-haired Bat	Spotted Sandpiper	Silver-haired Bat	Spotted Bat	Say's Phoebe	Swainson's Thrush
Spotted Towhee	Snowshoe Hare	Spotted Towhee	Snowshoe Hare	Spotted Sandpiper	Sharptail Snake	Tiger Salamander
Steller's Jay	Solitary Sandpiper	Steller's Jay	Solitary Sandpiper	Spotted Towhee	Sharp-tailed Grouse	Townsend's Big-eared Bat
Striped Skunk	Song Sparrow	Striped Skunk	Song Sparrow	Steller's Jay	Shrew-mole	Townsend's Solitaire
Swainson's Hawk	Southern Red-backed Vole	Swainson's Hawk	Southern Red-backed Vole	Striped Skunk	Silver-haired Bat	Townsend's Warbler
Swainson's Thrush	Spotted Bat	Swainson's Thrush	Spotted Bat	Swainson's Hawk	Snowshoe Hare	Tree Swallow
Tailed Frog	Spotted Sandpiper	Tailed Frog	Spotted Sandpiper	Swainson's Thrush	Solitary Sandpiper	Turkey Vulture
Three-toed Woodpecker	Spotted Towhee	Three-toed Woodpecker	Spotted Towhee	Tailed Frog	Song Sparrow	Vagrant Shrew
Tiger Salamander	Steller's Jay	Tiger Salamander	Steller's Jay	Three-toed Woodpecker	Southern Alligator Lizard	Vaux's Swift
Townsend's Big-eared Bat	Striped Skunk	Townsend's Big-eared Bat	Striped Skunk	Tiger Salamander	Southern Red-backed Vole	Veery
Townsend's Solitaire	Swainson's Hawk	Townsend's Solitaire	Swainson's Hawk	Townsend's Big-eared Bat	Spotted Bat	Violet-green Swallow
Townsend's Warbler	Swainson's Thrush	Townsend's Warbler	Swainson's Thrush	Townsend's Solitaire	Spotted Sandpiper	Virginia Opossum
Tree Swallow	Tailed Frog	Tree Swallow	Tailed Frog	Townsend's Warbler	Spotted Towhee	Warbling Vireo
Trowbridge's Shrew	Three-toed Woodpecker	Trowbridge's Shrew	Three-toed Woodpecker	Tree Swallow	Steller's Jay	Water Shrew
Turkey Vulture	Tiger Salamander	Turkey Vulture	Tiger Salamander	Trowbridge's Shrew	Striped Skunk	Western Bluebird
Vagrant Shrew	Townsend's Big-eared Bat	Vagrant Shrew	Townsend's Big-eared Bat	Turkey Vulture	Swainson's Hawk	Western Harvest Mouse
Vaux's Swift	Townsend's Solitaire	Vaux's Swift	Townsend's Solitaire	Vagrant Shrew	Swainson's Thrush	Western Jumping Mouse
Veery	Townsend's Warbler	Veery	Townsend's Warbler	Vaux's Swift	Tailed Frog	Western Pipistrelle
Violet-green Swallow	Tree Swallow	Violet-green Swallow	Tree Swallow	Veery	Three-toed Woodpecker	Western Rattlesnake
Virginia Opossum	Trowbridge's Shrew	Virginia Opossum	Trowbridge's Shrew	Violet-green Swallow	Tiger Salamander	Western Screech-owl
Warbling Vireo	Turkey Vulture	Warbling Vireo	Turkey Vulture	Warbling Vireo	Townsend's Big-eared Bat	Western Small-footed Myotis
Water Shrew	Vagrant	Water Shrew	Vagrant	Water Shrew	Townsend's	Western

Entiat	Lake Chelan	Wenatchee	Methow	Okanogan	Columbia Upper Middle	Crab
	Shrew		Shrew		Solitaire	Tanager
Water Vole	Vaux's Swift	Water Vole	Vaux's Swift	Water Vole	Townsend's Warbler	Western Terrestrial Garter Snake
Western Bluebird	Veery	Western Bluebird	Veery	Western Bluebird	Tree Swallow	Western Toad
Western Harvest Mouse	Violet-green Swallow	Western Harvest Mouse	Violet-green Swallow	Western Harvest Mouse	Trowbridge's Shrew	Western Wood-pewee
Western Jumping Mouse	Virginia Opossum	Western Jumping Mouse	Virginia Opossum	Western Jumping Mouse	Turkey Vulture	White-breasted Nuthatch
Western Pipistrelle	Warbling Vireo	Western Pipistrelle	Warbling Vireo	Western Pipistrelle	Vagrant Shrew	White-headed Woodpecker
Western Rattlesnake	Water Shrew	Western Rattlesnake	Water Shrew	Western Rattlesnake	Vaux's Swift	White-tailed Jackrabbit
Western Screech-owl	Water Vole	Western Screech-owl	Water Vole	Western Screech-owl	Veery	White-throated Swift
Western Small-footed Myotis	Western Bluebird	Western Small-footed Myotis	Western Bluebird	Western Small-footed Myotis	Violet-green Swallow	Wild Turkey
Western Tanager	Western Harvest Mouse	Western Tanager	Western Harvest Mouse	Western Tanager	Virginia Opossum	Willow Flycatcher
Western Terrestrial Garter Snake	Western Jumping Mouse	Western Terrestrial Garter Snake	Western Jumping Mouse	Western Terrestrial Garter Snake	Warbling Vireo	Wilson's Warbler
Western Toad	Western Pipistrelle	Western Toad	Western Pipistrelle	Western Toad	Water Shrew	Winter Wren
Western Wood-pewee	Western Rattlesnake	Western Wood-pewee	Western Rattlesnake	Western Wood-pewee	Water Vole	Wood Duck
White-breasted Nuthatch	Western Screech-owl	White-breasted Nuthatch	Western Screech-owl	White-breasted Nuthatch	Western Bluebird	Woodhouse' Toad
White-crowned Sparrow	Western Small-footed Myotis	White-crowned Sparrow	Western Small-footed Myotis	White-crowned Sparrow	Western Harvest Mouse	Yellow Warbler
White-headed Woodpecker	Western Tanager	White-headed Woodpecker	Western Tanager	White-headed Woodpecker	Western Jumping Mouse	Yellow-bellied Marmot
White-tailed Jackrabbit	Western Terrestrial Garter Snake	White-tailed Jackrabbit	Western Terrestrial Garter Snake	White-tailed Jackrabbit	Western Pipistrelle	Yellow-breasted Chat
White-throated Swift	Western Toad	White-throated Swift	Western Toad	White-throated Swift	Western Rattlesnake	Yellow-pine Chipmunk
Wild Turkey	Western Wood-pewee	Wild Turkey	Western Wood-pewee	Wild Turkey	Western Screech-owl	Yellow-rumped Warbler
Williamson's Sapsucker	White-breasted Nuthatch	Williamson's Sapsucker	White-breasted Nuthatch	Williamson's Sapsucker	Western Small-footed Myotis	Yuma Myotis

Entiat	Lake Chelan	Wenatchee	Methow	Okanogan	Columbia Upper Middle	Crab
Willow Flycatcher	White-crowned Sparrow	Willow Flycatcher	White-crowned Sparrow	Willow Flycatcher	Western Tanager	
Wilson's Warbler	White-headed Woodpecker	Wilson's Warbler	White-headed Woodpecker	Wilson's Warbler	Western Terrestrial Garter Snake	
Winter Wren	White-tailed Jackrabbit	Winter Wren	White-tailed Jackrabbit	Winter Wren	Western Toad	
Wood Duck	White-throated Swift	Wood Duck	White-throated Swift	Wood Duck	Western Wood-pewee	
Yellow Warbler	Wild Turkey	Woodhouse's Toad	Wild Turkey	Yellow Warbler	White-breasted Nuthatch	
Yellow-bellied Marmot	Williamson's Sapsucker	Yellow Warbler	Williamson's Sapsucker	Yellow-bellied Marmot	White-crowned Sparrow	
Yellow-breasted Chat	Willow Flycatcher	Yellow-bellied Marmot	Willow Flycatcher	Yellow-breasted Chat	White-headed Woodpecker	
Yellow-pine Chipmunk	Wilson's Warbler	Yellow-breasted Chat	Wilson's Warbler	Yellow-pine Chipmunk	White-tailed Jackrabbit	
Yellow-rumped Warbler	Winter Wren	Yellow-pine Chipmunk	Winter Wren	Yellow-rumped Warbler	White-throated Swift	
Yuma Myotis	Wood Duck	Yellow-rumped Warbler	Wood Duck	Yuma Myotis	Wild Turkey	
	Yellow Warbler	Yuma Myotis	Yellow Warbler		Williamson's Sapsucker	
	Yellow-bellied Marmot		Yellow-bellied Marmot		Willow Flycatcher	
	Yellow-breasted Chat		Yellow-breasted Chat		Wilson's Warbler	
	Yellow-pine Chipmunk		Yellow-pine Chipmunk		Winter Wren	
	Yellow-rumped Warbler		Yellow-rumped Warbler		Wood Duck	
	Yuma Myotis		Yuma Myotis		Woodhouse' Toad	
					Yellow Warbler	
					Yellow-bellied Marmot	
					Yellow-breasted Chat	
					Yellow-pine	

Entiat	Lake Chelan	Wenatchee	Methow	Okanogan	Columbia Upper Middle	Crab
					Chipmunk	
					Yellow-rumped Warbler	
					Yuma Myotis	

Table E-9. Wildlife species occurrence in agricultural habitat in the Columbia Cascade Ecoprovince, Washington (NHI 2003).

Entiat	Lake Chelan	Wenatchee	Methow	Okanogan	Columbia Upper Middle	Crab
Long-toed Salamander	Long-toed Salamander	Long-toed Salamander	Long-toed Salamander	Long-toed Salamander	Long-toed Salamander	Long-toed Salamander
Great Basin Spadefoot	Great Basin Spadefoot	Ensatina	Great Basin Spadefoot	Great Basin Spadefoot	Ensatina	Great Basin Spadefoot
Pacific Chorus (Tree) Frog	Pacific Chorus (Tree) Frog	Great Basin Spadefoot	Pacific Chorus (Tree) Frog	Pacific Chorus (Tree) Frog	Great Basin Spadefoot	Pacific Chorus (Tree) Frog
Painted Turtle	Painted Turtle	Pacific Chorus (Tree) Frog	Painted Turtle	Painted Turtle	Pacific Chorus (Tree) Frog	Painted Turtle
Western Fence Lizard	Western Fence Lizard	Painted Turtle	Western Fence Lizard	Western Fence Lizard	Painted Turtle	Western Skink
Western Skink	Western Skink	Southern Alligator Lizard	Western Skink	Western Skink	Southern Alligator Lizard	Rubber Boa
Rubber Boa	Rubber Boa	Western Fence Lizard	Rubber Boa	Rubber Boa	Western Fence Lizard	Racer
Racer	Racer	Western Skink	Racer	Racer	Western Skink	Sharptail Snake
Sharptail Snake	Sharptail Snake	Rubber Boa	Sharptail Snake	Gopher Snake	Rubber Boa	Ringneck Snake
Gopher Snake	Gopher Snake	Racer	Gopher Snake	Western Terrestrial Garter Snake	Racer	Gopher Snake
Western Terrestrial Garter Snake	Western Terrestrial Garter Snake	Sharptail Snake	Western Terrestrial Garter Snake	Common Garter Snake	Sharptail Snake	Western Terrestrial Garter Snake
Common Garter Snake	Common Garter Snake	Ringneck Snake	Common Garter Snake	Western Rattlesnake	Ringneck Snake	Common Garter Snake
Western Rattlesnake	Western Rattlesnake	Gopher Snake	Western Rattlesnake	American Bittern	Gopher Snake	Western Rattlesnake
Turkey Vulture	American Bittern	Western Terrestrial Garter Snake	American Bittern	Turkey Vulture	Western Terrestrial Garter Snake	American Bittern
Gadwall	Turkey Vulture	Northwestern Garter Snake	Turkey Vulture	Gadwall	Northwestern Garter Snake	Turkey Vulture
American Wigeon	Gadwall	Common Garter Snake	Gadwall	American Wigeon	Common Garter Snake	Gadwall
Mallard	American Wigeon	Western Rattlesnake	American Wigeon	Mallard	Western Rattlesnake	American Wigeon
Blue-winged Teal	Mallard	Turkey Vulture	Mallard	Blue-winged Teal	American Bittern	Mallard
Green-winged Teal	Blue-winged Teal	Gadwall	Blue-winged Teal	Green-winged Teal	Turkey Vulture	Blue-winged Teal
Northern Harrier	Green-winged Teal	Mallard	Green-winged Teal	Northern Harrier	Gadwall	Green-winged Teal
Swainson's Hawk	Northern Harrier	Blue-winged Teal	Northern Harrier	Swainson's Hawk	American Wigeon	Northern Harrier
Red-tailed Hawk	Swainson's Hawk	Green-winged Teal	Swainson's Hawk	Red-tailed Hawk	Mallard	Swainson's Hawk
Ferruginous Hawk	Red-tailed Hawk	Northern Harrier	Red-tailed Hawk	American Kestrel	Blue-winged Teal	Red-tailed Hawk

Entiat	Lake Chelan	Wenatchee	Methow	Okanogan	Columbia Upper Middle	Crab
American Kestrel	American Kestrel	Swainson's Hawk	American Kestrel	Prairie Falcon	Green-winged Teal	Ferruginous Hawk
Prairie Falcon	Prairie Falcon	Red-tailed Hawk	Prairie Falcon	Chukar	Northern Harrier	American Kestrel
Chukar	Chukar	Ferruginous Hawk	Chukar	Gray Partridge	Swainson's Hawk	Prairie Falcon
Gray Partridge	Gray Partridge	American Kestrel	Gray Partridge	Ring-necked Pheasant	Red-tailed Hawk	Chukar
Ring-necked Pheasant	Ring-necked Pheasant	Prairie Falcon	Ring-necked Pheasant	Ruffed Grouse	Ferruginous Hawk	Gray Partridge
Ruffed Grouse	Ruffed Grouse	Chukar	Ruffed Grouse	Sharp-tailed Grouse	American Kestrel	Ring-necked Pheasant
Sage Grouse	Sharp-tailed Grouse	Gray Partridge	Sharp-tailed Grouse	Wild Turkey	Prairie Falcon	Ruffed Grouse
Sharp-tailed Grouse	Wild Turkey	Ring-necked Pheasant	Wild Turkey	California Quail	Chukar	Sage Grouse
Wild Turkey	California Quail	Ruffed Grouse	California Quail	Virginia Rail	Gray Partridge	Sharp-tailed Grouse
California Quail	Virginia Rail	Sage Grouse	Virginia Rail	Sora	Ring-necked Pheasant	Wild Turkey
Virginia Rail	Sora	Wild Turkey	Sora	American Coot	Ruffed Grouse	California Quail
Sora	American Coot	California Quail	American Coot	Killdeer	Sage Grouse	Virginia Rail
American Coot	Killdeer	Virginia Rail	Killdeer	American Avocet	Sharp-tailed Grouse	Sora
Killdeer	American Avocet	Sora	American Avocet	Long-billed Curlew	Wild Turkey	American Coot
American Avocet	Long-billed Curlew	American Coot	Long-billed Curlew	Wilson's Snipe	California Quail	Killdeer
Long-billed Curlew	Wilson's Snipe	Killdeer	Wilson's Snipe	Ring-billed Gull	Virginia Rail	Black-necked Stilt
Wilson's Snipe	Ring-billed Gull	Long-billed Curlew	Ring-billed Gull	Rock Dove	Sora	American Avocet
Ring-billed Gull	Rock Dove	Wilson's Snipe	Rock Dove	Mourning Dove	American Coot	Long-billed Curlew
Rock Dove	Mourning Dove	Ring-billed Gull	Mourning Dove	Barn Owl	Killdeer	Wilson's Snipe
Mourning Dove	Barn Owl	Rock Dove	Barn Owl	Western Screech-owl	Black-necked Stilt	Ring-billed Gull
Barn Owl	Western Screech-owl	Mourning Dove	Western Screech-owl	Great Horned Owl	American Avocet	Rock Dove
Western Screech-owl	Great Horned Owl	Barn Owl	Great Horned Owl	Burrowing Owl	Long-billed Curlew	Mourning Dove
Great Horned Owl	Burrowing Owl	Western Screech-owl	Burrowing Owl	Long-eared Owl	Wilson's Snipe	Barn Owl
Burrowing Owl	Long-eared Owl	Great Horned Owl	Long-eared Owl	Short-eared Owl	Ring-billed Gull	Western Screech-owl
Long-eared Owl	Short-eared Owl	Burrowing Owl	Short-eared Owl	Common Nighthawk	Rock Dove	Great Horned Owl
Short-eared Owl	Common Nighthawk	Long-eared Owl	Common Nighthawk	Common Poorwill	Mourning Dove	Burrowing Owl
Common Nighthawk	Common Poorwill	Short-eared Owl	Common Poorwill	Black-chinned	Barn Owl	Long-eared Owl

Entiat	Lake Chelan	Wenatchee	Methow	Okanogan	Columbia Upper Middle	Crab
				Hummingbird		
Common Poorwill	Black-chinned Hummingbird	Common Nighthawk	Black-chinned Hummingbird	Rufous Hummingbird	Western Screech-owl	Short-eared Owl
Black-chinned Hummingbird	Rufous Hummingbird	Common Poorwill	Rufous Hummingbird	Lewis's Woodpecker	Great Horned Owl	Common Nighthawk
Rufous Hummingbird	Lewis's Woodpecker	Black-chinned Hummingbird	Lewis's Woodpecker	Red-breasted Sapsucker	Burrowing Owl	Common Poorwill
Lewis's Woodpecker	Red-breasted Sapsucker	Rufous Hummingbird	Red-breasted Sapsucker	Downy Woodpecker	Long-eared Owl	Black-chinned Hummingbird
Red-breasted Sapsucker	Downy Woodpecker	Lewis's Woodpecker	Downy Woodpecker	Hairy Woodpecker	Short-eared Owl	Rufous Hummingbird
Downy Woodpecker	Hairy Woodpecker	Red-breasted Sapsucker	Hairy Woodpecker	Northern Flicker	Common Nighthawk	Lewis's Woodpecker
Hairy Woodpecker	Northern Flicker	Downy Woodpecker	Northern Flicker	Western Wood-pewee	Common Poorwill	Downy Woodpecker
Northern Flicker	Western Wood-pewee	Hairy Woodpecker	Western Wood-pewee	Willow Flycatcher	Black-chinned Hummingbird	Hairy Woodpecker
Western Wood-pewee	Willow Flycatcher	Northern Flicker	Willow Flycatcher	Say's Phoebe	Rufous Hummingbird	Northern Flicker
Willow Flycatcher	Say's Phoebe	Western Wood-pewee	Say's Phoebe	Western Kingbird	Lewis's Woodpecker	Western Wood-pewee
Say's Phoebe	Western Kingbird	Willow Flycatcher	Western Kingbird	Eastern Kingbird	Red-breasted Sapsucker	Willow Flycatcher
Western Kingbird	Eastern Kingbird	Say's Phoebe	Eastern Kingbird	Loggerhead Shrike	Downy Woodpecker	Say's Phoebe
Eastern Kingbird	Loggerhead Shrike	Western Kingbird	Loggerhead Shrike	Warbling Vireo	Hairy Woodpecker	Western Kingbird
Loggerhead Shrike	Warbling Vireo	Eastern Kingbird	Warbling Vireo	Steller's Jay	Northern Flicker	Eastern Kingbird
Warbling Vireo	Steller's Jay	Loggerhead Shrike	Steller's Jay	Black-billed Magpie	Western Wood-pewee	Loggerhead Shrike
Steller's Jay	Black-billed Magpie	Warbling Vireo	Black-billed Magpie	American Crow	Willow Flycatcher	Warbling Vireo
Black-billed Magpie	American Crow	Steller's Jay	American Crow	Common Raven	Say's Phoebe	Steller's Jay
American Crow	Common Raven	Black-billed Magpie	Common Raven	Horned Lark	Western Kingbird	Black-billed Magpie
Common Raven	Horned Lark	American Crow	Horned Lark	Tree Swallow	Eastern Kingbird	American Crow
Horned Lark	Tree Swallow	Common Raven	Tree Swallow	Violet-green Swallow	Loggerhead Shrike	Common Raven
Tree Swallow	Violet-green Swallow	Horned Lark	Violet-green Swallow	Cliff Swallow	Warbling Vireo	Horned Lark
Violet-green Swallow	Cliff Swallow	Tree Swallow	Cliff Swallow	Barn Swallow	Steller's Jay	Tree Swallow
Cliff Swallow	Barn Swallow	Violet-green Swallow	Barn Swallow	Black-capped Chickadee	Black-billed Magpie	Violet-green Swallow
Barn Swallow	Black-capped Chickadee	Cliff Swallow	Black-capped Chickadee	Red-breasted Nuthatch	American Crow	Cliff Swallow

Entiat	Lake Chelan	Wenatchee	Methow	Okanogan	Columbia Upper Middle	Crab
Black-capped Chickadee	Red-breasted Nuthatch	Barn Swallow	Red-breasted Nuthatch	White-breasted Nuthatch	Common Raven	Barn Swallow
Red-breasted Nuthatch	White-breasted Nuthatch	Black-capped Chickadee	White-breasted Nuthatch	Brown Creeper	Horned Lark	Black-capped Chickadee
White-breasted Nuthatch	Brown Creeper	Red-breasted Nuthatch	Brown Creeper	House Wren	Tree Swallow	Red-breasted Nuthatch
Brown Creeper	House Wren	White-breasted Nuthatch	House Wren	Western Bluebird	Violet-green Swallow	White-breasted Nuthatch
House Wren	Western Bluebird	Brown Creeper	Western Bluebird	Mountain Bluebird	Cliff Swallow	Brown Creeper
Western Bluebird	Mountain Bluebird	House Wren	Mountain Bluebird	Swainson's Thrush	Barn Swallow	House Wren
Mountain Bluebird	Swainson's Thrush	Western Bluebird	Swainson's Thrush	American Robin	Black-capped Chickadee	Western Bluebird
Swainson's Thrush	American Robin	Mountain Bluebird	American Robin	Gray Catbird	Red-breasted Nuthatch	Mountain Bluebird
American Robin	Gray Catbird	Swainson's Thrush	Gray Catbird	European Starling	White-breasted Nuthatch	Swainson's Thrush
Gray Catbird	European Starling	American Robin	European Starling	Cedar Waxwing	Brown Creeper	American Robin
European Starling	Cedar Waxwing	Gray Catbird	Cedar Waxwing	Orange-crowned Warbler	House Wren	Gray Catbird
Cedar Waxwing	Orange-crowned Warbler	European Starling	Orange-crowned Warbler	Nashville Warbler	Western Bluebird	European Starling
Orange-crowned Warbler	Nashville Warbler	Cedar Waxwing	Nashville Warbler	Macgillivray's Warbler	Mountain Bluebird	Cedar Waxwing
Nashville Warbler	Black-throated Gray Warbler	Orange-crowned Warbler	Black-throated Gray Warbler	Common Yellowthroat	Swainson's Thrush	Orange-crowned Warbler
Black-throated Gray Warbler	Macgillivray's Warbler	Nashville Warbler	Macgillivray's Warbler	Wilson's Warbler	American Robin	Nashville Warbler
Macgillivray's Warbler	Common Yellowthroat	Black-throated Gray Warbler	Common Yellowthroat	Yellow-breasted Chat	Gray Catbird	Macgillivray's Warbler
Common Yellowthroat	Wilson's Warbler	Macgillivray's Warbler	Wilson's Warbler	Spotted Towhee	European Starling	Common Yellowthroat
Wilson's Warbler	Yellow-breasted Chat	Common Yellowthroat	Yellow-breasted Chat	Chipping Sparrow	Cedar Waxwing	Wilson's Warbler
Yellow-breasted Chat	Spotted Towhee	Wilson's Warbler	Spotted Towhee	Brewer's Sparrow	Orange-crowned Warbler	Yellow-breasted Chat
Spotted Towhee	Chipping Sparrow	Yellow-breasted Chat	Chipping Sparrow	Vesper Sparrow	Nashville Warbler	Spotted Towhee

Entiat	Lake Chelan	Wenatchee	Methow	Okanogan	Columbia Upper Middle	Crab
Chipping Sparrow	Brewer's Sparrow	Spotted Towhee	Brewer's Sparrow	Savannah Sparrow	Black-throated Gray Warbler	Chipping Sparrow
Brewer's Sparrow	Vesper Sparrow	Chipping Sparrow	Vesper Sparrow	Grasshopper Sparrow	Macgillivray's Warbler	Brewer's Sparrow
Vesper Sparrow	Savannah Sparrow	Brewer's Sparrow	Savannah Sparrow	Song Sparrow	Common Yellowthroat	Vesper Sparrow
Savannah Sparrow	Grasshopper Sparrow	Vesper Sparrow	Grasshopper Sparrow	White-crowned Sparrow	Wilson's Warbler	Savannah Sparrow
Grasshopper Sparrow	Song Sparrow	Savannah Sparrow	Song Sparrow	Dark-eyed Junco	Yellow-breasted Chat	Grasshopper Sparrow
Song Sparrow	White-crowned Sparrow	Grasshopper Sparrow	White-crowned Sparrow	Black-headed Grosbeak	Spotted Towhee	Song Sparrow
White-crowned Sparrow	Dark-eyed Junco	Song Sparrow	Dark-eyed Junco	Lazuli Bunting	Chipping Sparrow	Dark-eyed Junco
Dark-eyed Junco	Black-headed Grosbeak	White-crowned Sparrow	Black-headed Grosbeak	Bobolink	Brewer's Sparrow	Black-headed Grosbeak
Black-headed Grosbeak	Lazuli Bunting	Dark-eyed Junco	Lazuli Bunting	Red-winged Blackbird	Vesper Sparrow	Lazuli Bunting
Lazuli Bunting	Bobolink	Black-headed Grosbeak	Bobolink	Western Meadowlark	Savannah Sparrow	Bobolink
Red-winged Blackbird	Red-winged Blackbird	Lazuli Bunting	Red-winged Blackbird	Yellow-headed Blackbird	Grasshopper Sparrow	Red-winged Blackbird
Western Meadowlark	Western Meadowlark	Red-winged Blackbird	Western Meadowlark	Brewer's Blackbird	Song Sparrow	Western Meadowlark
Yellow-headed Blackbird	Yellow-headed Blackbird	Western Meadowlark	Yellow-headed Blackbird	Brown-headed Cowbird	White-crowned Sparrow	Yellow-headed Blackbird
Brewer's Blackbird	Brewer's Blackbird	Yellow-headed Blackbird	Brewer's Blackbird	Bullock's Oriole	Dark-eyed Junco	Brewer's Blackbird
Brown-headed Cowbird	Brown-headed Cowbird	Brewer's Blackbird	Brown-headed Cowbird	House Finch	Black-headed Grosbeak	Brown-headed Cowbird
Bullock's Oriole	Bullock's Oriole	Brown-headed Cowbird	Bullock's Oriole	American Goldfinch	Lazuli Bunting	Bullock's Oriole
House Finch	House Finch	Bullock's Oriole	House Finch	House Sparrow	Bobolink	House Finch
American Goldfinch	American Goldfinch	House Finch	American Goldfinch	Vagrant Shrew	Red-winged Blackbird	American Goldfinch
House Sparrow	House Sparrow	American Goldfinch	House Sparrow	Trowbridge's Shrew	Western Meadowlark	House Sparrow
Virginia Opossum	Virginia Opossum	House Sparrow	Virginia Opossum	Coast Mole	Yellow-headed Blackbird	Virginia Opossum
Vagrant	Vagrant	Virginia	Vagrant	California	Brewer's	Vagrant

Entiat	Lake Chelan	Wenatchee	Methow	Okanogan	Columbia Upper Middle	Crab
Shrew	Shrew	Opossum	Shrew	Myotis	Blackbird	Shrew
Trowbridge's Shrew	Trowbridge's Shrew	Vagrant Shrew	Trowbridge's Shrew	Yuma Myotis	Brown-headed Cowbird	Coast Mole
Shrew-mole	Shrew-mole	Trowbridge's Shrew	Shrew-mole	Little Brown Myotis	Bullock's Oriole	California Myotis
Coast Mole	Coast Mole	Shrew-mole	Coast Mole	Long-legged Myotis	House Finch	Yuma Myotis
California Myotis	California Myotis	Coast Mole	California Myotis	Fringed Myotis	American Goldfinch	Little Brown Myotis
Yuma Myotis	Yuma Myotis	California Myotis	Yuma Myotis	Long-eared Myotis	House Sparrow	Long-legged Myotis
Little Brown Myotis	Little Brown Myotis	Yuma Myotis	Little Brown Myotis	Big Brown Bat	Virginia Opossum	Fringed Myotis
Long-legged Myotis	Long-legged Myotis	Little Brown Myotis	Long-legged Myotis	Spotted Bat	Vagrant Shrew	Long-eared Myotis
Fringed Myotis	Fringed Myotis	Long-legged Myotis	Fringed Myotis	Townsend's Big-eared Bat	Trowbridge's Shrew	Big Brown Bat
Long-eared Myotis	Long-eared Myotis	Fringed Myotis	Long-eared Myotis	Pallid Bat	Shrew-mole	Spotted Bat
Big Brown Bat	Big Brown Bat	Long-eared Myotis	Big Brown Bat	Nuttall's (Mountain) Cottontail	Coast Mole	Townsend's Big-eared Bat
Spotted Bat	Spotted Bat	Big Brown Bat	Spotted Bat	Snowshoe Hare	California Myotis	Pallid Bat
Townsend's Big-eared Bat	Townsend's Big-eared Bat	Spotted Bat	Townsend's Big-eared Bat	White-tailed Jackrabbit	Yuma Myotis	Eastern Cottontail
Pallid Bat	Pallid Bat	Townsend's Big-eared Bat	Pallid Bat	Black-tailed Jackrabbit	Little Brown Myotis	Nuttall's (Mountain) Cottontail
Nuttall's (Mountain) Cottontail	Nuttall's (Mountain) Cottontail	Pallid Bat	Nuttall's (Mountain) Cottontail	Least Chipmunk	Long-legged Myotis	Snowshoe Hare
Snowshoe Hare	Snowshoe Hare	Eastern Cottontail	Snowshoe Hare	Yellow-bellied Marmot	Fringed Myotis	White-tailed Jackrabbit
White-tailed Jackrabbit	White-tailed Jackrabbit	Nuttall's (Mountain) Cottontail	White-tailed Jackrabbit	Columbian Ground Squirrel	Long-eared Myotis	Black-tailed Jackrabbit
Black-tailed Jackrabbit	Black-tailed Jackrabbit	Snowshoe Hare	Black-tailed Jackrabbit	Golden-mantled Ground Squirrel	Big Brown Bat	Least Chipmunk
Least Chipmunk	Least Chipmunk	White-tailed Jackrabbit	Least Chipmunk	Eastern Fox Squirrel	Spotted Bat	Yellow-bellied Marmot
Yellow-bellied Marmot	Yellow-bellied Marmot	Black-tailed Jackrabbit	Yellow-bellied Marmot	Northern Pocket Gopher	Townsend's Big-eared Bat	Washington Ground Squirrel
Washington Ground Squirrel	Washington Ground Squirrel	Least Chipmunk	Washington Ground Squirrel	Great Basin Pocket Mouse	Pallid Bat	Columbian Ground Squirrel
Columbian	Columbian	Yellow-	Columbian	Western	Eastern	California

Entiat	Lake Chelan	Wenatchee	Methow	Okanogan	Columbia Upper Middle	Crab
Ground Squirrel	Ground Squirrel	bellied Marmot	Ground Squirrel	Harvest Mouse	Cottontail	Ground Squirrel
Northern Pocket Gopher	Golden-mantled Ground Squirrel	Washington Ground Squirrel	Golden-mantled Ground Squirrel	Deer Mouse	Nuttall's (Mountain) Cottontail	Golden-mantled Ground Squirrel
Great Basin Pocket Mouse	Eastern Fox Squirrel	Columbian Ground Squirrel	Eastern Fox Squirrel	Northern Grasshopper Mouse	Snowshoe Hare	Northern Pocket Gopher
Western Harvest Mouse	Northern Pocket Gopher	California Ground Squirrel	Northern Pocket Gopher	Bushy-tailed Woodrat	White-tailed Jackrabbit	Great Basin Pocket Mouse
Deer Mouse	Great Basin Pocket Mouse	Northern Pocket Gopher	Great Basin Pocket Mouse	Montane Vole	Black-tailed Jackrabbit	Western Harvest Mouse
Northern Grasshopper Mouse	Western Harvest Mouse	Great Basin Pocket Mouse	Western Harvest Mouse	Long-tailed Vole	Least Chipmunk	Deer Mouse
Bushy-tailed Woodrat	Deer Mouse	Western Harvest Mouse	Deer Mouse	Creeping Vole	Yellow-bellied Marmot	Northern Grasshopper Mouse
Montane Vole	Northern Grasshopper Mouse	Deer Mouse	Northern Grasshopper Mouse	Muskrat	Washington Ground Squirrel	Bushy-tailed Woodrat
Long-tailed Vole	Bushy-tailed Woodrat	Northern Grasshopper Mouse	Bushy-tailed Woodrat	Norway Rat	Columbian Ground Squirrel	Montane Vole
Creeping Vole	Montane Vole	Bushy-tailed Woodrat	Montane Vole	House Mouse	California Ground Squirrel	Long-tailed Vole
Muskrat	Long-tailed Vole	Montane Vole	Long-tailed Vole	Western Jumping Mouse	Golden-mantled Ground Squirrel	Muskrat
Black Rat	Creeping Vole	Long-tailed Vole	Creeping Vole	Pacific Jumping Mouse	Eastern Fox Squirrel	Norway Rat
Norway Rat	Muskrat	Creeping Vole	Muskrat	Nutria	Northern Pocket Gopher	House Mouse
House Mouse	Black Rat	Muskrat	Black Rat	Coyote	Great Basin Pocket Mouse	Western Jumping Mouse
Western Jumping Mouse	Norway Rat	Black Rat	Norway Rat	Red Fox	Western Harvest Mouse	Nutria
Pacific Jumping Mouse	House Mouse	Norway Rat	House Mouse	Raccoon	Deer Mouse	Coyote
Nutria	Western Jumping Mouse	House Mouse	Western Jumping Mouse	Ermine	Northern Grasshopper Mouse	Red Fox
Coyote	Pacific Jumping Mouse	Western Jumping Mouse	Pacific Jumping Mouse	Long-tailed Weasel	Bushy-tailed Woodrat	Raccoon

Entiat	Lake Chelan	Wenatchee	Methow	Okanogan	Columbia Upper Middle	Crab
Red Fox	Nutria	Pacific Jumping Mouse	Nutria	American Badger	Montane Vole	Ermine
Raccoon	Coyote	Coyote	Coyote	Striped Skunk	Long-tailed Vole	Long-tailed Weasel
Ermine	Red Fox	Red Fox	Red Fox	Bobcat	Creeping Vole	American Badger
Long-tailed Weasel	Raccoon	Raccoon	Raccoon	Rocky Mountain Elk	Muskrat	Striped Skunk
American Badger	Ermine	Ermine	Ermine	Mule Deer	Black Rat	Bobcat
Striped Skunk	Long-tailed Weasel	Long-tailed Weasel	Long-tailed Weasel		Norway Rat	Rocky Mountain Elk
Bobcat	American Badger	American Badger	American Badger		House Mouse	Mule Deer
Rocky Mountain Elk	Striped Skunk	Striped Skunk	Striped Skunk		Western Jumping Mouse	
Mule Deer	Bobcat	Bobcat	Bobcat		Pacific Jumping Mouse	
White-tailed Deer	Rocky Mountain Elk	Rocky Mountain Elk	Rocky Mountain Elk		Nutria	
	Mule Deer	Mule Deer	Mule Deer		Coyote	
					Red Fox	
					Raccoon	
					Ermine	
					Long-tailed Weasel	
					American Badger	
					Striped Skunk	
					Bobcat	
					Roosevelt Elk	

Appendix F: Focal Species Information

White-headed Woodpecker
(*Picoides albolarvatus*)

1.0 Introduction

The white-headed woodpecker (*Picoides albolarvatus*) is a year round resident in the Ponderosa pine (*Pinus ponderosa*) forests found at the lower elevations (generally below 950m). White-headed woodpeckers are particularly vulnerable due to their highly specialized winter diet of Ponderosa pine seeds and the lack of alternate, large cone producing, pine species.

Nesting and foraging requirements are the two critical habitat attributes limiting the population growth of this species of woodpecker. Both of these limiting factors are very closely linked to the habitat attributes contained within mature open stands of Ponderosa pine. Past land use practices, including logging and fire suppression, have resulted in significant changes to the forest structure within the Ponderosa pine ecosystem.

2.0 White-headed Woodpecker Life History and Habitat Requirements

2.1 Life History

2.1.1 Diet

White-headed woodpeckers feed primarily on the seeds of large Ponderosa pines. This is makes the white-headed woodpecker quite different from other species of woodpeckers who feed primarily on wood boring insects (Blood 1997, Cannings 1987 and 1995). The existence of only one suitable large pine (Ponderosa pine) is likely the key limiting factor to the white-headed woodpecker's distribution and abundance.

Other food sources include insects (on the ground as well as hawking), mullein seeds and suet feeders (Blood 1997, Joe *et al.* 1995). These secondary food sources are used throughout the spring and summer. By late summer, white-headed woodpeckers shift to their exclusive winter diet of Ponderosa pine seeds.

2.1.2 Reproduction

White-headed woodpeckers are monogamous and may remain associated with their mate throughout the year. They build their nests in old trees, snags or fallen logs but always in dead wood. Every year the pair bond constructs a new nest. This may take three to four weeks. The nests are, on average 3m off the ground. The old nests are used for overnight roosting by the birds.

The woodpeckers fledge about 3-5 birds every year. During the breeding season (May to July) the male roosts in the cavity with the young until they are fledged. The incubation period usually lasts for 14 days and the young leave the nest after about 26 days. White-headed woodpeckers have one brood per breeding season and there is no replacement brood if the first brood is lost. The woodpeckers are not very territorial except during the breeding season. They are not especially social birds outside of family groups and pair bonds and generally do not have very dense populations (about 1 pair bond per 8 ha).

2.1.3 Nesting

Generally large Ponderosa pine snags consisting of hard outer wood with soft heartwood are preferred by nesting white-headed woodpeckers. In British Columbia 80% of reported nests have been in Ponderosa pine snags, while the remaining 20% have been recorded in douglas fir snags. Excavation activities have also been recorded in Trembling Aspen, live Ponderosa pine trees and fence posts (Cannings *et al.* 1987).

In general, nesting locations in the South Okanagan, British Columbia have ranged between 450 - 600m (Blood 1997), with large diameter snags being the preferred nesting tree. Their nesting cavities range from 2.4 to 9 m above ground, with the average being about 5m. New nests are excavated each year and only rarely are previous cavities re-used (Garrett *et al.* 1996).

2.1.4 Migration

The white-headed woodpecker is a non-migratory bird.

2.1.5 Mortality

Information for this section is not available.

2.2 Habitat Requirements

2.2.1 Breeding

White-headed woodpeckers live in montane, coniferous forests from British Columbia to California and seem to prefer a forest with a relatively open canopy (50-70% cover) and an availability of snags (a partially collapsed, dead tree) and stumps for nesting. The birds prefer to build nests in trees with large diameters with preference increasing with diameter. The understory vegetation is usually very sparse within the preferred habitat and local populations are abundant in burned or cut forest where residual large diameter live and dead trees are present.

Highest abundances of white-headed woodpeckers occur in old-growth stands, particularly ones with a mix of two or more pine species. They are uncommon or absent in monospecific Ponderosa pine forests and stands dominated by small-coned or closed-cone conifers (e.g., lodgepole pine or knobcone pine).

Where food availability is at a maximum such as in the Sierra Nevadas, breeding territories may be as low as 10 ha (Milne and Hejl 1989). Breeding territories in Oregon are 104 ha in continuous forest and 321 ha in fragmented forests (Dixon 1995b). In general, open Ponderosa pine stands with canopy closures between 30 - 50 % are preferred. The openness however, is not as important as the presence of mature or veteran cone producing pines within a stand (Milne and Hejl 1989). In the South Okanagan, British Columbia, Ponderosa pine stands in age classes 8 -9 are considered optimal for white-headed woodpeckers (Haney 1997). Milne and Hejl (1989) found 68% of nest trees to be on southern aspects, this may be true in the South Okanagan as well, especially, towards the upper elevational limits of Ponderosa pine (800 - 1000m).

3.0 White-headed Woodpecker Population and Distribution

3.1 Population

3.1.1 Historic

Information for this section is not available.

3.1.2 Current

Information for this section is not available.

3.2 Distribution

3.2.1 Historic

Information for this section is not available.

3.2.2 Current

These woodpeckers live in montane, coniferous forests from southern British Columbia in Canada, to eastern Washington, southern California and Nevada and Northern Idaho in the United States (Figure 1). White-headed woodpecker breeding distribution is illustrated in Figure 2. The exact population of the white-headed woodpecker is unknown but there are thought to be less than 100 of the birds in British Columbia. Woodpecker abundance appears to decrease north of California. They are uncommon in Washington and Idaho and rare in British Columbia. However, they are still common in most of their original range in the Sierra Nevada and mountains of southern California. The birds are non-migratory but do wander out of their range sometimes in search of food.

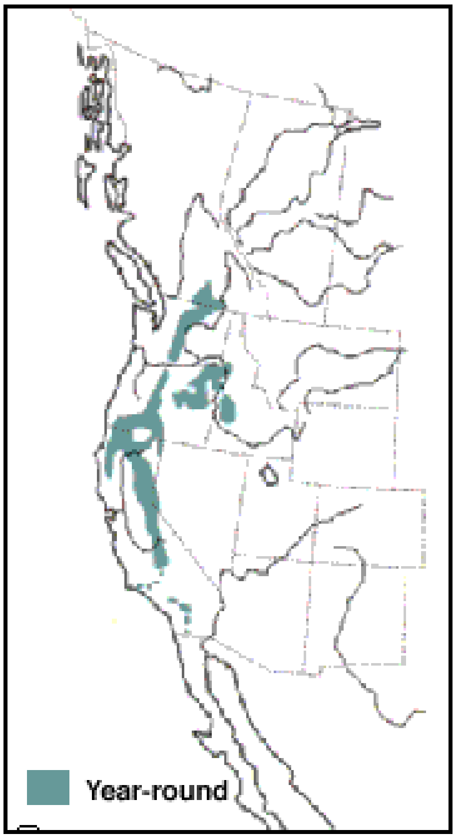

Figure 1. White-headed woodpecker year-round range.

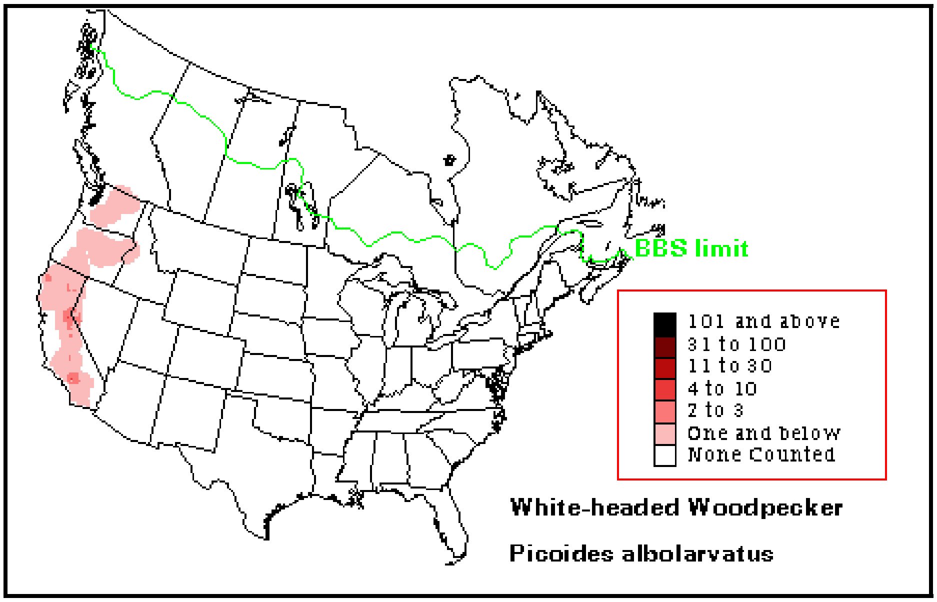

Figure 2. White-headed woodpecker breeding distribution (Sauer *et al.* 2003).

4.0 White-headed Woodpecker Status and Abundance Trends

4.1 Status

Although populations appear to be stable at present, this species is of moderate conservation importance because of its relatively small and patchy year-round range and its dependence on mature, montane coniferous forests in the West. Knowledge of this woodpecker's tolerance of forest fragmentation and silvicultural practices will be important in conserving future populations.

4.2 Trends

North American Breeding Bird Survey data indicate a population change of greater than 1.5 percent change per year throughout most of its year-round range (Figure 3).

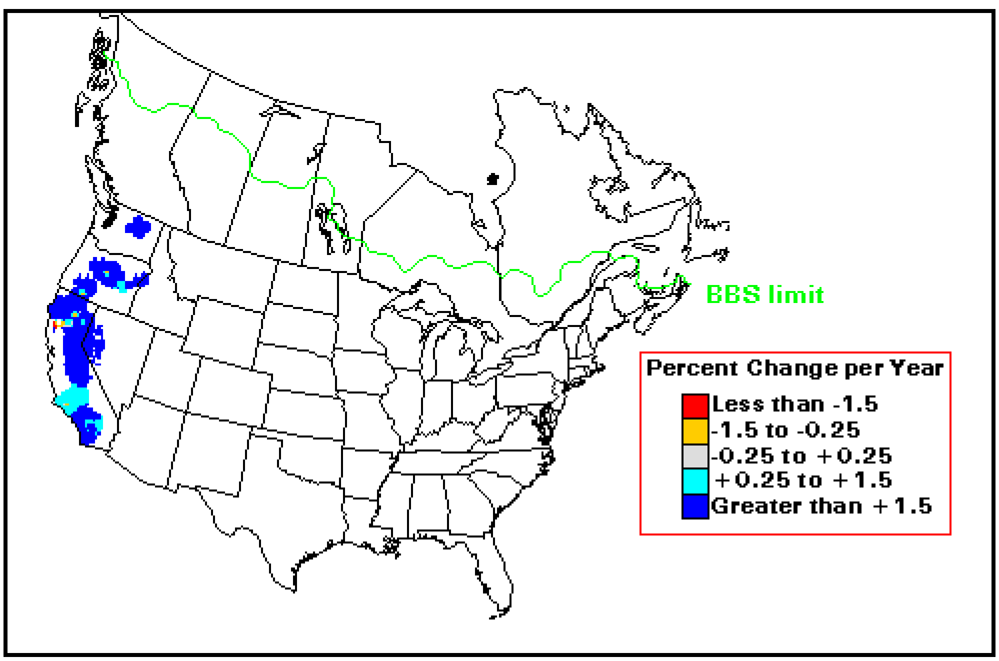

Figure 3. White-headed woodpecker population trend: 1966-1996 (Sauer *et al.* 2003).

5.0 Factors Affecting White-headed Woodpecker Populations and Ecological Processes

5.1 Logging

Logging has removed much of the old cone producing pines throughout the South Okanagan. Approximately 27, 500 ha of Ponderosa pine forest remain in the South Okanagan and 34.5 % of this is classed as old growth forest (Ministry of Environment Lands and Parks 1998). This is a significant reduction from the estimated 75% in the mid 1800s (Cannings 2000). The 34.5 % old growth estimate may in fact be even less since some of the forest cover information is incomplete and needs to be ground truthed to verify the age classes present. The impact from the decrease in old cone producing Ponderosa pines is even more exaggerated in the South Okanagan because there are no alternate pine species for the white-headed woodpecker to utilize. This is especially true over the winter when other major food sources such as insects are not available. Suitable snags (dbh>60cm) are in short supply in the South Okanagan.

5.2 Fire Suppression

Fire suppression has altered the stand structure in many of the forests in the South Okanagan. Lack of fire has allowed dense stands of immature Ponderosa pine as well as the more shade tolerant Douglas fir to establish. This has led to increased fuel loads resulting in more severe stand replacing fires where both the mature cone producing trees and the large suitable snags are destroyed. These dense stands of immature trees has also led to increased competition for nutrients as well as a slow change from a Ponderosa pine climax forest to a Douglas fir dominated climax forest.

5.3 Predation

There are a few threats to white-headed woodpeckers such as predation and the destruction of its habitat. Chipmunks are known to prey on the eggs and nestlings of white-headed woodpeckers. There is also predation by the great horned owl on adult white-headed woodpeckers. However, predation does not appreciably affect the woodpecker population.

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Flammulated Owl
(*Otus flammeolus*)

1.0 Introduction

The flammulated owl is a Washington State Candidate species. Limited research on the flammulated owl indicates that its demography and life history, coupled with narrow habitat requirements, make it vulnerable to habitat changes. The flammulated owl is a species dependent on large diameter Ponderosa pine forests (Hillis *et al.* 2001). The mature and older forest stands that are used as breeding habitat by the flammulated owl have changed during the past century due to fire management and timber harvest.

2.0 Flammulated Owl Life History and Habitat Requirements

2.1 Life History

2.1.1 Diet

Flammulated owls are entirely insectivores; nocturnal moths are especially important during spring and early summer (Reynolds and Linkhart 1987). As summer progresses and other prey become available, lepidopteran larvae, grasshoppers, spiders, crickets, and beetles are added to the diet (Johnson 1963; Goggans 1986). The flammulated owl is distinctively nocturnal although it is thought that the majority of foraging is done at dawn and dusk.

2.1.2 Reproduction

Males arrive on the breeding grounds before females. In Oregon, they arrive at the breeding sites in early May and begin nesting in early June (Goggans 1986). They call to establish territories and to attract arriving females. Birds pair with their mates of the previous year, but if one does not return, they often pair with a bird from a neighboring territory. The male shows the female potential sites from which she selects the one that will be used, usually an old pileated woodpecker or northern flicker hole.

2.1.3 Nesting

The laying of eggs happens from about mid-April through the beginning of July. Generally 2 - 4 eggs are laid and incubation requires 21 to 24 days, by female and fed by male. The young fledge at 21 -25 days, staying within about 100 yards of the nest and being fed by the adults for the first week. In Oregon, young fledge in July and August (Goggans 1986). The young leave the nest around after about 25 days but stay nearby. In Colorado, owlets dispersed in late August and the adults in early October (Reynolds and Linkhart 1987).Sometimes the brood divides, with each parent taking one or two of the young. Adults and young stay together for another month before the young disperse.

2.1.4 Migration

The flammulated owl is one of the most migratory owls in North America. Flammulated owls are presumed to be migratory in the northern part of their range (Balda *et al.* 1975), and winter migrants may extend to neotropical areas in Central America. Flammulated owls can be found in Washington only during their relatively short breeding period. They migrate at night, moving through the mountains on their way south but through the lowlands in early spring.

2.1.5 Mortality

Although the maximum recorded age for a wild owl is only 8 years, 1 month, their life span is probably longer than this.

2.2 Habitat Requirements

2.2.1 General

The flammulated owl occurs mostly in mid-level conifer forests that have a significant Ponderosa pine component (McCallum 1994b) between elevations of 1,200 ft. to 5,500 ft. in the north, and up to 9,000 ft. in the southern part of its range in California (Winter 1974).

Flammulated owls are typically found in mature to old, open canopy yellow pine (Ponderosa pine [*Pinus ponderosa*] and Jeffrey pine [*Pinus jeffreyi*]), Douglas-fir (*Pseudotsuga menziesii*), and grand fir (*Abies grandis*) (Bull and Anderson 1978; Goggans 1986; Howie and Ritchie 1987; Reynolds and Linkhart 1992; Powers *et al.* 1996). In central Colorado, Linkhart and Reynolds (1997) reported that 60% of the habitat within the area defended by territorial males consisted of old (200-400 year) Ponderosa pine/Douglas-fir forest.

Flammulated owls are obligate secondary cavity nesters (McCallum 1994b), requiring large snags in which to roost and nest.

2.2.2 Nesting

Flammulated owls nest in habitat types with low to intermediate canopy closure (Zeiner *et al.* 1990). The owls selectively nest in dead Ponderosa pine snags, and prefer nest sites with fewer shrubs in front than behind the cavity entrance, possibly to avoid predation and obstacles to flight. Flammulated owls will nest only in snags with cavities that are deep enough to hold the birds, and far enough off the ground to be safe from terrestrial predators. The cavity is typically unlined, 11 to 12 in. deep with the average depth being 8.4 in. (McCallum and Gehlbach 1988). California black oak may also provide nesting cavities, particularly in association with ridge tops and xeric mid-slopes, with two layered canopies, tree density of 1270 trees/2.5 acres, and basal area of 624 ft.^{2}/2.5acres (McCallum 1994b). The nest is usually 3-39 ft. above the ground (Zeiner *et al.* 1990) with 16 ft. being the average height of the cavity entrance (McCallum and Gehlbach 1988).

Territories most consistently occupied by breeding pairs (>12 years) contained the greatest (>75%) amount of old Ponderosa pine/Douglas-fir forest. Marcot and Hill (1980) reported that California black oak (*Quercus kellogii*) and Ponderosa pine occurred in 67% and 50%, respectively, of the flammulated owl nesting territories they studied in northern California. In northeastern Oregon, Bull and Anderson (1978) noted that Ponderosa pine was an overstory species in 73% of flammulated owl nest sites. Powers *et al.* (1996) reported that Ponderosa pine was absent from their flammulated owl study site in Idaho and that Douglas-fir and quaking aspen (*Populus tremuloides*) accounted for all nest trees.

The owls nest primarily in cavities excavated by flickers (*Colates spp*.), hairy woodpeckers (*Picoides villosus*), pileated woodpeckers (*Dryocopus pileatus*), and sapsuckers (*Sphyrapicus spp*.) (Bull *et al.* 1990; Goggans 1986; McCallum 1994b). Bull *et al.* (1990) found that flammulated owls used pileated woodpecker cavities with a greater frequency than would be expected based upon available woodpecker cavities. There are only a few reports of this owl using nest boxes (Bloom 1983). Reynolds and Linkhart (1987) reported occupancy in 2 of 17 nest boxes put out for flammulated owls.

In studies from northeastern Oregon and south central Idaho, nest sites were located 16-52 ft. high in dead wood of live trees, or in snags with an average diameter at breast height (dbh) of >20 in. (Goggans 1986; Bull *et al.* 1990; Powers *et al.* 1996). Most nests were located in snags. Bull *et al.* (1990) found that stands containing trees greater than 20 in. dbh were used more often than randomly selected stands. Reynolds and Linkhart (1987) suggested that stands with trees >20 in. were preferred because they provided better habitat for foraging due to the open nature of the stands, allowing the birds access to the ground and tree crowns. Some stands containing larger trees also allow more light to the ground that produces ground vegetation, serving as food for insects preyed upon by owls (Bull *et al.* 1990).

Both slope position and slope aspect have been found to be important indicators of flammulated owl nest sites (Goggans 1986; Bull *et al.* 1990). In general, ridges and the upper third of slopes were used more than lower slopes and draws (Bull *et al.* 1990). It has been speculated that ridges and upper slopes may be preferred because they provide gentle slopes, minimizing energy expenditure for carrying prey to nests. Prey may also be more abundant or at least more active on higher slopes because these areas are warmer than lower ones (Bull *et al.* 1990).

2.2.3 Breeding

Breeding occurs in mature to old coniferous forests from late April through early October. Nests typically are not found until June (Bull *et al.* 1990). The peak nesting period is from mid-June to mid-July (Bent 1961). Mean hatching and fledging dates in Idaho were 26 June and 18 July, respectively (Powers *et al.* 1996).

In Oregon, individual home ranges averaged about 25 acres (Goggans 1986). Territories are typically found in core areas of mature timber with two canopy layers present (Marcot and Hill 1980). The uppermost canopy layer is formed by trees at least 200 years old. Core areas are near, or adjacent to clearings of 10-80% brush cover (Bull and Anderson 1978, Marcot and Hill 1980). Linkhart and Reynolds (1997) found that flammulated owls occupying stands of dense forest were less successful that owls whose territories contain open, old pine/fir forests.

2.2.4 Foraging

Flammulated owls prefer to forage in older stands that support understories, and need slightly open canopies and space between trees to facilitate easy foraging. The open crowns and park-like spacing of the trees in old growth stands permit the maneuverability required for hawk and glean feeding tactics (USDA 1994a).

In Colorado, foraging occurred primarily in old Ponderosa pine and Douglas-fir with an average tree age of approximately 200 years (Reynolds and Linkhart 1992). Old growth Ponderosa pine was selected for foraging, and young Douglas-firs were avoided. Flammulated owls principally forage for prey on the needles and bark of large trees. They also forage in the air, on the ground, and along the edges of clearings (Goggans 1986). Grasslands in and adjacent to forest stands are thought to be important foraging sites (Goggans 1986). However, Reynolds (personal communication) suggests that ground foraging is only important from the middle to late part of the breeding season, and its importance may vary annually depending upon the abundance of ground prey. Ponderosa pine and Douglas-fir were the only trees selected for territorial singing in male defended territories in Colorado (Reynolds and Linkhart 1992).

A pair of owls appear to require about 2-10 acres during the breeding season, and substantial patches of brush and understory to help maintain prey bases (Marcot and Hill 1980). Areas with edge habitat and grassy openings up to 5 acres in size are beneficial to the owls (Howle and Ritcey 1987) for foraging.

3.0 Flammulated Owl Population and Distribution

3.1 Population

3.1.1 Historic

Information for this section is not available.

3.1.2 Current

There is only one recognized race of flammulated owl. There are several races described although they have not been verified. Some of these that may come about are: the longer winged population in the north part of the range, separated as *idahoensis*, darker birds from Guatemala as rarus, (winter specimen thus invalid), *meridionalis* from S. Mexico and Guatemala, *frontalis* from Colorado and borealis from central British Columbia to northeastern California.

3.2 Distribution

3.2.1 Historic

Information for this section is not available.

3.2.2 Current

Flammulated owl distribution is illustrated in Figure 1. Flammulated owls are uncommon breeders east of the Cascade in the Ponderosa pine belt from late May to August. There have been occasional records from western Washington, but they are essentially an east side species. Locations where they may sometimes be found include Blewett Pass (straddling Chelan and Kittitas Counties), Colockum Pass area (Kittitas County), and Satus Pass (Klickitat County) (Figure 2).

Figure 1. Flammulated owl distribution (Kaufman 1996).

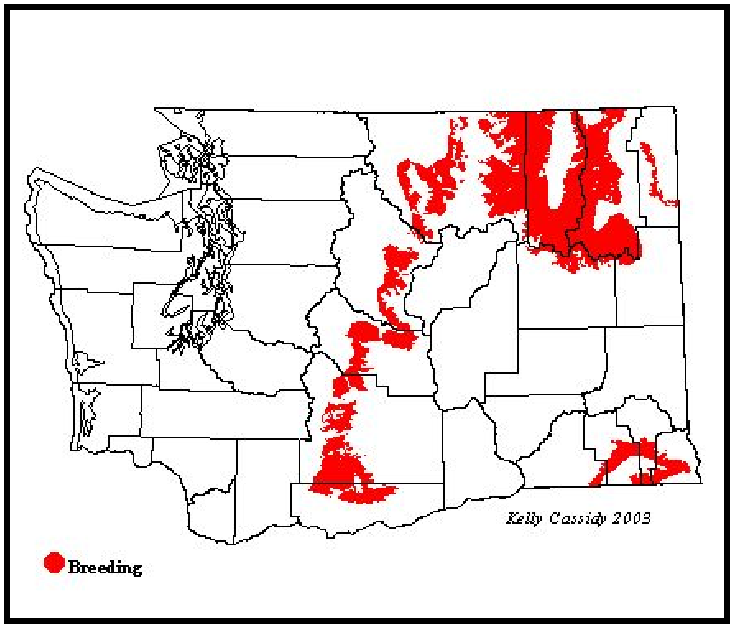

Figure 2. Flammulated owl distribution, Washington (Kaufman 1996).

Except for migration, this species is restricted to montane elevations with seasonally temperate climates. Climate may influence the distribution of the species indirectly through the prey base, (primarily nocturid moths) rather than directly through thermoregulatory abilities as this species tends to forage at night when the temperatures are lowest for the day (McCallum 1994b).

4.0 Flammulated Owl Status and Abundance Trends

4.1 Status

Flammulated owls are candidates for inclusion on the Washington Department of Fish and Wildlife endangered species list and are considered a species-at-risk by the Washington Gap Analysis and Audubon-Washington.

Because old-growth ponderosa pine is rarer in the northern Rocky Mountains than it was historically, and little is known about the local flammulated owl distribution and habitat use, the USFS has listed the flammulated owl as a sensitive species in the Northern Region (USDA 1994b). It is also listed as a sensitive species by the USFS in the Rocky Mountain, Southwestern, and Intermountain Regions, and receives special management consideration in the States of Montana, Idaho, Oregon, and Washington (Verner 1994).

4.2 Trends

So little is known about flammulated owl populations that even large scale changes in their abundance would probably go unnoticed (Winter 1974). Several studies have noted a decline in flammulated owl populations following timber harvesting (Marshall 1939; Howle and Ritcey 1987). However, more and more nest sightings occur each year, but this is most likely due to the increase in observation efforts.

5.0 Factors Affecting Flammulated Owl Populations and Ecological Processes

5.1 Disturbance (Natural or Managed)

The owls have been shown to prefer late seral forests, and logging disturbance and the loss of breeding habitat associated with it has a detrimental effect on the birds (USDA 1994a). Timber harvesting is often done in preferred flammulated owl habitat, and some of the species' habitat and range may be declining as a result (Reynolds and Linkart 1987b; Bull *et al.* 1990). Several studies have shown a decline in flammulated owl numbers following timber harvesting (Marshall 1957; Howle and Ritcey 1987).

A main threat to the species is the loss of nesting cavities as this species cannot create its own nest and relies on existing cavities. Management practices such as intensive forest management, forest stand improvement, and the felling of snags and injured or diseased trees (potential nest sites) for fire wood effectively remove most of the cavities suitable for nesting (Reynolds *et al.* 1989). However, the owls will nest in stands that have been selectively logged, as long as they contain residual trees (Reynolds *et al.* 1989).

The suppression of wildfires has allowed many ponderosa pines to proceed to the more shade resistant fir forest types, which is less suitable habitat for these species (Marshall 1957; Reynolds *et al.* 1989). Encroachment of conifers along ridgetops can also negatively impact the black oak component in the stand through competition of resources and shading resulting in loss of potential nest cavities for flammulated owls in live hardwood trees. Roads and fuelbreaks are often placed on ridgetops and the resultant removal of snags and oaks for hazard tree removal can result in the loss of existing and recruitment nest trees.

Flammulated owls are most susceptible to disturbance during the peak of their breeding season (June and July), which corresponds to the time when they are the most vocal. Clark (1988) cautions against the extensive use of taped calls, stating that they can disrupt coutship behavior. McCallum (1994b) mentions that owls are tolerant of humans, nesting close to occupied areas and tolerating observation by flashlight at night while feeding young. Wildlife viewing, primarily bird watching and nature photography has the potential to disrupt species activity and increase their risk of exposure to predation especially during the nesting season (Knight and Gutzwiller 1995) when birds are most vocal and therefore easier to locate.

The effects of mechanical disturbance have not been assessed, but moderate disturbance may not have an adverse impact on the species. Whether a nesting pair would tolerate selective harvesting during the breeding season is not known, however, mechanical disturbance that flushes roosting birds may be a threat to adult survival in October when migrating accipiters may be more common than in June, when the possibility of lost reproduction is greater (McCallum 1994b).

5.2 Pesticides

Aerial spraying of carbaryl insecticides to reduce populations of forest insect pests may affect the abundance of non-target insects important in the early spring diets of flammulated owls (Reynolds *et al.* 1989). Although flamulated owls rarely take rodents as prey, they could be at risk, like other raptors, of secondary poisoning by anticoagulant rodenticides. Possible harmful doses could cause hemmorhaging upon the ingestion of anticoagulants such as Difenacoum, Bromadiolone, or Brodifacoum (Mendenhall and Pank 1980).

5.3 Predators/Competitors

Predators include spotted and other larger owls, accipiters, long-tailed weasels (Zeiner *et al.* 1990), felids and bears (McCallum 1994b). Nest predation has also been documented by northern flying squirrel in the Pacific Northwest (McCallum 1994a).

As flammulated owls come late to breeding grounds, competitors may limit nest site availability (McCallum 1994b). Saw-whet owls, screech owls, and American kestrels compete for nesting sites, but flammulated owls probably have more severe competition with non-raptors, such as woodpeckers, other passerines, and squirrels for nest cavities (Zeiner *et al.* 1990, McCallum 1994b). Birds from the size of bluebirds upward are potential competitors. Owl nests containing bluebird eggs and flicker eggs suggest that flammulated owls evict some potential nest competitors (McCallum 1994b). Any management plan that supports pileated woodpecker and northern flicker populations will help maintain high numbers of cavities, thereby minimizing this competition (Zeiner *et al.* 1990).

Flammulated owls may compete with western screech-owls and American kestrels for prey (Zeiner *et al.* 1990) as both species have a high insect component in their diets. Common poorwills, nighthawks, and bats may also compete for nocturnal insect prey especially in the early breeding season (April and May) when the diet of the owls is dominated by moths. (McCallum 1994b).

5.4 Exotic Species Invasion/Encroachment

Flicker cavities are often co-opted by European starlings, reducing the availability of nest cavities for both flickers and owls (McCallum 1994a). Africanized honey bees will nest in in tree cavities (Merrill and Visscher 1995) and may be a competitor where natural cavities are limiting, particulary in southern California where the bee has expanded its range north of Mexico.

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Gray Flycatcher
(*Empidonax wrightii*)

1.0 Gray Flycatcher Life History and Habitat Requirements

1.1 Life History

1.1.1 Diet

Information for this section is not available.

1.1.2 Reproduction

Clutch size is three to four. Incubation by female and lasts 14 days. Nestlings are altricial and downy, tended by both parents, leave nest in 16 days, fed by parents for 14 more days.

1.1.3 Nesting

Information for this section is not available.

1.1.4 Migration

Information for this section is not available.

1.1.5 Mortality

Information for this section is not available.

1.2 Habitat Requirements

Information for this section is not available.

2.0 Gray Flycatcher Population and Distribution

2.1 Population

2.1.1 Historic

Information for this section is not available.

2.1.2 Current

See Trends, below.

2.2 Distribution

2.2.1 Historic

Information for this section is not available.

2.2.2 Current

2.2.2.1 Breeding

Gray flycatchers are found in extreme southern British Columbia (Cannings 1992) and south-central Idaho south to southern California, southern Nevada, central Arizona, south-central New Mexico, and locally western Texas (Terres 1980; AOU 1983).

2.2.2.2 Non-breeding

Gray flycatchers during the non-breeding season occur in southern California, central Arizona, south to Baja California and south-central mainland of Mexico (Terres 1980).

3.0 Gray Flycatcher Status and Abundance Trends

3.1 Status

Information for this section is not available.

3.2 Trends

North American Breeding Bird Survey (BBS) shows a survey-wide significantly increasing trend of 10.2 percent average per year (n = 89), 1966-1996; a nonsignificant decline of -1.0 percent average per year (n = 22), 1966-1979; and a significant increase from 1980 to 1996 of 10.0 percent average per year (n = 84) (Figure 1). Data for Oregon reflect strong long-term increase of 7.9 percent average per year (n = 29), 1966-1996. Sample sizes too low for accurate trend estimates in other states (Sauer *et al.* 1997). Gray flycatcher breeding season abundance is illustrated in Figure 2.

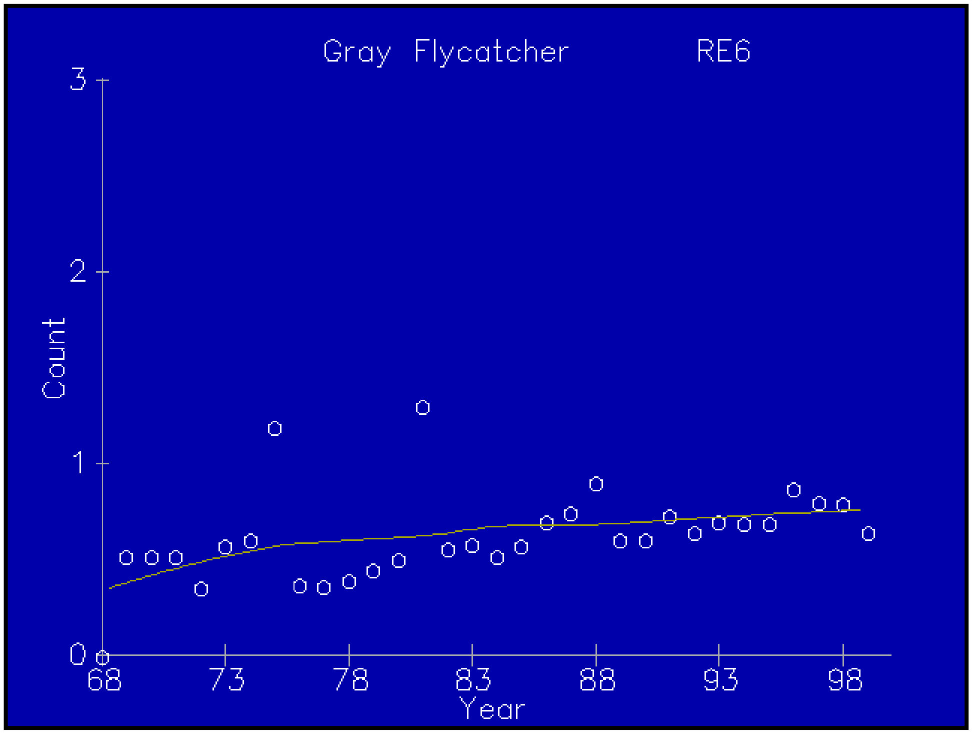

Figure 1. Gray flycatcher population trend data (Sauer *et al.* 1997).

Christmas Bird Count (CBC) data for 1959 to 1988 show a significant survey wide increase of 4.3 percent average per year, and a significant increase in Arizona (4.6 percent average per year, n = 28). Trend for California apparently stable over the period (nonsignificant increase of 0.2 percent average per year, n = 21; Sauer *et al.* 1996). Christmas Bird Count abundance data are illustrated in Figure 3.

Reportedly declining as a wintering bird in southern California; extensions in Washington and California at western edges of breeding range noted in the 1970s (USDA Forest Service 1994).

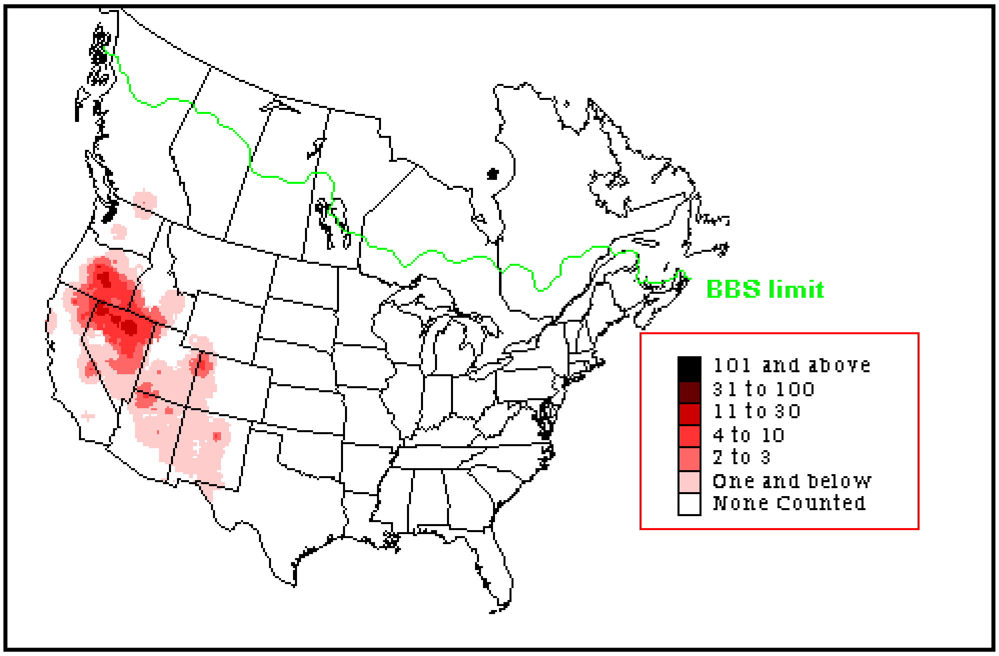

Figure 2. Gray flycatcher breeding season abundance (Sauer *et al.* 1997).

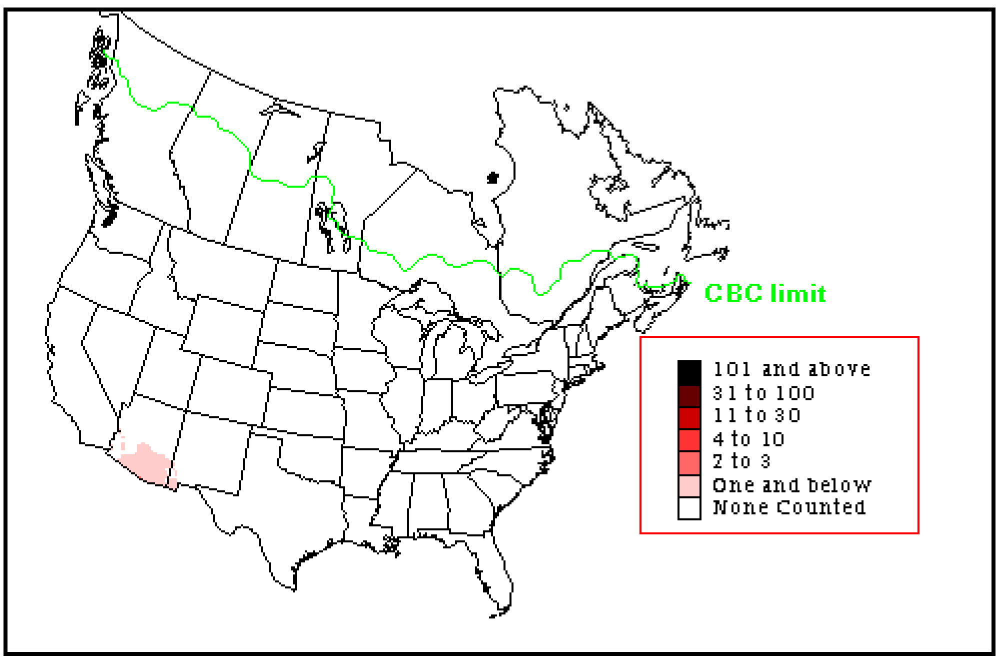

Figure 3. Winter season abundance (Sauer *et al.* 1996).

4.0 Factors Affecting Gray Flycatcher Populations and Ecological Processes

Reasons for decline of wintering birds in southern California are unknown. Gray flycatchers would be vulnerable to land clearing, but generally found in very arid environments that are not usually converted to agriculture (USDA Forest Service 1994). Clearing of pinyon-juniper for mining of coal and oil shale deposits or in favor of grassland for livestock grazing, or widespread harvesting of pinyon-juniper could be detrimental (O'Meara *et al.* 1981 in Sterling 1999). Levels of predation or brood parasitism are unknown. Chipmunks and jays have been observed destroying nests. Other mortality factors are unknown.

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Pygmy Nuthatch
(*Sitta pygmaea*)

1.0 Introduction

The pygmy nuthatch (*Sitta pygmaea*) is a common resident of western yellow pine forests in the United States, principally Ponderosa pine (*Pinus ponderosa*). The geographic distribution of the species ranges from southern interior British Columbia, northern Idaho, western Montana, central Wyoming, and southwestern South Dakota south to northern Baja California (Kingery and Ghalambor 2001). Several subspecies occur throughout this range. A sister species to the brown-headed nuthatch (*Sitta pusilla*) of pine forests in the southeastern United States, the pygmy nuthatch is a small (less than 10 grams), highly social, and gregarious species that during the non-breeding season forms noisy and conspicuous flocks (Kingery and Ghalambor 2001). The pygmy nuthatch breeds in nest cavities it usually excavates in snags and is peculiar among North America's songbirds in that it often breeds cooperatively (Norris 1958). Because they rely on cavities for roosting and for breeding, pygmy nuthatches typically reach their highest population densities in mature pine forests little affected by disturbance and with a large number of standing dead trees (Kingery and Ghalambor 2001). In fact the pygmy nuthatch often serves as an indicator of unmanaged mature ponderosa pine forests (Kingery and Ghalambor 2001).

2.0 Pygmy Nuthatch Life History and Habitat Requirements

2.1 Life History

2.1.1 Diet

The pygmy nuthatch diet varies seasonally and by location. The winter diet is primarily seeds in some populations and mostly insects in others. During the breeding season the diet mainly consists of insects and spiders. Beal (1907) reported that 31 pygmy nuthatch stomachs contained 83% animal matter and 17% vegetable matter. These individuals were collected in Monterey County, California during the summer and contained the following arthropods: Hymenoptera (mostly wasps with a few ants) 38%, Hemiptera (mainly Cercropidae) 23%, Coleoptera (mainly weevils, plus some coccinellids) 12%, also caterpillars 8% and spiders 1%. The vegetable matter consisted entirely of seeds, mainly from conifers.

In contrast, Norris (1958), using year-round samples from Marin County, California, found a diet, by weight, of 65% vegetable matter. He examined 73 stomachs collected in 9 different months. Vegetable food (all seeds of Bishop pine) exceeded 85% of diet from October to January. In late spring the proportion dropped to 39% in April 2% in May, 65% in June and July, and 42% in September. Insect food, most important in spring and fall, consisted of beetles (in 51% of the stomachs), mainly snout weevils (Curculionidae), leaf beetles (Chrysomelidae), bark beetles (Scolytidae), and wood- or bark-infesting larvae, but no Hymenoptera as in Beal's (1907) sample. Nestlings received food from most of the above groups, plus coccinellids. The oldest nestlings also received pine seeds with the hard integument removed. The stomachs of six fledglings had 0-98% pine seeds (average 45%) in them. Eight stomach samples collected in December from Napa County, California, showed a much lower proportion of ponderosa seeds (range 0-65%, mean 39%; Norris 1958).

During the breeding season, pygmy nuthatches appear to select only a few insect taxa among the many available. In Oregon, the pygmy nuthatch breeding diet (by volume) consists of 45% weevils, 37% leaf beetles, and varying amounts of ants and bark-dwelling insects. Weevils disappear from the post-breeding diet, which consists of 59% leaf beetles, 3% weevils, and 38% other insects. Winter diet switches to only 12% leaf beetles, 25% weevils, 12% Hemiptera, 50%

other insects, and only 4% vegetable matter (seeds). The winter diet also includes twice as many bark-dwelling insects (7% cf. 3%) as in the post-breeding diet (Anderson 1976). The amount of food in the stomach reaches its maximum in winter and spring: 0.18-0.20 g (wet weight) in November-May, compared with 0.13-0.15 g in June-September (Norris 1958).

2.1.2 Reproduction

Pygmy nuthatches produce one brood per year, and rarely produce a second replacement clutch (Kingery and Ghalambor 2001). It has the highest nest success, 86.8% (nests that successfully fledged at least one young), of 114 passerine species examined in North America (Martin 1995). The presence of helpers increases the production of offspring (Sydeman *et al.* 1988). Habitat quality also affects nest success; in good quality habitat, 64 breeding units fledged an average of 5.5 young, whereas in poorer habitat 77 units fledged an average of only 4.4 young (see also Limiting Factors below for more information on habitat features associated with breeding productivity). In central Arizona, nesting success is 80% (% of nests that successfully fledge > 1 young, n = 416 nests). This estimate of nest success breaks down by stages in the following way: 89% of nests survive through egg-laying, 85% survive through incubation period, and 80% survive through nestling period (Li and Martin 1991). In the Okanagan Valley, British Columbia, nest success of pygmy nuthatches is 81.9% for birds using nest boxes and using natural cavities. By stage, nest success breaks down as 89.7% of eggs hatching and 91.3% of nestlings fledging (n = 204 eggs, 183 young hatched, 167 fledglings; Cannings *et al.* 1987). In British Columbia, the number of young fledged per successful clutch ranges from 2-12 young in 66 (Campbell *et al.* 1997).

No information is available on lifetime breeding success. The number of broods normally reared per season is almost always only one (Norris 1958; Kingery and Ghalambor 2001). Second broods are likely to be rare because of the long period from egg-laying to full independence (72-78 d; Norris 1958). However, near Flagstaff, Arizona two breeding units had two successful broods in one season (n = 147; Sydeman *et al.* 1988). Also, second broods are known to occasionally occur in the Okanagan Valley, British Columbia (Cannings *et al.* 1987). Second attempts at re-nesting after nest failure are also unusual. Two instances of re-nesting were reported by Norris (1958) and four instances (3 successful; n = 141) by Sydeman *et al.* (1988).

Only the female broods the young. Brooding is intermittent, with the greatest attentiveness during the first 2-3 hours after sunrise. Brooding bouts last about 60% as long as incubation bouts (Norris 1958). During the first 3 days of the nestling period, the female spends about 75% of daytime hours brooding young (mean bout length 12.7 minutes). Ambient temperature affects female attentiveness, in that colder morning temperatures result in greater brooding time. The amount of time the female spends brooding becomes progressively less as the young grow, but remains appreciable until the young reach 3 weeks old (Norris 1958). Both parents and any helpers also spend the night in cavity with the young (Norris 1958; Kingery and Ghalambor 2001). Males feed the brooding female on the nest and provision young when the female is off the nest.

No data on clutch initiation and size are available for the Black Hills region. S. p. pygmaea populations on the California coast appear to breed earlier than the interior populations of S. p. melanotis (Kingery and Ghalambor 2001). For *S. p. pygmaea* in Monterey County, California, nests were occupied from 12 March and had young (n = 3) from 3 May-12 July (the latest dates come from pairs breeding at higher elevations; see Roberson 1993). The median egg date for *S. p. pygmaea* is 9 May (n = 38; Norris 1958). The median egg date for S. p. melanotis populations breeding at lower elevations is 28 May (ranges from 4 May-20 May; Kingery and Ghalambor 2001), and for populations breeding at high elevations in California and the Rocky

Mountains the median egg date is 28 May (ranges from 4 May-20 June, n = 29; Norris 1958). Nests with young have been observed from 29 April-26 July (n = 84). In British Columbia nests with young have been observed from 1 May-1 September (53% occur 27 May- 18 June; n = 156; Campbell *et al.* 1997). In Spokane County, Washington, nests with young have been observed from 29 Apr-3 July (n = 5). In Missoula County, Montana, nests with young were observed from 14 May-11 Jun (n = 4). In Colorado, nests with young have been observed from 3 June-22 July (n = 19; Jones 1998). In New Mexico, nests with young have been observed from 19 May- 13 July (n = 39; Travis 1992).

2.1.3 Nesting

Males appear to take the lead in selecting the nest site, but data supporting this observation are lacking (Norris 1958). Pygmy nuthatches most often use ponderosa pine and other yellow longneedled pines throughout their range, but do occasionally use other conifers and quaking aspen (see Nesting Habitat above). The pygmy nuthatch is both a primary and secondary cavity nester. It typically excavates its own cavity, but will use and modify old woodpecker holes and natural cavities (Bent 1948, Norris 1958). In central Arizona, 73% of all nests were new excavations, 23% were in old cavities excavated in the previous years, and 4% were in natural cavities (n = 237 nests; T. Martin pers. comm.). Both sexes, and sometimes helpers, excavate the cavity and later bring material to the build the nest with (Norris 1958). Both sexes share in excavation equally and the average excavation bouts last 9.2 and 9.9 min for males and females respectively (Storer 1977). The excavating individual can be readily observed swinging back and forth, delivering several blows at the hole, then pausing motionless for a few seconds, before resuming excavation. Birds working inside and outside the cavity make a noise similar to an excavating woodpecker, but typically not as loud. One bird excavating inside the hole exited 3 times in 10 minutes to flip chips and sawdust into wind with its bill (Grinnell *et al.* 1930). The adults more typically make 3-15 blows per session (but up to 25 at a time), and average 6-7. Norris (1958) describes this behavior in detail. Birds may spend up to 63% of their entire day excavating (Norris 1958).

2.1.4 Migration

Pygmy nuthatches are sedentary and resident throughout their range; they do not migrate. No broad scale movements have been observed in any population to date.

2.1.5 Mortality

The estimated average life span of pygmy nuthatches is 1.7 years (the maximum is 6 years, n = 122; Kingery and Ghalambor 2001). However, this estimate is based on a relatively small number of birds and is not corrected for variation in the probability of re-sighting an individual. A larger sample of birds may yield a significantly higher estimate for life span (see Survival And Reproduction below). The pygmy nuthatch has a lower life expectancy than the very closely related brown-headed nuthatch, presumably due to its having larger broods, denser populations, a more “vigorous” way of life (manifested by vocal tempo, rate of feeding female and nestlings, and foraging activity generally), and living in a cooler climate (Norris 1958). The maximum recorded life span, based on recaptures of banded birds is 8 years and 2 months (Klimkiewicz *et al.* 1983; Klimkiewicz 1997).

Males and females are capable of breeding in their first year, however, first year males commonly assist parents as helpers before breeding on their own in their second year. In contrast, most females are likely to breed in their first year (Norris 1958). At the population level, approximately one third of all nests have between 1 and 3 helpers (Norris 1958; Sydeman *et al.* 1988).

No information is available on the proportion of the population that are non-breeders, although non-breeders are more likely to be males (Norris 1958). Because young birds are more likely to disperse from their parent's home range, estimating non-breeders is difficult.

The estimated annual adult survival rate is 65.0%, a high rate for a passerine bird (Martin 1995), and in stark contrast to the short estimated life span of 1.7 years. Over 3 years in Marin County, California, an average of 38% of color-banded birds remained alive in 1 of the 2 following breeding seasons (Norris 1958). First year birds have a 27% annual survival rate (Norris 1958). Sydeman *et al.* (1988) reported a higher survival rate for first-year birds of 44% (21 of 48), but also found an unclear pattern of autumn dispersal. Because first-year birds move and establish breeding sites that are 4 times farther away from their birthplaces compared to the distance adults move between breeding sites, first-year birds are less likely to use a discrete study area making it difficult to separate dispersal from mortality (Norris 1958). Norris (1958) reported as many yearlings in relation to adults in spring and summer as in fall and winter; the ratio of adults to sub-adults in spring and summer (probably including some dependent fledglings) is 1:1.46, while in the fall and early winter it is 1:1.30. Norris (1958) suggested that this indicates similar mortalities for yearlings and adults, but more information is needed to verify this claim.

2.2 Habitat Requirements

Pygmy nuthatches show a strong and almost exclusive preference for yellow pine forests. Their geographic range is almost co-extensive with that of ponderosa pine (*Pinus ponderosa*), Jeffrey pine (*Pinus jeffrey*), and similar species (Kingery and Ghalambor 2001). Among all breeding birds within ponderosa pine forests, the density of pygmy nuthatches is most strongly correlated with the abundance of ponderosa pine trees (Balda 1969). In Colorado 93% of breeding bird atlas observations occurred in coniferous forests, 70% of those in ponderosa pines. Indeed the distribution of pygmy nuthatches in Colorado coincides with that of ponderosa pine woodlands in the state (Jones 1998).

Several studies identify the pygmy nuthatch as the most abundant or one of the most abundant species in ponderosa forests (e.g. Mt. Charleston, Nevada, Arizona's mountains and plateaus, New Mexico, Colorado statewide, and Baja California, see Reassumes 1941; Brandt 1951; Norris 1958; Stallcup 1968; Balda 1969; Farris 1985; Travis 1992; Kingery 1998) as well as in other yellow long-needled pines such as those of coastal California and Popocatépetl, Mexico (Norris 1958; Paynter 1962).

In California's mountains, it favors open park-like forests of ponderosa and Jeffrey pines in the Sierra Nevada Mountains (Gaines 1988) but also ranges to 3050 m in open stands of large lodgepole pine in the White Mountains of California (Shuford and Metropulos 1996). In the Mogollon Rim region of central Arizona, it breeds and feeds in vast expanses of ponderosa pine that extend throughout the Colorado plateau, and, is also common in shallow snow-melt ravines that course through the pine forests. These snow-melt drainages contain white fir (*Abies concolor*), Douglas-fir (*Pseudotsuga menziesii*), Arizona white pine (*Pinus strobiformis*), quaking aspen (*Populus tremuloides*), and an understory of maples (*Acer* sp.) (Kingery and Ghalambor 2001).

In New Mexico, it is most common in ponderosa pine, including ponderosa/oak and ponderosa/Douglas-fir forests (Kingery and Ghalambor 2001). In Washington, it uses Douglas-fir zones rarely, and then only those in or near ponderosa pines (Smith *et al.* 1997). In Summit County, Colorada, a small group of pygmy nuthatches occupy a small section of lodgepole pine at the edge of an extensive lodgepole forest (Kingery and Ghalambor 2001).

In coastal California (Sonoma, Marin, Monterey, San Luis Obispo Counties) pygmy nuthatches occur in the "coastal fog belt" (Burridge 1995) in Bishop pine (*Pinus muricata*), Coulter pine (*Pinus coulteri*), natural and planted groves of Monterey pine (*Pinus radiate*) (Roberson 1993, Shuford 1993), other pine plantations (Burridge 1995), and wherever ponderosa pines grow (e.g., Santa Lucia Mountains, Monterey County) (Roberson 1993).

In Mexico, where it occurs in arid pine forests of the highlands, it follows pines to their upper limits at tree line on Mount Popocatépetl (3,800-4,050 m) (Paynter 1962) and Pico Orizaba (4,250 m) (Cox 1895). In Distrito Federal, it is primarily restricted to coniferous forests above 3,000 m (Wilson and Ceballos-Lascurain 1993). Almost no other contemporary information is available on the habitat preferences of pygmy nuthatches in Mexican mountain ranges. It is known to favor pine and pine-oak woodlands, these pine species include ponderosa-type pines: *Pinus engelmanii, P. arizonica, P. montezumae* and non-ponderosa-types *Pinus teocote, P. hartwegii, P. leiophylla, and P. cooperi*. Associated Mexican tree species in pygmy nuthatch habitat include oaks (*Quercus rugosa, Q. castanea, Q. durifolia, and Q. hartwegii*), madrones (*Arbutus xalapensis* and *A. glandulosa*), and alders (*Alnus firmifolia*) (Nocedal 1984, 1994). It also occurs, in small numbers, in fir (*Abies religiosa*) forests (Nocedal 1984, 1994).

2.2.1 Foraging Habitat

The pygmy nuthatch feeds almost exclusively in pines. It explores the whole tree for food, in this respect it is a more generalized feeder than chickadees and other nuthatches. Pygmy nuthatches typically seek static insect food in needle clusters, cones, twigs, branches, and trunks. It climbs over and under branches, from and to the outermost twigs and needles, and both up and down tree trunks (Bent 1948; Stallcup 1968; Bock 1969; Manolis 1977; McEllin 1978, 1979b; Ewell and Cruz 1998). It spends more time in areas with the highest density and greatest cubic feet of foliage (Balda 1967, 1969). Pygmy nuthatches forage higher in trees and farther from the trunk than the white-breasted nuthatch (*Sitta carolinensis*) and mountain chickadee (Poecile gambeli), but use various zones of the tree in more equal proportions than those flock associates (McEllin 1979b).

Time spent by pygmy nuthatches foraging in different zones of the tree remains relatively similar within the breeding and non-breeding seasons, but differs between seasons. Four studies that quantify time spent in different foraging zones confirm this but differ on the proportionate time spent in the various zones (Stallcup 1968, Larimer County, Colorado.; Bock 1969, Boulder County, Colorado; McEllin 1978, 1979a, Larimer County, Colorado; Ewell and Cruz 1998, Boulder County, Colorado). These studies report that during the breeding season, the percentage of time foraging in different zones of a tree are: trunks 3-35%, large branches 12-15%, small branches, 10-25%, and needles, twigs, and cone clusters, 34-74%. Foraging during the non-breeding season then shifts primarily to the cone clusters: trunks 1-23%; large branches, 7-16%; small branches, 22-34%; needles, twigs, and cone clusters, 34-71%. This shift reflects the greater reliance on pine seeds during the non-breeding season.

In Larimer County, Colorado, the time spent in foraging zones does not differ with respect to foraging height, tree diameter, or location within the tree, and, more time is spent at each foraging location in the non-breeding season than in the breeding season (McEllin 1978). In addition, the pygmy nuthatch uses a greater amount of a tree's vertical height during the nonbreeding season (foraging height averages 9.51 m " .051 SE in the breeding season and 10.40 " .056 SE in the non-breeding season) (McEllin 1979b).

In Boulder County, Colorado, non-breeding birds spent 92.0% of their foraging time in ponderosa pines, 5.3% in Douglas firs, 1.4% in dead brush, and 1.1% on the ground. When in the pines, they spent 34.6% of their feeding time on the trunk, 25.4% on branches, and 22.0% on needles and twigs (Bock 1969). Some foraging on fallen pinecones during the non-breeding and breeding season has also been reported (Stallcup 1968).

2.2.2 Nesting Habitat

Because the pygmy nuthatch nests primarily in dead pines and live trees with dead sections, it prefers mature and undisturbed forests that contain a number of large snags (Szaro and Balda 1982). Pygmy nuthatch abundance correlates directly with snag density and foliage volume of the forest, but inversely with trunk volume, implying that it needs heterogeneous stands with a mixture of well spaced, old pines and vigorous trees of intermediate age (Balda *et al.* 1983). Scott (1979) illustrated the importance of snags for pygmy nuthatch populations by comparing two plots that had been harvested for trees, but differed in that snags were removed in one plot and left in the other. Pygmy populations decreased by half on the plot where snags had been removed (16.3 pairs/ ha to 7.6 pairs/ ha), whereas populations slightly increased on the plot where snags were left (18.7 pairs/ ha to 22.6 pairs/ ha) (Scott 1979). This reliance on ponderosa pine forests with high amounts of foliage volume and numerous snags has led some authors to regard the pygmy nuthatch as one of best indicator species for overall “health” of bird communities in mature ponderosa pine forests (Szaro and Balda 1982).

The mean height of nest trees for *S. p. melanotis* populations nesting in Colorado, Montana, and Arizona is 16.03 m. The mean diameter at breast height (dbh) of nest trees for S. p. melanotis populations nesting in Arizona is 47.83 cm. The mean height of the nest cavity for S. p. melanotis populations nesting in Colorado, Montana, and Arizona is 10.57 m (2.83 SE). Cavity height also varies by tree species: ponderosa pine, 1-21.3 m, mean 7.6 m (n = 78); Jeffrey pine, 2.4-7.6 m, mean 5.6 m. (n = 7); Bishop pine 3.4-15 m, mean 10.1 (n = 22); Douglas-fir 9-23 m, mean 14.8 (n = 7); quaking aspen, 9-23 m, mean 5.7 (n = 8).

In a comparison of habitat characteristics surrounding the nest tree, Li and Martin (1991) compared an 11.3 radius circular plot around the nest to a random plot centered on a similar sized tree of the same tree species used for nesting. They found that the circular plots surrounding the nest trees had significantly more aspen and conifer snags, more conifers of greater than 15 cm (dbh), and fewer deciduous trees of greater than 15 cm (dbh) in comparison to the randomly selected plots (Li and Martin 1991).

In central Arizona, pygmy nuthatches placed 78% of their nests in completely dead snags, 11% in the dead portions of live trees, and 11% in completely live trees (n = 18 nests) (Li and Martin 1991).

3.0 Pygmy Nuthatch Population and Distribution

3.1 Historic

Little or no information exists on the historic range, but it is unlikely to differ significantly from the current distribution, which is closely tied to the distribution of ponderosa pines.

3.2 Current

The pygmy nuthatch is resident in ponderosa and similar pines from south central British Columbia and the mountains of the western United States to central Mexico. The patchy distribution of pines in western North America dictates the patchy distribution of the pygmy nuthatch throughout its range. The reliance on pines distinguishes pygmy nuthatches from other western nuthatches such as the red-breasted and white breasted, which are associated with fir/spruce and deciduous forests respectively (Ghalambor and Martin 1999). The following is a review of the distribution of populations in the United States, Canada, and Mexico (Kingery and Ghalambor 2001).

The pygmy nuthatch occurs in southern interior British Columbia, particularly in Okanagan and Similkameen valleys and adjacent plateaus (Campbell *et al.* 1997) south into the Okanagan Highlands and the northeast Cascades of Washington. It is scattered along the eastern slope of the Cascades from central Washington (Jewett *et al.* 1953; Smith *et al.* 1997) into Oregon and in the Blue Mountains in southwest Washington (Garfield County only) (Smith *et al.* 1997) but widespread in Oregon along the west slope of the Cascades (Gabrielson and Jewett 1940; Jewett *et al.* 1953; Gilligan *et al.* 1994). It ranges south from the Cascades in Oregon into northern California and south into the Sierra Nevadas and nearby mountains of Nevada (Brown 1978). In the southern Sierra Nevadas it is found on the east and west side of the range in the Mono Craters and Glass Mountain region (Gaines 1988; Shuford and Metropulos 1996) and in the White Mountains of Nevada and California (Norris 1958; Brown 1978; Shuford and Metropulos 1996). It is also found throughout the mountain ranges of southern California, including the Sierra Madres in Santa Barbara County, the Mt. Pinos area (Kern and Ventura Counties), the San Gabriel and San Bernardino Mountains in Los Angeles and San Bernardino Counties (Norris 1958), the San Jacinto and Santa Rosa Mountains in Riverside County (Norris 1958), and in the Laguna and Cuyamaca Mountains, as well as Mt. Palomar, Volcan and Hot Springs Mountains of San Diego County (San Diego County Breeding Bird Atlas preliminary data). The range extends south into the Sierra Juarez and Sierra San Pedro Mártir Mountains in Baja California Norte, Mexico (Grinnell 1928; Norris 1958).

In eastern Washington, the pygmy nuthatch is common in the pine forests of Spokane County (Jewett *et al.* 1953; Smith *et al.* 1997) and adjacent Kootenai County, ID (Burleigh 10 1972). Only scattered records exist for the rest of Idaho’s mountains (Burleigh 1972; Stephens and Sturts 1991) but pygmy nuthatches are well distributed in the Rocky Mountains of far western Montana (Montana Bird Distribution Committee 1996).

4.0 Pygmy Nuthatch Status and Abundance Trends

4.1 Status

The pygmy nuthatch is not currently listed as a threatened or endangered species by the U.S. Fish and Wildlife Service. However, it is listed as a “sensitive” species in the Rocky Mountain Region (R2) of the U.S. Forest Service. Sensitive species are those for which population viability is a concern as evidenced by: a) significant current or predicted downward trends in population numbers or density; or b) significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution. The justification for the sensitive status of the pygmy nuthatch is based on its close association with unmanaged mature ponderosa pine forests, a habitat type that has substantially declined in recent years (e.g. Hutto 1989; Wisdom *et al.* 2000). The pygmy nuthatch also serves as a Management Indicator Species (MIS) within the Rocky Mountain Region (R2) and on many National Forests within the Southwestern Region (R3) (e.g. Coconino and Prescott National Forests, Arizona and Cibola National Forest, New Mexico). The indicator species designation exists because numerous lines of evidence suggest that negative changes in the population status of pygmy nuthatches within managed ponderosa pine forests may reflect adverse changes to the community as a whole (see also Diem and Zeveloff 1980). Within the Pacific Northwest Region (R6), the pygmy nuthatch was selected along with 39 other bird species to be the “focus” of a broad scale analysis of source habitats in the interior Columbia basin (Wisdom *et al.* 2000). The criteria for selecting the pygmy nuthatch as a focal species was based on a petition filed by the Natural Resources Defense Council with the Regional Forester of the Pacific Northwest Region (Wisdom *et al.* 2000).

At the state level, Arizona, Colorado, Idaho, Oregon, and Wyoming list the pygmy nuthatch as a species of special concern based on its status as an indicator species (Clark *et al.* 1989; Luce *et al.* 1997; Webb 1985). However, within each state different organizations take different positions on the status of the species, for example the Colorado Natural Heritage Program classifies it as "very common, demonstrably secure" (Kingery and Ghalambor 2001) and it is only ranked as being a species of "moderate concern" in Arizona by Arizona Partners in Flight (Hall *et al.* 1997).

4.2 Trends

Survey-wide estimates of all BBS routes suggest pygmy nuthatch populations are stable (Sauer *et al.* 2000). However, these estimates are based on small samples that do not provide a reliable population trend nor reliable trends for any states or physiographic regions, due to too few routes, too few birds, or high variability (Sauer *et al.* 2000). The lack of reliable data is particularly the case in the Black Hills, where there are too few data to perform even the most basic trend analysis (Sauer *et al.* 2000). Where long-term data are available for particular populations, natural fluctuations in population numbers have been documented. For example, a constant-effort nest-finding study in Arizona recorded a major population crash. On this site between 1991-1996 the number of nests found each year varied from 23-65 (mean = 50.2), whereas in the same site from 1997-1999, only 2-5 nests were found each year (Kingery and Ghalambor 2001). Likewise, Scott's (1979) study also portrays a pygmy nuthatch population swing, but no clear factor has been identified as being responsible for rapid changes in population numbers. No definitive explanation currently exists for why some pygmy nuthatch populations may be prone to large fluctuations, but it is suspected that an intolerance to cold winter temperatures, and or a poor cone crop may play a role.

5.0 Factors Affecting Pygmy Nuthatch Populations and Ecological Processes

There is good evidence for at least two main limiting factors in pygmy nuthatch populations: 1) the availability of snags for nesting and roosting, and 2) sufficient numbers of large cone-producing trees for food.

5.1 Nest Site Availability

Pygmy nuthatches depend on snags for nesting and roosting. In all cases where timber harvesting has reduced the number of available snags, the number of breeding pairs declines (McEllin 1979a; Brawn 1987; Brawn and Balda 1988a; Bock and Fleck 1995.). Experimental evidence on the role of nest sites in limiting population numbers comes from nest box addition studies. The addition of nest boxes increases breeding pairs by 67-200% and this increase is greater in selectively cut and clear-cut forests with reduced snag availability (Brawn 1987; Brawn and Balda 1988a; Bock and Fleck 1995). These experiments do not address use of boxes during the non-breeding season and the effect upon winter survival, but boxes are seldom used for roosting during non-breeding season. Further evidence that snag availability plays a role in limiting population numbers comes from estimates of population density on logged sites with and without nest boxes added. Addition of nest boxes increases the density of pygmy nuthatches on "severely thinned" and "moderately thinned" plots respectively, from 3 pairs/40ha to 10 pairs/40 ha and from 15/40ha to 25 pairs/40 ha (Brawn and Balda 1988a). Similarly, a comparison of unlogged, moderately thinned, and severely thinned plots showed that pygmy nuthatches will use natural and self-excavated cavities in unlogged forest (15 of 16 nests), but switch to nest boxes in moderately thinned (15 of 16 nests) and heavily thinned (10 of 10 nests) forests where snag availability has been reduced (Brawn 1988).

5.2 Roost Site Availability

Pygmy nuthatches choosing roost sites during the non-breeding use a different set of characteristics compared to nest sites. In a heavily harvested forest near Flagstaff, Arizona, birds chose atypical cavities with poorer thermal properties compared to adjacent unlogged forests (Hay and Güntert 1983). This suggests that a considerable reduction in snag densities may affect overwinter survivorship and possibly reproduction by forcing pygmy nuthatches to use cavities in snags they would normally avoid (Hay and Güntert 1983; Matthysen 1998). More research on the differences among snags is clearly needed in order to distinguish those factors that make some snags more desirable than others.

5.3 Availability of Foraging Substrate

Pygmy nuthatches differ from other nuthatches in that they prefer to forage amongst the foliage of trees rather than simply on the bark. A number of lines of evidence suggest that because pygmy nuthatches rely heavily on pine seeds during the non-breeding season and preferentially feed in dense foliage, they are particularly sensitive to significant habitat alterations. For example, in a comparison of open forests that have been severely thinned of all snags and have a 75% reduction in pine foliage and forests that were only "moderately thinned", Brawn and Balda (1988a) found that even with the addition of nest boxes, pygmy nuthatch densities were significantly higher on the moderately thinned plot. These results suggest that foliage volume and food resources can influence pygmy nuthatch densities independent of cavity availability. In a comparison of "clear-cut", "heavy cut", "medium cut", "light cut", and "uncut" forests, Szaro and Balda (1986) similarly found that pygmy nuthatches and other species that select dense foliage became less abundant as the habitat became more "modified". Rosenstock (1996) concluded that pygmy nuthatches and other species that prefer to forage in more dense foliage decline in forests that have low canopy density, high canopy patchiness, and reduced vertical vegetation density, as commonly occur as a result of timber harvesting. Furthermore, there is also a general positive correlation between pygmy nuthatches and the diameter (dbh) of pine trees (Rosenstock 1996). Finally, Sydeman *et al.* (1988) report that pygmy nuthatches achieve higher breeding success in "undisturbed mature" forests compared to forests that were selectively cut in the past and were being continually cut for fuelwood. The "undisturbed forests" had not been disturbed for over 70 years and had a greater basal area of ponderosa pine (13.97 vs. 10.46 m2/hectare, fewer but larger ponderosa pines per hectare (50.65 vs. 40.37 cm dbh), and taller ponderosa pines (18.82 vs. 15.36 m) compared to the disturbed site (Sydeman *et al.* 1988). The undisturbed site also contained more junipers and oaks per hectare, and significantly more snags per hectare (112 vs. 24) than the disturbed site (Sydeman *et al.* 1988).

5.4 Risk Factors

The following is a prioritized list (beginning with the most important) of risk factors or threats faced by pygmy nuthatches. These risk factors are based on the most current knowledge available and are discussed in the context of the Black Hills.

5.5 Snag Availability

Pygmy nuthatches are dependent on snags for nesting and roosting, and reduced snag availability has been shown to have negative effects on populations. Because pygmy nuthatches nest and roost in excavated tree cavities, the importance of snags is manifested during both the breeding and non-breeding season. During the breeding season, numerous studies have documented a decline in the number of breeding pairs and a reduction in population density on sites where timber harvesting reduced the number of available snags. During the non-breeding season, studies show that timber harvests that remove the majority of snags, cause communally roosting groups to use atypical cavities with poorer thermal properties.

5.6 Foraging Habitat

Pygmy nuthatch populations rely heavily on the availability of pine seeds and arthropods that live on pines. In comparison to other nuthatches and woodpeckers, pygmy nuthatches forage more amongst the foliage of live trees rather than on the bark. The preferred foraging habitat for pygmy nuthatches appears to contain a high canopy density, low canopy patchiness, and increased vertical vegetation density, a common feature of mature undisturbed forests.

5.7 Loss of Continuous Habitat

Pygmy nuthatch populations are very sedentary. Young birds have been observed to only move 286.5 meters from their natal territories. Such limited dispersal reduces the number of individuals that emigrate and immigrate from local populations, which in turn reduces gene flow and demographic stability. Thus, in contrast to the majority of North America's songbirds, movement and dispersal patterns in pygmy nuthatch populations is limited to a relatively small geographic area. Therefore, pygmy nuthatches may need a greater amount of connectivity between suitable habitat potentially in comparison to other resident birds.

5.8 Timber Harvest

The effects of timber harvesting on bird communities as a whole may have both beneficial and negative effects. Because timber harvesting changes the structure, density, age, and vegetative diversity within forests, the new habitats created following timber harvesting activities may be either suitable or unsuitable to different species of birds. Furthermore, the type of timber harvesting (e.g. clear-cut, partial-cut, strip-cut) may also have differential consequences on the local bird community. No study to date has quantified the effects of timber harvesting on pygmy nuthatches in the Black Hills (see Dykstra *et al.* 1997 for other species). Nevertheless, various lines of research suggest that some timber harvesting treatments have negative impacts on pygmy nuthatches (Hejl *et al.* 1995; Finch *et al.* 1997). Comparisons between uncut mature forests and forests that have been subject to various silvicultural treatments reveal that the density of pygmy nuthatches is significantly reduced on harvested forests (Franzreb and Ohmart 1978; Brawn 1988, Sydeman *et al.* 1988), and these reduced numbers are significantly correlated with reduced snag density and the volume of ponderosa pine foliage. For example, Szaro and Balda (1979) report that the average number of breeding pygmy nuthatches over a three year period in uncut mature forests (582.5 ponderosa pines/ha) was 14 pairs / 40 ha, in a strip cut forest (145 ponderosa pines/ha) it was 4.0 pairs /40 ha, in a severely thinned forest (59.7 ponderosa pines/ha) 1.3 pairs /40 ha, and in a selectively cut forest (216.1 ponderosa pines/ha) that only removed some old mature trees 13.5 pairs /40 ha. Pygmy nuthatches were always found to be absent from clear cut forests (Szaro and Balda 1979). Similarly, Balda (1975) reports the number of breeding pairs on three uncut mature ponderosa pine forests to be 26, 15, and 43 pairs per 100 acres, whereas on two plots where all snags were removed the number of pairs dropped to 2 and 3 pairs per 100 acres. Scott (1979, 1983) reports that the before-and-after density of pygmy nuthatches dropped from 16.3 pairs/ 100 ha to 7.6 pairs/ 100 ha on plots where timber harvesting reduced the basal area of live trees from 110 to 64 square feet per acre and also resulted in the removal of all snags. In contrast, on plots where timber harvesting reduced the basal area from 107 to 51 square feet per acre but no snags were removed, the number of breeding pairs increased from 18.7 pairs/ 100 ha to 22.6 pairs/ ha (Scott 1979). During the same time, pygmy nuthatch populations on control plots that had a standing basal area of 102 square feet per acre and were not cut, numbers increased from 13.6 pairs/ ha to 20.4 pairs/ ha (Scott 1979). The pygmy nuthatch was one of four species that showed a significant reduction in population density with a reduction in snags (Scott 1979, 1983). These results illustrate the importance of retaining snags during timber harvests. In addition, work by Balda (1969, 1975), Szaro and Balda (1986), O'Brien (1990) and Rosenstock (1996) all conclude that pygmy nuthatches prefer to forage in dense foliage and populations decline in forests that have low canopy density, high canopy patchiness, and reduced vertical density, which are a common result of timber harvesting activities. For example, even using "coarse" forest survey plot data, O'Brien (1990) found that the number of pygmy nuthatches was significantly correlated with both foliage volume of ponderosa pine and the estimated availability of food in ponderosa pines (computed using average canopy height and canopy closure; see O'Brien 1990 for more details). Furthermore, O'Brien (1990) found that the average number of pygmy nuthatches observed was much higher (6.5 vs. 1.5) and more birds were observed at more locations in a more remote less intensively managed forest than a forest intensively managed for timber. Using a somewhat similar approach, Rosenstock (1996) found a general positive correlation between pygmy nuthatches and the diameter of pine trees.

Dykstra *et al.* (1997) examined the effects of timber harvesting on birds in ponderosa pine forests in the Black Hills, but did not record the presence of pygmy nuthatches on either harvested or unharvested stands.

5.9 Recreation

Recreational activities can negatively impact bird populations through the accidental and purposeful taking of individuals, habitat modification, changes in predation regimes, and disturbance (Knight and Cole 1995; Marzluff 1997). In a recent review of the effects of recreation on songbirds within ponderosa pine forests, Marzluff (1997) hypothesized that "nuthatches" would experience moderate decreases in population abundance and productivity in response to impacts associated with established campsites (although pygmy nuthatch was not specifically identified). Impacts associated with camping that might negatively influence nuthatches include changes in vegetation, disturbance of breeding birds, and increases in the number of potential nest predators (Marzluff 1997). However, other recreational activities associated with resorts and recreational residences might moderately increase nuthatch population abundance and productivity (Marzluff 1997). This positive effect on nuthatch populations is likely to occur through food supplementation, such as bird feeders, that are frequently visited by pygmy nuthatches.

5.10 Livestock Grazing

No study to date has considered the effects of livestock grazing on the pygmy nuthatch or any other cavity-nesting bird. In the short-term it is unlikely that grazing would have any negative or positive impacts on the pygmy nuthatch because their foraging is largely confined to foliage in large trees. The long-term effects of grazing in ponderosa pine forests on pygmy nuthatches are difficult to predict. On one hand, grazing can reduce grass cover and plant litter that in turn can enhance survival of pine seedlings and reduce the frequency of low-intensity ground fires. On the other hand, heavy grazing can also change the recruitment dynamics of ponderosa pines and aspens that eventually would be used for breeding, roosting, and foraging and also alter the frequency of high-intensity crown fires. Studies that compare the vegetation characteristics and productivity of pygmy nuthatches in grazed and non-grazed forests could provide important information in this regard.

5.11 Mining

No study to date has considered the effects of mining on the pygmy nuthatch or other cavity nesting bird. However, mining or any related activity that resulted in a significant loss of snags or reduced the number of large mature trees could have negative consequences. Mining could also have negative consequences on pygmy nuthatches by disrupting breeding birds.

5.12 Prescribed Fire

Because fire is an important natural process in ponderosa pine forests and is an important factor in creating snags, the restoration of natural fire regimes has been proposed as a management tool (Covington and Moore 1994; Arno *et al.* 1995; Fule and Covington 1995). In particular, the use of prescribed fires to reduce fuel loads has been suggested as being necessary in order to return fire regimes to more “natural” conditions (e.g. Covington and Moore 1994; Arno *et al.* 1995). Because frequent, low intensity ground fires play an important role in maintaining the character of natural ponderosa woodlands (Moir *et al.* 1997), prescribed low intensity ground fires are presumed to have beneficial effects on the pygmy nuthatch. However, little information exists on the short- and long-term benefits of fire on pygmy nuthatches. The short-term effects of large crown fires appears to have negative effects on pygmy nuthatch populations because of a reduction in the sources of food and shelter (Brawn and Balda 1988b). Lowe *et al.* (1978) examining more long term effects, report that pygmy nuthatches were more common in an unburned plot, rather than on plots that had undergone stand replacing fires at various times in the previous 20 years. However, many of these burned sites may have been salvage logged, making it difficult to distinguish fire effects from logging effects (Finch *et al.* 1997). Similar problems have plagued other studies (Overturf 1979; Blake 1982; Aulenbach and O’Shea- Stone 1983) attempting to quantify the effects of fire on pygmy nuthatches and other birds within ponderosa pine forests (Finch *et al.* 1997). The importance of experimental design is illustrated by Horton and Mannan (1988) who examined the effects of a prescribed broadcast understory fire on breeding birds in a ponderosa pine forest. They found that pygmy nuthatch densities dropped from 24.4 individuals / 40 ha to 14.2 individuals/ 40 ha following the prescribed fire (Horton and Mannan 1988), however, on non-burned control plots they found a similar decrease of 26.2 individuals / 40 ha to 15.8 individuals / 40 ha (Horton and Mannan 1988). These results suggest that the decrease in pygmy nuthatch numbers on the burned plots may have been unrelated to the prescribed fire. However, although this study incorporated a control plot, there was only a single replicate for the experimental and control treatments. Clearly, more research on the effects of low intensity and high intensity fires on pygmy nuthatch 59 populations is needed.

Thus, the current level of information makes it difficult to accurately predict the effects of fire on pygmy nuthatches. However, it seems reasonable to conclude that low intensity ground fires would have little or no negative effects, whereas high intensity crown fires would have significant negative short-term effects because of the reduction in foraging habitat.

5.13 Fire Suppression

Long-term fire suppression can lead to changes in forest structure and composition, and result in the accumulation of fuel levels that can lead to severe crown fires that replace entire stands of trees. Little information is available on populations of pygmy nuthatches prior to fire suppression policies, although evidence from Arizona and New Mexico suggest they were abundant (Scurlock and Finch 1997). Attempts to restore ponderosa pine forests to their pre-European structure and function (i.e. conditions prior to forest suppression) should have positive impacts on pygmy nuthatch populations, but too little information is currently available. Current work by Paul Beier and colleagues at Northern Arizona University is looking at the abundance and diversity of birds in a ponderosa pine forest that is being restored by the Bureau of Land Management to its historic condition. This work should provide some insight into how pygmy nuthatch populations respond to a large-scale effort to restore old-growth ponderosa pine. Decades of fire suppression also increase the risk of large stand replacing fires. While the effects of fire on pygmy nuthatch populations remains unclear (see above), large crown fires are expected to have negative affects on pygmy nuthatches by reducing or eliminating sources of food and shelter (Brawn and Balda 1988b).

5.14 Non-Native Plant Establishment And Control

No study to date has investigated how the establishment or control of non-native plants influences pygmy nuthatches or any other cavity-nesting bird species in ponderosa pine forests. Some techniques employed to control non-native plants such as prescribed fires are expected to have little or no effect as long as these fires are low intensity ground fires. To the extent that establishment of non-native plants alters the recruitment of trees used for foraging or nesting, such as ponderosa pine or quaking aspen, there could be long-term impacts.

5.15 Fuelwood Harvest

Fuelwood harvesting occurs at two levels. At a large-scale, forest managers often harvest dead or diseased trees from large areas, particularly after fires, windstorms, and other natural events. The justification for removing dead and diseased trees is to reduce the accumulation of fuelwood that could lead to high-intensity fires. At a smaller-scale, standing dead trees, fallen trees and other downed woody debris are collected for firewood at campsites or other personal uses. Any fuelwood harvesting that removes standing snags is expected to reduce the population density of pygmy nuthatches. The harvesting of fallen trees and downed woody debris is not expected to have any negative consequences.

5.16 Insect Epidemics

Insect populations typically show large fluctuations over time. Within ponderosa pine forests, attention and concern over insect populations is primarily focused on the mountain pine beetle (*Dendroctonus ponderosae*) because of its potential to kill trees that would otherwise be desirable for harvesting. No study to date has investigated how pine beetle outbreaks influence pygmy nuthatch populations. The ultimate effects of insect epidemics may be related to the scale at which outbreaks occur. Small insect outbreaks that only kill small patches of trees may have beneficial effects on pygmy nuthatch populations, because the increase in tree mortality results in more snags for nesting and roosting. However, large-scale epidemics that result in large amounts of tree mortality could have negative consequences on pygmy nuthatches because of they rely heavily on the foliage of live pine trees for foraging. Thus, the ultimate net effect may be related to how extensive the outbreaks are. Clearly, further study in this area would be warranted.

5.17 Wind Events

Wind events have the potential to negatively influence pygmy nuthatch populations by blowing down snags used for nesting and roosting. During the non-breeding season, when large numbers of pygmy nuthatches communally roost in a single cavity, severe wind events have the potential to harm large numbers of individuals by blowing down roost trees. During the breeding season, such risks are minimized because individuals are distributed among many snags used for breeding.

5.18 Other Weather Events

Cold temperatures, particularly during the winter months, have the potential to reduce pygmy nuthatch populations. Szaro and Balda (1986) report that breeding bird densities (including pygmy nuthatches) were highest following the mildest winter conditions and bird densities were lowest following a winter with the highest winter snowfall on record in their Arizona study sites. Given that pygmy nuthatches have a low tolerance to cold temperatures, as exemplified by their use of torpor and communal roosting, cold winter temperatures may have disproportionately greater effects on their populations.

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Pygmy Rabbit
(*Brachylagus idahoensis*)

1.0 Introduction

The pygmy rabbit (*Brachylagus idahoensis*) is the smallest native rabbit in North America. The Columbia Basin pygmy rabbit has been isolated from other pygmy rabbit populations for thousands of years, is genetically unique, and occupies an unusual ecological setting compared to other pygmy rabbit populations. Adults weigh approximately 1 pound and measure less than 1 foot in length. They are one of only two rabbit species in North America that dig their own burrows. Pygmy rabbits are usually found in areas of dense sagebrush cover with relatively deep, loose soils.

The number of Columbia Basin pygmy rabbits and active burrows in Washington State has declined dramatically over the past decade. The entire wild Columbia Basin pygmy rabbit population is now considered to consist of fewer than 30 individuals from just one known site. This population segment is imminently threatened by its small population size and fragmentation, coupled with habitat loss, disease, predation, and inbreeding.
Barely hanging on in the wild, these pygmy rabbits have been collected for a captive breeding program in the hopes of building up numbers and reintroducing them. For a successful reintroduction, habitat needs to be identified, connected, and protected, and grazing and off-road vehicle use should be curtailed.

Because of low numbers and limited distribution, pygmy rabbit populations in Washington are vulnerable to fire, disease, intense predation, and the random variation in birth and death rates, sex ratios, and combinations of demographic parameters that sometimes cause the collapse of small populations. Habitat degradation and loss are likely to continue without active prevention efforts. Before the pygmy rabbit can be considered at low risk of extirpation in Washington, numbers and distribution must be increased. In addition, adequate habitat must be managed for the long-term protection of features that support pygmy rabbits.

Recovery strategies for this species include protection of existing habitat, identification and management of lands for creation of new habitat, monitoring of the pygmy rabbit population, and research to better understand the effects of management actions. Grazing, if it occurs in pygmy rabbit areas, should be managed to be compatible with pygmy rabbit habitat needs. In all pygmy rabbit areas, steps should be taken to reduce the risk of range fire. To increase the extent of pygmy rabbit habitat, efforts should be directed at identifying lands where soil conditions are suitable for pygmy rabbits. If necessary, lands with appropriate soil conditions should be restored or enhanced to provide pygmy rabbit habitat. Pygmy rabbits should be introduced to selected vacant habitat. Other strategies, including enforcement, data management, cooperative work with landowners and other agencies, research, and public information should all play a role in pygmy rabbit recovery efforts.

2.0 Pygmy Rabbit Life History and Habitat Requirements

2.1 Life History

2.1.1 Diet

The diet of Idaho pygmy rabbits was studied by analysis of fecal pellets (Green and Flinders 1980b). Sagebrush (*Artemisia spp.*) comprised 99% of the winter diet. During spring and summer, sagebrush continued to be important in the diet (51% relative density), though grasses (39%) and forbs (10%) increased in importance. Preference indices (PI) indicated that pygmy rabbits ate sagebrush in the same proportion as found in their environment (PI=1). The highest preference indices, indicating food items eaten in greater proportion than their occurrence in the habitat, were obtained for wheatgrass (*Agropyron spp*.) (PI=37) and bluegrass (*Poa spp*.) (PI=14).

Fecal pellets were collected adjacent to pygmy rabbit burrows at two sites in Washington (Burton Draw and Coyote Canyon) during November and December 1988. The Washington State University Wildlife Habitat Laboratory completed a diet analysis and provided a report. Based on an analysis of plant cell proportions, shrubs were the most important food, comprising a mean 81.5% of the diet. Mean forb content was 13.1% and mean grass content was 4.4%. Big sagebrush was the most important shrub species (67.0% of diet) and rabbitbrush (*Chrysothamnus spp*.) was the next most important shrub, comprising a mean 12.8% of the diet.

At Sagebrush Flat, Gahr (1993) evaluated diet based on visual observations of feeding. Each observation of feeding on an identifiable plant species was given equal importance with an observation of feeding on another plant species. Therefore, the amount eaten was not taken into consideration. Rabbits were observed feeding 82 times and the food item was identified in 53 cases. The rabbits ate shrubs during each month except September, when only one observation of feeding was made. Grasses were the most frequently observed food and were eaten during each month, March through September. Forbs were only observed to be eaten from April through June. There was no difference in feeding activity by plant class between areas grazed and areas not currently grazed (grazed area: shrubs 32%, grasses 45%, forbs 23%; area not currently grazed: shrubs 39%, grasses 45%, forbs 16%).

2.1.2 Reproduction

Sexual development in males begins in January, peaks in March and declines in June (Janson1946; Wilde 1978). Females are fertile from late February through March in Utah (Janson 1946) and from late March through late May in Idaho (Wilde *et al.* 1976). In Washington, males are reproductively active from January through June, females can be pregnant from February through August, and some females are nursing young from March through September (Gahr 1993). Gestation has been estimated at 39 days (Fisher 1979). Pygmy rabbits are able to breed during their second spring or summer. They do not breed during the year of their birth (Wilde 1978; Fisher 1979).

Bradfield (1974) reports that young are born in the burrows. However, nests are unknown. Excavated burrows do not reveal chambers or nesting material and burrows excavated where lactating females are taken also reveal no young (Janson 1946; Bradfield 1975; Gahr 1993). Wilde (1978) found two small (90 g) juvenile pygmy rabbits underneath separate clumps of sagebrush, far removed from any burrows. He theorized that young are not raised in burrows but are individually hidden at the bases of separate and scattered shrubs.

Litter size ranges from four to eight and averages six (Davis 1939; Wilde *et al.* 1976; Wilde 1978; Fisher 1979). Females reportedly produce up to three litters per year (Green 1978; Wilde 1978), though Fisher (1979) found no histological evidence of three litters. Two litters had been produced by the five females examined. Based on the observed length of the breeding season and histological determination of conception dates, a maximum of 17 and 29% of the adult female population could have produced three litters in 1975 and 1976, respectively. Wilde (1978) described the existence of a third cohort during 1976 and 1977 in the same study area where Fisher did his work.

In Idaho, Fisher (1979) estimated that 13.0 and 13.7 young were produced per female during 1975 and 1976, respectively. Wilde (1978) reported that the number of young captured per adult female before September 1 was 3.6 in 1976 and 4.9 in 1976. Breeding appears to be highly synchronous within the population and juveniles belong to recognizable cohorts (Wilde 1978; Fisher 1979). In monitoring recaptures of juveniles from 1976 cohorts, Wilde found that 33% the first cohort survived for 20 weeks, reduced to 23% for the second cohort. In the third cohort, none were recaptured after 5 weeks.

2.1.3 Burrowing

The pygmy rabbit is a burrowing species that digs relatively simple burrows in soil and often extensive burrows in snow (Bradfield 1974). Unlike other species of rabbits native to North America, this species usually digs its own burrows (Borell and Ellis 1934; Walker *et al.* 1964). Burrow systems usually consist of two to seven openings, with the main entrance concealed at the base of a sagebrush plant (Olterman 1972; Green 1979). Gahr (1993) found that Washington burrows contained an average of 2.7 entrances (range 1-10) and entrance diameter averaged 19 cm (8 in) with a range of 10-35 cm (4-14 in) (n=82). A small trench or terrace was present outside burrow entrances and no chambers or enlarged areas were found along the tunnels. Janson (1946) reports that in Utah four or five entrances are typical, but 10 are sometimes observed. In Idaho, two entrances are most often found (Wilde 1978). Tunnels usually extend to no more than 1 m (3 ft) in depth (Green and Flinders 1980a; Kehne 1991; Gahr 1993). Three burrows excavated in Idaho extended below the hardpan and never showed evidence of water (Wilde 1978).

During the winter months the rabbits burrow through the snow to forage. Snow burrows are constructed to lead from one sagebrush plant to another (Bradfield 1974).

2.1.4 Mortality

The chief cause of mortality is predation (Green 1979). Wilde (1978) found that mean annual adult mortality could be as high as 88%. The period of greatest mortality begins in January and extends through March. The survival of juveniles is initially very low, with more than 50% disappearing within 5 weeks of emergence. Complete loss of a cohort is possible as Wilde reports during a year of his study. Starvation and environmental stress probably account for some loss.

Predators of pygmy rabbits include long-tailed weasel (*Mustela frenata*), coyote (*Canis latrans*), and badger (*Taxidea taxus*), which may enter or dig up pygmy rabbit burrows (Wilde 1978). Other predators, which will take pygmy rabbits encountered above ground, include bobcats (*Felis rufus*), great horned owls (*Bubo virginianus*), long-eared owls (*Asio otus*), ferruginous hawks (*Buteo regalis*), and northern harriers (*Circus cyaneus*) (Gashwiler *et al.* 1960; Borell and Ellis 1934; Hall 1946; Janson 1946; Ingles 1965; Green 1978; Wilde 1978; Olendorff 1993). In Washington, burrows frequently show signs of being dug out by badgers or coyotes (Dobler and Dixon 1990). Short-eared owls (*Asio flammeus*) and northern harriers frequently hunt over pygmy rabbit colonies. Gahr (1993) concluded that at least two cases of pygmy rabbit mortality at Sagebrush Flat were due to predation by raptors. Potential predators seen in the area included great-horned owls, northern harriers, prairie falcons (*Falco mexicanus*), and golden eagles (*Aquila chrysaetos*).

Pygmy rabbits are protected by law and cannot be legally killed. However, discussions with hunters in the Columbia Basin indicate most hunters do not distinguish pygmy from cottontail rabbits. This suggests that pygmy rabbits could be accidentally taken by hunters. However, sites that are currently known to have pygmy rabbits are infrequently visited by hunters. Disease is probably not a significant mortality factor (Green 1979).

2.2 Habitat Requirements

2.2.1 Vegetation

The pygmy rabbit is dependent upon sagebrush, primarily big sagebrush (*Artemisia tridentata*), and is usually found in areas where big sagebrush grows in very dense stands. Tall, dense sagebrush clumps are essential (Orr 1940).

At Sagebrush Flat, Washington, big sagebrush is the dominant shrub species (Gahr 1993). In one pygmy rabbit area in Idaho, bitterbrush (*Purshia tridentata*) and big sagebrush are present in equal amounts (19% coverage of each) (Green and Flinders 1980b). In Oregon, sagebrush species account for 23.7% of the cover at pygmy rabbit sites. Overall shrub cover at pygmy rabbit sites averaged 28.8% with a range of 21.0-36.2%. When 10 habitat variables were submitted to discriminant analysis, shrub cover best distinguished sites occupied by pygmy rabbits from adjacent sites (r = 0.71), followed by soil depth (r = 0.48) and mean shrub height (r = 0.46) (Weiss and Verts 1984).

Several studies have compared shrub cover and height between burrow locations and randomly selected locations (Table 1). While the values reported by these studies are not the same, partly a product of different techniques of measurement, all indicate that sagebrush cover is a major habitat feature selected by pygmy rabbits. Where measured, burrow sites always had greater shrub cover and taller shrubs than random sites. Historically, conditions suitable for pygmy rabbits were probably uncommon, limited to areas with deep, moisture-retaining soil or areas where disturbance provided opportunities for sagebrush to invade and flourish, relieved from the competition of grasses. Daubenmire (1970) concluded that the pristine condition of the Artemisia tridentata-Agropyron association was characterized by 5-26% coverage in big sagebrush. Subsoil conditions probably account for much of the variation. On moist, sandy loams big sagebrush may exceed 2 m in height. Ellison (1960) and Tisdale and Hironaka (1981) indicated that disturbed conditions, grazed or abandoned cultivation, can also contribute to the development of heavy sagebrush cover.

Table 1. Comparisons of shrub cover and density between pygmy rabbit burrow sites and non-burrow sites (WDFW 1995).

Location	Mean shrub cover (%)	Mean shrub height (cm)	Reference
Sagebrush Flat burrow sites	32.7	82	Gahr (1993)
Sagebrush Flat random sites	17	53.4	
Idaho burrow sites	46	56	Green and Flinders (1980b)
Idaho random sites	unknown	25	
Oregon burrow sites	28.8	84	Weiss and Verts (1984)
Oregon random sites	17.7	53	

Most typically, heavy grazing increases the density of big sagebrush. Most of Washington's pygmy rabbit sites have a long history of grazing. One pygmy rabbit site in Washington (Burton Draw) has a history of cultivation. When cultivation ended years ago, big sagebrush invaded the fields and provided heavy shrub cover (Dobler and Dixon 1990).The burrowing and grazing activity of pygmy rabbits may increase sagebrush cover. The area around active pygmy rabbit burrows is heavily grazed by the rabbits (Wilde 1978). In Wilde's words, "growth and reproduction of sagebrush at pygmy rabbit burrows may be increased (Janson 1946; Wilde in prep.). Whether this is due to burrowing activity, per se, or to browsing(Pearson 1965) is unknown." Gahr found that percent cover of bunchgrasses was less at burrow sites (3.2%) than at random sites around burrows (8.9%). The removal of grasses and the disturbance of the soil can create conditions suitable for colonization by sagebrush seedlings. In addition, sagebrush growth may increase with the increase in available moisture which occurs when competing grasses and forbs are removed. The extent to which seedling survival is effected by the browsing of pygmy rabbits is unknown.

2.2.2 Burrows

Habitat suitable for pygmy rabbits must allow the animals to burrow. Burrows provide protection during periods of severe weather conditions, safety from predators, and may be used for raising young (Bradfield 1974). Burrows are usually under big sagebrush and only rarely are located in an opening in the vegetation (Green 1978; Wilde 1978). However, pygmy rabbits have been observed using abandoned badger and yellow-bellied marmot (*Marmota flaviventris*) burrows, as well as natural cavities, holes in volcanic rock, rock piles, and around abandoned buildings (Green 1979, 1980; Wilde 1978). These are used in association with typical burrows in deep soil amidst sagebrush. They probably do not represent a habitat alternative capable of totally replacing dense sagebrush and deep soils.

2.2.3 Soil Characteristics

Since pygmy rabbits excavate their own burrows, soil structure is a key habitat feature. Generally, soft, deep soils are required for burrowing. However, three burrows excavated by Wilde (1978) extended below the hardpan. Alluvial fans may provide the soil requirement in some cases (Orr 1940; Green and Flinders 1980b). Oregon burrow sites are located where soils are significantly deeper and looser than adjacent sites (Weiss and Verts 1984). Pygmy rabbits will select sites where wind-borne soil deposits are deeper (Wilde 1978).

A study in Oregon measured habitat variables at sites occupied by pygmy rabbits and adjacent unoccupied sites. When 10 habitat variables were submitted to discriminant analysis, soil depth was the second most important variable distinguishing sites occupied by pygmy rabbits from adjacent sites ($r = 0.48$). Shrub cover was the only variable of greater importance ($r = 0.71$) (Weiss and Verts 1984).

Kehne (1991) documented soil and other characteristics at 80 active burrow sites at Sagebrush Flat. The soils at Sagebrush Flat are derived from loess, or wind-borne parent materials. Carbonates, which make soils less compact, looser and generally easier to dig, were found at an average of 72 cm (28 in) deep. This depth is shallower than expected in this precipitation zone. Burrows at Sagebrush Flat tend to be in deep soils; 96% are in soils at least 51 cm (20 in) deep. A limiting layer of basalt, duripan, weak pan, or gravel often underlays the soil. A family control characterization of soil types indicates that burrows are found in coarse-silty (46%), fine-loamy (28%), ashy (17%), and coarse-loamy (9%) soils.

2.2.4 Topography

Landform, as well as soil characteristics, plays a part in burrow site selection. The rabbits use the contours of the soil, most often digging into a slope (Wilde 1978; Kehne 1991). At Sagebrush Flat, 77% of 80 active burrows were on mound/intermound or dissected topography (Kehne 1991). Although they do use level sites, even here they often utilize a small rise or change in contour for the burrow entrance. Gahr (1993) found that topography influenced the distribution and abundance of burrow sites at Sagebrush Flat. The study area was divided along 12 and 18 m contour intervals with drainage bottoms defining the base elevation. More burrows were found along four main drainage systems running northeast to southwest. There was almost a four-fold increase in burrow density in the 0-12 m (0-39 ft) interval compared to the 18 m (59 ft) interval.

Kehne (1991) observed that the most common similarity between the known pygmy rabbit sites is mound/intermound topography with dissected hillslopes adjacent to narrowly dissected alluvial areas. Soils can be derived from loess, as is the case at Sagebrush Flat, or glacial parent materials.

2.2.5 Seasonal

Pygmy rabbit diet changes somewhat with season. Sagebrush is eaten to the virtual exclusion of all other foods during winter. Grasses and forbs become more important in spring and summer (Bradfield 1974; Green 1979; Gahr 1993).Pygmy rabbits are not known to move seasonally to exploit new or different habitats. During winter, pygmy rabbits excavate extensive snow burrows which are heavily utilized for foraging (Bradfield 1974).

3.0 Pygmy Rabbit Population and Distribution

3.1 Population

3.1.1 Historic

Paleontological investigations suggest shrinkage of the pygmy rabbit's Pacific Northwest range over the past 7,000 years. This shrinkage may be the result of changes in climatic conditions which affect sagebrush plant communities (Butler 1972; Lyman 1991).

Within the past 75 years, available evidence suggests a marked decline in the pygmy rabbit's Washington range, now believed to be restricted to Douglas County and Grant County north of Quincy. Verified localities (Figure 2) indicate a past distribution which included portions of five counties. Virtually nothing is known about the abundance of the pygmy rabbit at any of these localities or the extent of area they occupied.

Published information does little to clarify the situation. Taylor and Shaw (1929) reported the pygmy rabbit as fairly common in the coulees and slopes of Adams County. Booth (1947) reported them very scarce, occurring only in small, limited areas in the arid parts of Adams and Grant counties. Dalquest (1948) considered the species rare and of local occurrence, restricted to the central portion of the Columbia Plateau. Buechner (1953), in reviewing the dramatic agricultural changes occurring in eastern Washington, predicted that the pygmy rabbit would disappear entirely in Washington. Maughn and Poelker (1976) indicated that due to its specialized habitat requirements, the pygmy rabbit was suffering a decline in numbers from habitat destruction.

There were no verified pygmy rabbit collections or reports between 1962 and 1979. In 1979, Washington Department of Fish and Wildlife biologists found pygmy rabbits at Sulphur Canyon in Douglas County (Lloyd 1979). Surveys of this area during 1985 found no signs of an extant colony (Poole 1985). It is likely that the Sagebrush Flat population identified in 1949-62 still existed at this time, but the specific location for the historic records was not known when the surveys were conducted. Because the 1985 searches failed to find pygmy rabbits anywhere in Washington, there was speculation that the species may have been extirpated. In December 1987, Department biologists discovered a colony of pygmy rabbits at Burton Draw in Douglas County (Table 2). Intensive surveys conducted in 1988 found colonies at four additional sites (Sagebrush Flat, Coyote Canyon, Whitehall, and Clay Site).

The five pygmy rabbit populations found during the late 1980s existed in pockets of suitable habitat in Douglas County. These populations were probably isolated from one another since

Table 2. Historic pygmy rabbit localities in Washington based on museum specimens and reliable reports. Map # refers to Figure 2 (WDFW 1995).

Location	County	Map #	Date(s)	Source[a]
Schrag	Adams	7	1956	WSU 56-45 (Drake)
Lind	"	8	1923	USNM 243294, 243344 (Finley)
Lind	"	8	1924	CSUF #643 (Lane)
Rattlesnake slope	Benton	9	1979	R. Fitzner (pers. comm.)
Hanford Reservation				
10 km E of Mansfield	Douglas	1	1950	PSM 2300 (Clanton)
Sulphur Canyon	"	2	1979	PSM 25856 (Lloyd)
Sagebrush Flat	"	3	1949	PSM 1992-7 (Clanton)
Sagebrush Flat	"	3	1949	WSU 49-357-362, 49-375 (Hudson)
Sagebrush Flat	"	3	1952	WSU 52-40, UBC 3058 (Hudson)
Sagebrush Flat	"	3	1962	PSM 8955-6 (Johnson)
Sagebrush Flat	"	3	1988	F. Dobler (pers. comm.)
Burton Draw	"	shaded	1987	R. Friesz (pers. comm.)
Coyote Canyon	"	shaded	1988	R. Friesz (pers. comm.)
Whitehall	"	shaded	1988	C. Garber (pers. comm.)
Clay Site	"	shaded	1988	R. Friesz (pers. comm.)
4.8 km NW of Ephrata	Grant	4	1949	PSM 2229 (Clanton)
Warden	"	5	1921	Couch (1923)
13 km W of Odessa	Lincoln	6	1949	PSM 2230 (Clanton)

[a] Museum abbreviations as follows: James R. Slater Museum of Natural History, University of Puget Sound, Tacoma, Washington (PSM); Conner Museum, Washington State University, Pullman, Washington (WSU); University of British Columbia, Vancouver, B.C. (UBC); U.S National Museum, Washington D.C. (USNM); California State University, Fresno (CSUF). Specimen numbers are followed by collector's name in parentheses.

there is little to no sagebrush landscape connecting them. Gahr (1993) suggested that although maximum movement distances found at Sagebrush Flat may not represent the absolute maximum possible of pygmy rabbits, movement of rabbits between the occupied sites was unlikely.

Three of the populations were extremely small (estimated at fewer than 30 active burrows), and one is estimated to comprise from 70 to 80 active burrows. The Sagebrush Flat population was the largest known population in Washington, with an estimated 588 active burrows. Since pygmy rabbits use multiple burrows and share some burrows, the number of rabbits is fewer than the number of active burrows. Gahr (1993) used two techniques to estimate rabbit numbers at Sagebrush Flat. Using data on shared and unshared burrows, she estimated the Sagebrush Flat population to be 78 pygmy rabbits, with a possible range of 55 to 142. Using a second, independent technique based on radio telemetry data, she estimated the population to be 107 pygmy rabbits.

3.1.2 Current

The number of populations and numbers of pygmy rabbits have been declining since 1997. In 1995, five pygmy rabbit populations were known to exist in Douglas County and a sixth population was found in 1997. Between 1997 and 2000 five of the six populations disappeared; by March 2001, only one area, Sagebrush Flat, was known to still have rabbits. Small populations at several sites were extirpated for unknown reasons; other populations were extirpated by known wildfires. Numbers of active burrows on standardized plots at Sagebrush Flat have declined from 229 in 1995 to zero in 2001. Random searches did reveal some active burrows at Sagebrush Flat in March and April 2001. WDFW monitored known active burrows during December 2002 and found active burrows in one of the 3 general areas previously known. In this area, 6 of 7 burrows active during the 2001-2002 survey were still active, and in addition 5 newly active or constructed burrows were located. Additional scattered unknown active burrow may occur through movement of rabbits throughout the year.

3.2 Distribution

3.2.1 Historic

The population segment of pygmy rabbits in central Washington is believed to have been physically separated from the remainder of the species' range for the past 7,000 to 10,000 years. Columbia Basin pygmy rabbits historically occurred only in central Washington, including portions of Douglas, Grant, Lincoln, Adams, and Benton Counties. Currently, they are only known from a single site in southern Douglas County.

3.2.2 Current

3.2.2.1 North America

The pygmy rabbit is found throughout much of the sagebrush area of the Great Basin as well as some of the adjacent intermountain areas (Figure 1) (Green and Flinders 1980a). The eastern boundary extends to southwestern Montana and western Wyoming (Campbell *et al.* 1982). The southeastern boundary extends to southwestern Utah (Janson 1946, Pritchett *et al.* 1987) and includes the only occurrence of the species outside the limits of the Pleistocene Lake Bonneville (Columbia River) drainage. Central Nevada (Nelson 1909) and northeastern California (Orr 1940) form the southern and western limits. The northern boundary of the species' core range historically reached to the southern foothills of the Blue Mountain Plateau in eastern Oregon (Bailey 1936). However, Washington populations are farther north, extending into Douglas County. Within its range, the pygmy rabbit's distribution is far from continuous. It is patchily distributed, being found only in areas where sagebrush is tall and dense, and the soil is relatively deep.

3.2.2.2 Washington

The pygmy rabbit's Washington range is disjunct from the core range of the species, and likely has been for some time (Lyman 1991, Grayson 1987). The pygmy rabbit's current range is thought to be smaller than during its post-glacial population high, which occurred more than 7,000 years ago (Butler 1972). In the Northwest, a discontinuity developed when the pygmy rabbit's core range shrunk southward toward the central part of eastern Oregon (Weiss and Verts 1984). This discontinuity has left Washington populations isolated in a portion of their prehistoric range (Lyman 1991). The paleontological record verifies pygmy rabbits in Washington over 100,000 years ago. Documented localities of prehistoric occurrence indicate a former range slightly larger than what is documented from historic times. These records do not establish the prehistoric link to populations in either Oregon or Idaho, a link which must have occurred (Lyman 1991). Habitat changes, which reflect climate change over thousands of years, likely account for the isolation of Washington populations.

Table 2 lists reliable historic pygmy rabbit locations in Washington. In most cases voucher specimens are available in museums. The basis for much of our understanding of the pygmy rabbit's historic range in Washington comes from a 1949-50 study of the occurrence of campestral plague in rodents. W. Clanton was the field investigator for this study. One of Clanton's collection localities, Sagebrush Flat, was also a collection site of G. Hudson of the Charles R. Conner museum at Washington State University and M. Johnson, a mammalogist with the University of Puget Sound. The museum records associated with these collections describe the location differently, resulting in the mistaken impression that several localities were involved. Conversations with M. Johnson, examination of Hudson's field notes and Clanton's field maps have resulted in a clear understanding that all specimens were collected at Sagebrush Flat.

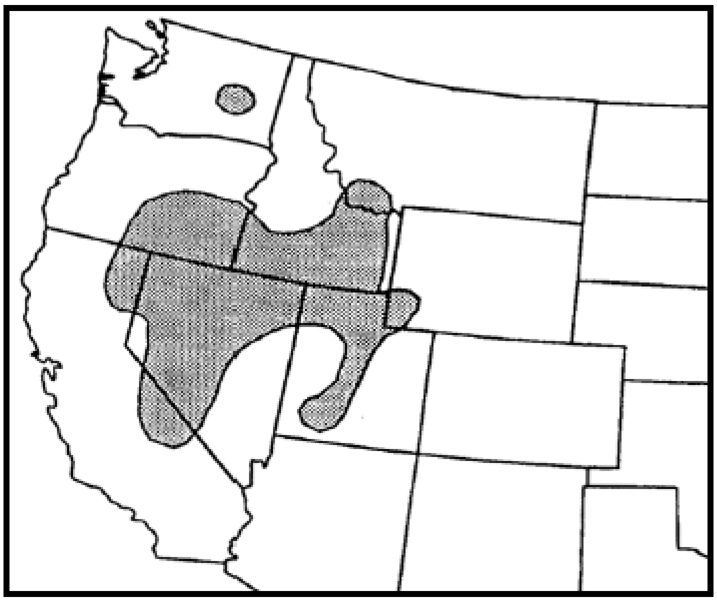
Figure 1. Current range of the pygmy rabbit (WDFW 1995).

Written information has contributed to confusion about the pygmy rabbit's former distribution in Washington. Couch (1923) described J. Finley's collection of pygmy rabbits as "near Ritzville" in Adams County. Hall (1981) referenced a record at Lind, also in Adams County. Rather than two separate locales, both of these published sources refer to J. Finley's collection of two pygmy rabbits which is part of the U.S. National Museum collection in Washington D.C. (Table 2). Booth (1947) reported collecting a pygmy rabbit from Crab Creek in Grant County. Recent examination of the specimen verifies that it is a Nuttall's cottontail (*Sylvilagus nuttallii*).

Williams (1975) was likely mistaken in reporting contemporary occurrence of pygmy rabbits in the Juniper Forest of Franklin County. He identified remains found in great horned owl (*Bubo virginianus*) pellets as those of pygmy rabbits and attributed an abundance of tracks observed in the area to pygmy rabbits. He also described pygmy rabbit sub-fossils from wind eroded dunes in the Juniper Forest. However, while Williams' work was an attempt at characterizing the complete bird and mammal fauna of the Juniper Forest, it did not recognize the presence of Nuttall's cottontails. Since there is considerable evidence that Nuttall's cottontails are the only abundant rabbit at the Juniper Forest (Miller 1977), it is likely that Williams misidentified the remains from the owl pellets and the tracks he observed. The skeletal remains recovered from owl pellets could not be found in the University of Idaho's collection so they cannot be examined for verification of species.

Miller (1977) examined bones from erosion sites similar to the sites where Williams recovered sub-fossils. The bones found in these sites, where the wind has scoured away the sand, were left by animals inhabiting the Juniper Forest prior to sand dune formation. Pygmy rabbit bones were not uncommon and their occurrence provided evidence that pygmy rabbits have inhabited the area during the late Holocene (between 3,000 years ago and present). Miller trapped small mammals in the Juniper Forest but did not catch pygmy rabbits. He caught Nuttall's cottontails and considered them locally common. State biologists have surveyed portions of the area and have not found suitable pygmy rabbit habitat in the areas examined.

Recent Department of Fish and Wildlife field inventories verify pygmy rabbits at five sites (all within the shaded area of Figure 2) within Douglas County, including the largest known Washington population at the Sagebrush Flat site where Clanton, Hudson, and Johnson collected.

The range of extant populations in Washington is provided in Figure 2.

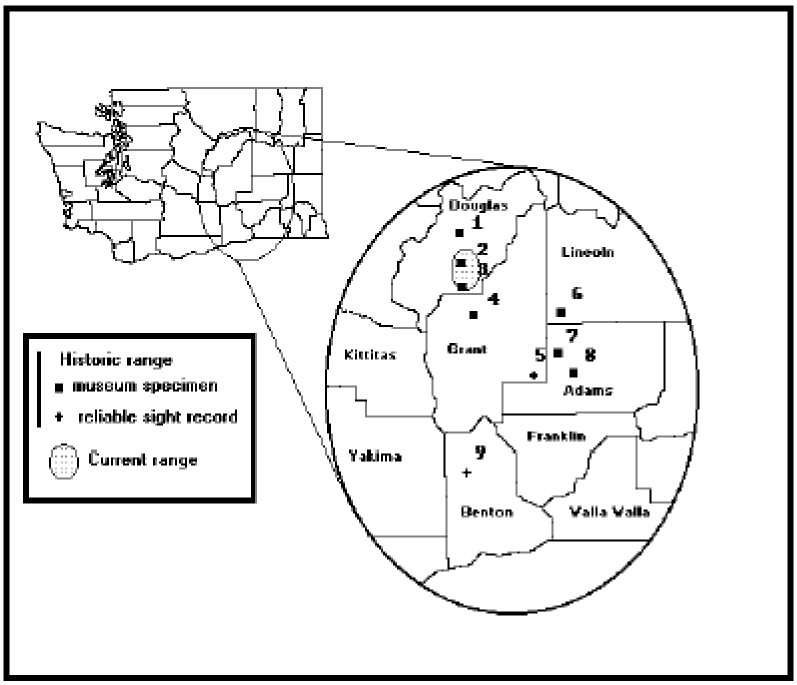

Figure 2. Distribution of the pygmy rabbit in Washington. Numbers refer to entries in Table 2 (WDFW 1995).

3.3 Pygmy Rabbit Status and Abundance Trends

3.3.1 Status

The U.S. Fish and Wildlife Service (USFWS) listed the pygmy rabbits in the Columbia Basin of Washington under emergency provisions of the Endangered Species Act in November 2001. Emergency provisions were for an 8 month period, pending review and development of a final status decision. A final decision to list the Columbia Basin pygmy rabbit as federally endangered was issued in March 2003. A state recovery plan for the rabbit was written in 1995 and efforts have been underway to implement the plan despite less than full funding. In 1995, five pygmy rabbit populations were known to exist in Douglas and northern Grant Counties; a sixth population was found in 1997. Between 1997 and 2001 five of the six populations disappeared; by March 2001, only one area, Sagebrush Flat, was known to still have rabbits (Figure 3). Small populations at several sites were extirpated for unknown reasons; other populations were extirpated by known wildfires.

Detectable population cycles have been documented for some lagomorphs, such as the snowshoe hare (*Lepus americanus*) (Green and Evans 1940). Such predictable cycles are not known for pygmy rabbit populations.

Figure 3. Pygmy rabbit population decline.

Wilde (1978) concluded that pygmy rabbits have a lower potential for rapid increase in numbers than other lagomorphs. Unlike many lagomorphs, pygmy rabbits do not appear to be able to produce extra litters in response to favorable environmental conditions. It is, perhaps, their dependence upon a long-lived, slow-recovering food source (sagebrush) which has produced this population inertia. There is, however, evidence of marked population fluctuations in some areas. Local population declines have been reported during studies in Idaho, Utah, Oregon, and Wyoming (Janson 1946; Bradfield 1975; Weiss and Verts 1984).

3.3.2 Trends

With the collapse of the pygmy rabbit population in the wild, WDFW evaluated a number of options. Leaving a few remaining rabbits in the wild would encumber the population with extreme risk. WDFW biologists believed the best option was to maintain the unique Washington pygmy rabbit was to collect rabbits from the wild that represent the unique genetic makeup of Washington pygmy rabbits and begin a captive breeding program to raise and release Washington pygmy rabbits.

A decision was made in May 2001 that the WDFW would work to maintain the unique genetics represented by Washington pygmy rabbits and would collect rabbits from the wild to begin a captive breeding program. The goal is to develop a captive population to ensure the maintenance of Washington's unique pygmy rabbits and to reintroduce sufficient numbers of captive-bred rabbits to re-establish populations in suitable habitat. Not all pygmy rabbits were collected from the wild; the decision was only to take enough rabbits to begin a captive breeding program. This decision was supported by the Wildlife Diversity Advisory Council and the Pygmy Rabbit Working Group. WDFW continued to follow those same goals in 2002.

3.4 Factors Affecting Pygmy Rabbit Population Status

3.4.1 Key Factors Inhibiting Populations and Ecological Processes

3.4.1.1 Present and Threatened Habitat Loss

Most of the former pygmy rabbit habitat in Washington has been altered to the point that it can no longer support pygmy rabbits. Additional losses may occur in the future through conversion of shrubsteppe to cropland, sagebrush removal for cattle grazing, or wildfire. This is especially likely in areas where pygmy rabbits occur but have not yet been discovered.

3.4.1.2 Low Population

Even if the five existing pygmy rabbit habitats are maintained in their current condition, populations will remain vulnerable to extirpation. The historic pressures of habitat loss appear to be less important today, mainly due to recognition of the pygmy rabbit's endangered status. However, existing populations are believed to be below the level necessary for long-term viability. Populations comprised of few individuals are vulnerable to extirpation from a variety of factors, often acting in concert. Shaffer (1981) grouped threats to small populations into four categories: demographic stochasticity, environmental stochasticity, natural catastrophies, and genetic stochasticity. Demographic stochasticity is the natural random variation in survival and reproductive success of individuals in a population. Environmental stochasticity is variation in environmental factors such as food sources, disease vectors, predator and parasite populations, climate, and so forth. Natural catastrophes include fire, volcano eruptions, floods, landslides, and other devastating events. Genetic stochasticity results from changes in gene frequencies due to founder effect, random fixation, or inbreeding. Many of these factors vary naturally over time and do not pose a threat to large populations. However, small populations can be extinguished by unfavorable extremes of one or a combination of these factors.

Comparisons of initial population sizes for extant and extinct rabbit populations suggest that populations for this group need to be much larger than those of many other mammals to be secure (Soulé 1987). The wide fluctuations that have been evident in pygmy rabbit populations (Janson 1946; Bradfield 1975; Weiss and Verts 1984) suggest that it is a species, like other lagomorphs, that needs to be maintained at higher population levels than many other vertebrates to be considered secure.

From 2001 through 2003 Dr. Kenneth Warheit, WDFW conservation geneticist conducted population genetic analyses of pygmy rabbits from Washington, Oregon, Idaho, and Montana (WDFW; unpublished data). These analyses were based on muscle (ear punches) or blood tissue collected in the field, and skin tissue collected from museum specimens. Warheit (unpublished data) analyzed two types of DNA data: molecular sequences from the mitochondrial cytochrome *b* locus, and DNA fragment sizes from nine nuclear microsatellite loci. The cytochrome *b* locus or gene evolves more slowly than that of any of the microsatellite loci, and can provide a measure of genetic isolation at long temporal scales (thousand to millions of years).

Based on the samples analyzed thus far, the cytochrome *b* type (haplotype) from Washington is invariant (i.e., only one haplotype present) and different from the three haplotypes shared among Montana, Idaho, and Oregon populations. The cytochrome *b* and microsatellite data conclusively demonstrate that the Washington pygmy rabbit is isolated and very distinct from other pygmy rabbits and may have been isolated and distinct for thousands of years.

The Washington pygmy rabbit has reduced genetic variability compared with other pygmy rabbit populations. Based on a microsatellite analysis of museum skin samples from Sagebrush Flats, it appears that this reduction in genetic variability has existed for at least 50 years. Furthermore, genetic variability within Washington has continued to decline during the past 50 years in wild pygmy rabbits.

Genetic variability of captive animals has declined since the breeding program was initiated in 2001. In less than two years the captive pygmy rabbit population has lost a total of two microsatellite alleles, and one of the microsatellite loci has become fixed at a single allele. Observed heterozygosity, a measure of genetic diversity, has declined nearly one-third from 0.35 in the founding population to 0.24 today. Moreover, since genetic drift occurs rather swiftly in small populations, many alleles are now present in only a few individuals, and one locus is now one individual away from fixation at a single allele. If this locus becomes fixed, three of the nine microsatellite loci will contain no genetic variability. Finally, the average relatedness among individuals in the captive Columbia Basin pygmy rabbit population is now 0.33, which represents a pairwise relatedness between a full (0.50) and half (0.25) sibling.

3.4.1.3 Habitat Linkages

Green and Flinders (1980b) noted the importance of habitat connectivity and travel corridors. The ability of pygmy rabbits to rebound after periods of unfavorable conditions depends, in part, on landscape features that allow animals to disperse and recolonize suitable habitats. Long-term population maintenance, without human intervention, will likely depend upon establishment of habitat corridors linking the existing small, isolated populations. Such habitat linkages would increase the probability that the habitat which now supports a population would continue to be occupied by pygmy rabbits in the future.

3.4.1.4 Fire

Range fires can eliminate sagebrush from large areas and are a potential threat to existing pygmy rabbit populations. Sagebrush is slow to re-establish after a range fire. A Benton County pygmy rabbit habitat discovered by R. Fitzner in 1979 was destroyed by fire soon after its discovery. Sagebrush Flat, which contains Washington's largest known pygmy rabbit population, is an area penetrated by open, poor quality roads that are used for night-time parties and other social activities where fires are sometimes built.

3.4.1.5 Interspecific Relationships

Because existing pygmy rabbit colonies are mostly small in size and found in isolated patches of habitat, predators may be a significant factor in reducing or limiting populations. Davis (1939) states that pygmy rabbits are infested with endoparasites as well as ectoparasites. Ticks, fleas, and lice may be found on every animal examined (Davis 1939). Fleas are abundant on some specimens. Gahr (1993) observed fleas on pygmy rabbits at Sagebrush Flat year-round, with the greatest infestations occurring from February to May. Ticks were seen on rabbits from March to September with the highest infestation in the spring. Bot fly larvae (*Cuterebra maculata*) were found on two pygmy rabbits in grazed portions of Sagebrush Flat during September. Bot fly larvae were also found on three cottontail rabbits in the grazed area.

Although Gahr cautioned that the sample size was too small to draw conclusions, she suggested that cows may act as a vector for spreading the parasites or that the bot flies might be attracted to the grazed area by cow manure. At the Idaho National Engineering Laboratory site, 19% of pygmy rabbits trapped during a 1975-1977 study had bot fly larvae. The study area had been closed to grazing since 1953 (Wilde 1978). Bot fly larvae develop under a rabbit's skin, dropping out through a hole in the skin during late summer or fall. In general, bot fly larvae do not result in serious injury or death.

3.4.1.6 Grazing

The influence of cattle grazing on pygmy rabbit habitat is not well understood. There have been no studies specifically designed to determine the influences of grazing or grazing management strategies on pygmy rabbit habitat or population conditions. Green (1978) speculated that the preference of cattle for grasses might result in competition during the spring and summer when pygmy rabbits preferentially select grasses.

In general, grazing is known to affect the characteristics of sagebrush communities. The effects depend on a variety of factors including timing and intensity of grazing, stocking densities, locations of water or salt, and other factors that would concentrate cattle use. In some cases grazing can increase cover of sagebrush (Ellison 1960; Daubenmire 1970; Tisdale and Hironaka 1981; Stevens 1984). Tisdale and Hironaka (1981) found that grazing reduced the more palatable herbaceous species, allowing the shrubs to flourish. This resulted in a dense and vigorous stand of sagebrush with a relatively sparse understory of annuals and unpalatable perennials. Ellison (1960) found that grazing by either cattle or sheep reduced the production of perennial forbs and grasses and increased the volume of sagebrush. Annual grasses also increased. Daubenmire (1970) indicated that sagebrush population density becomes static at only 5-25% coverage when there is good cover of perennial grasses but increases when these grasses are removed. Daubenmire added that sagebrush suffers from breakage when the concentration of cattle or horses is high. Habitat can be rendered unsuitable for pygmy rabbits when broken shrubs result in open canopy conditions.

Pygmy rabbits have evolved in the presence of ungulate grazing. During the 100,000 plus years that pygmy rabbits have inhabited eastern Washington, mule deer, elk, bison, antelope, and bighorn sheep have shared portions of their range. Like the pygmy rabbit, bison and antelope have declined in this region over the past several thousand years (Buechner 1953; Daubenmire 1970). The abundance of grazing ungulates likely never approached the levels found in the grasslands east of the Rocky Mountains and this is evidenced by the lower resilience of eastern Washington plant communities to the effects of heavy grazing (Daubenmire 1970).

Gahr (1993) was able to partition some of the data collected in her study of pygmy rabbits at Sagebrush Flat. The occupied habitat at Sagebrush Flat has been divided by a fence for many years. The approximately 1,133 ha (2,800 ac) area north of the fence has been grazed by cattle and horses at varying intensities and duration for many decades. At the time of Gahr's study, the area was being grazed by cattle for 3 months each fall. The 272 ha (680 ac) area south of the fence has not been grazed since at least 1957 (Guinn 1993). Gahr found no differences in the densities of burrow systems and burrow sites between the grazed and not recently grazed areas at Sagebrush Flat. Both burrow systems and burrow sites were distributed proportional to the area available in each type. However, there are differences in proportions of the areas in different soil conditions. Guinn (1993) reported these differences in terms of "range sites" which have not been characterized for their value to pygmy rabbits. The northern unit of the grazed section was estimated to be about 80% loamy sites, the southern section about 60% loamy and 25% shallow sites. The area not recently grazed was estimated to be comprised of about one third each shallow and loamy sites.

Gahr also found that the average home range size of adult males in the grazed area was significantly larger than that of adult males in the area not recently grazed. Adult males in the grazed area made more frequent long distance movements to search out females for breeding. This suggested that the density of adult females may have been lower in the grazed area. The ratio of animals trapped in the grazed and not recently grazed areas was lower than expected based on land area. Trapping effort for the two areas was not standardized so this result is not conclusive.

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Sage Thrasher
(*Oreoscoptes montanus*)

1.0 Introduction

Sage thrasher (*Oreoscoptes montanus*) appears to be stable or increasing in much of its range. Sage thrashers can likely persist with moderate grazing and other land management activities that maintain sagebrush cover, tall vigorous shrubs, and the quality and integrity of native vegetation. Sage thrashers are vulnerable where sagebrush habitats are severely degraded or converted to annual grasslands or to other land uses.

There is a high probability of sustaining sage thrashers wherever native sagebrush habitats are maintained with high shrub vigor, tall shrubs, horizontal shrub patchiness, and an open understory of bare ground and native bunchgrasses and forbs.

2.0 Sage Thrasher Life History and Habitat Requirements

2.1 Life History

2.1.1 Diet

Sage thrashers forage on the ground for a variety of insect prey, especially ants, ground beetles, and grasshoppers (Vander Haegen 2003). Birds may also eat other arthropods, berries, and plant material (Reynolds *et al.* 1999). All foraging activity occurs during the day. Little information is available on the importance of access to free water (Reynolds *et al.* 1999). Sage thrashers may occasionally predate nests of other shrubsteppe bird species (Vander Haegen *et al.* 2002).

2.1.2 Reproduction

Sage thrasher clutch size is four to seven (usually three to five). The incubation period is about 15 days, by both sexes. Sage thrasher nestlings are altricial and downy. Sage thrashers can probably raise two broods per season, but probably only one brood per year in British Columbia (Cannings 1992). In Oregon, reproductive parameters were not associated with climatic variation (Rotenberry and Wiens 1989).

Chicks fledge when 10 - 11 days of age (Howe 1992; Reynolds 1999). Both parents brood and feed the young. Juveniles continue to be fed by parents for about a week after fledging, during which time they remain close to the nest (Reynolds *et al.* 1999).

2.1.3 Nesting

In Idaho, nest success (number of nests producing 1 fledgling) averaged 46%. The mean number of young fledged per successful nest varied from an average of 2.2 - 3.5 (Reynolds and Rich 1978; Reynolds 1981; Howe 1992). In eastern Washington, nest success is 38 % (Altman and Holmes 2000).

Females usually lay one clutch per breeding season but will lay a replacement clutch if the first nest is predated (Reynolds and Rich 1978). In Washington, egg laying commences in early April (Reynolds *et al.* 1999). A five-year study of sage thrashers in central Oregon found significant differences in clutch size among years (Rotenberry and Wiens 1989).

2.1.4 Migration

Sage thrasher populations in Washington are migratory. Birds arrive in late March to establish breeding territories and leave in August - September. Territory size averaged 0.96 ha (2.4 ac) and ranged from 0.6 to 1.6 ha (1.5 - 4.0 ac) in south central Idaho (Reynolds and Rich 1978).

2.1.5 Mortality

Little information is available regarding sage thrasher survivorship or longevity. Snakes, particularly gopher snakes (*Pituophis melanoleucus*) and Townsend's ground squirrels (*Spermophilus townsendi*) are known nest predators (Rotenberry and Wiens 1989). Presumed nest predators include common ravens (*Corvus corax*), loggerhead shrike (*Lanius ludovicianus*), and long-tailed weasels (*Mustela frenata*) (Rotenberry and Wiens 1989; Reynolds *et al.* 1999).

2.2 Habitat Requirements

Sage thrashers are considered a shrubsteppe obligate species and are dependent upon areas of tall, dense sagebrush (*Artemisia tridentata*) within large tracts of shrubsteppe habitat (Knock and Rotenberry 1995; Paige and Ritter 1999; Vander Haegen 2003). In shrubsteppe communities in eastern Washington, sage thrashers are more abundant on loamy and shallow soils than areas of sandy soils, and on rangelands in good and fair condition than those of poor condition (Vander Haegen *et al.* 2000; Vander Haegen 2003). The presence of sage thrashers is positively associated with percent shrub cover and negatively associated with increased annual grass cover (Dobler *et al.* 1996). Total shrub cover and abundance of shrub species, especially sage brush are important habitat features for sage thrashers. Occurrence of sage thrashers in sagebrush habitat has been correlated with increasing sagebrush, shrub cover, shrub patch size, and decreasing disturbance (Knick and Rotenberry 1995).

2.2.1 Nesting

Sage thrasher nests are constructed either in or under sagebrush shrubs. Twenty-one of 34 (62%) nests located in south central Idaho were constructed on the ground. Elevated nests were constructed 4-16 in. above ground in sagebrush 30-45 in. tall while ground nests were constructed under sagebrush 22-35 in. tall (Reynolds and Rich 1978). Sagebrush shrubs selected for nesting are usually taller, and have greater crown height and width than random (Reynolds *et al.* 1999). In Washington, nests are usually located in tall sagebrush shrubs, average height 40 in. (Vander Haegen 2003).

2.2.2 Breeding

Sage thrashers breed in sagebrush plains, primarily in arid or semi-arid situations, rarely around towns (AOU 1998). The birds usually breed between 1,300 and 2,000 meters above sea level (Reynolds and Rich 1978). In eastern Washington, sage thrashers showed the strongest correlation to the amount of sagebrush cover of all shrubsteppe birds and were most abundant where sagebrush percent cover was 11%, which is similar to estimated historic sagebrush cover (Dobler 1992, Dobler *et al.* 1996). In northern Great Basin, the sage thrasher breeds and forages in tall sagebrush/bunchgrass, juniper/sagebrush/bunchgrass, mountain mahogany/shrub, and aspen/sagebrush/bunchgrass communities (Maser *et al.* 1984).
Sage thrashers are positively correlated with shrub cover, shrub height, bare ground, and horizontal heterogeneity (patchiness). They are negatively correlated with spiny hopsage, budsage, and grass cover (Rotenberry and Wiens 1980; Wiens and Rotenberry 1981). In Idaho, sage thrashers are more likely to occur in sites with higher sagebrush cover and greater spatial similarity within a one-kilometer radius (Knick and Rotenberry 1995). In Nevada, sage thrashers are found most often on plots with taller, denser sagebrush (Medin 1992).

Sage thrashers usually nests within 1 meter of the ground in a fork of shrub (almost always sagebrush) and sometimes nest on the ground (Harrison 1978; Reynolds 1981; Rich 1980). In southeastern Idaho, sage thrashers nested in clumps of tall big sagebrush, with dense foliage overhead, invariably a depth of 0.5 meter from nest to shrub crown, and nests tending to be on the southeast side of the shrub (Petersen and Best 1991). Reynolds (1981) recorded a mean nest shrub height of 89 cm, a mean nest height 18 cm, and a mean distance between nest and shrub crown of 58 cm. For nests placed within shrubs, Rich (1980) observed a mean nest shrub height of 83 cm, a mean nest height of 23 cm, and a mean distance between nest and shrub crown of 60 cm (n = 114 nests). The distance between nest and shrub crown is nearly always the same (58 to 60 cm) whether the nest is placed on the ground or within a shrub, presumably for optimum shading and shelter (Reynolds 1981; Rich 1980).

2.2.3 Non-breeding

In winter, sage thrashers use arid and semi-arid scrub, brush and thickets.

3.0 Sage Thrasher Population and Distribution

3.1 Population

3.1.1 Historic

The only historic population estimate found was Jewett *et al.* (1953) given by Kennedy (1914: 252) who estimated there were 5 pairs/mi^2 through the Yakima Valley.

3.1.2 Current

Breeding density rarely exceeds 30 per km^2 (Rotenberry and Wiens 1989). In eastern Washington sagebrush shrubsteppe, mean breeding densities were reported at 0.09-0.2 individuals/ha (Dobler *et al.* 1996). Medin (1990) reported breeding densities of 0.05 individuals/ha or less in shadscale habitat in eastern Nevada. Territory size in eastern Idaho averaged 8 territories/1.86 ha in one year, and 11 territories/1.14 ha the following year (Reynolds 1981).

On the Yakima Training Center density estimates ranged from 17-31 birds/km^2 in sagebrush habitat (Shapiro and Associates 1996), whereas Schuler *et al.* (1993) on Hanford Reservation, reported density from 0.17-0.23 birds/km^2.

The relative abundance of sage thrashers is significantly positively correlated with the following species in the western U.S., based on BBS data (T.D. Rich, unpubl. data): Brewer's sparrow (*Spizella breweri*) ($r = 0.87$, $P < 0.001$), sage sparrow (*Amphispiza belli*) ($r = 0.73$, $P < 0.001$), gray flycatcher (E*mpidonax wrightii*) ($r = 0.73$, $P < 0.001$), sage grouse (*Centrocercus urophasianus*) ($r = 0.71$, $P < 0.001$), rock wren (*Salpinctes obsoletus*) ($r = 0.61$, $P < 0.001$), vesper sparrow (*Pooecetes gramineus*) ($r = 0.53$, $P < 0.001$), prairie falcon (*Falco mexicanus*) ($r = 0.53$, $P < 0.001$), and green-tailed towhee (*Pipilo chlorurus*) ($r = 0.51$, $P < 0.001$).

3.2 Distribution

3.2.1 Historic

Jewett *et al.* (1953) described the distribution of the sage thrasher as a summer resident at least from March to August irregularly through the sagebrush of the Upper Sonoran Zone in eastern Washington. They describe its summer range as north to Soap Lake, Almira, St. Andrews and Withrow; east to Sprague and Spokane; south to Bickleton, Wallula, Horse Heaven, and Kiona; and west to Ellensburg and Yakima Valley. Jewett *et al.* (1953) also note that Snodgrass observed none in the desert of Franklin and western Walla Walla counties, but found it rather numerous on the west side of the Columbia River between White Bluffs and Yakima, a few inhabiting tree-covered area along the Yakima River, and abundant in the arid Horse Heaven country. They note that the species has been reported as far east as Sprague and Riverside. Hudson and Yocom (1954) described the sage thrasher as uncommon and locally distributed summer resident in sagebrush areas. They note it presence was recorded by Taylor around Spokane and also that one record exits near Pullman.

Sage thrashers inhabited large, lowland areas of southeast Washington when it consisted of shrubsteppe habitat. Conversion of shrub-step to agricultural use has greatly reduced the habitat available to the sage thrasher, resulting in localized populations associated with existing sagebrush habitat in eastern Walla Walla and northeast Asotin counties (Smith *et al.* 1997).

3.2.2 Current

Sage thrashers are a migratory species in the state of Washington; birds are present only during the breeding season. Confirmed breeding evidence has been recorded in Douglas, Grant, Lincoln, Adams, Yakima, and Kittitas counties. Core habitats also occur in Okanogan, Chelan, Whitman, Franklin, Walla Walla, Benton, Klickitat, and Asotin counties (Smith *et al.* 1997). Estimates of sage thrasher density in eastern Washington during 1988-89 was 0.5 birds/ac (Dobler *et al.* 1996).

3.2.2.1 Breeding

During the breeding season, sage thrashers are found in southern British Columbia, central Idaho, and south-central Montana south through the Great Basin to eastern California, northeastern Arizona, and west-central and northern New Mexico (AOU 1983; Reynolds *et al.* 1999). Sage thrashers breed at least irregularly in southern Alberta and southern Saskatchewan (Cannings 1992) (Figure 1).

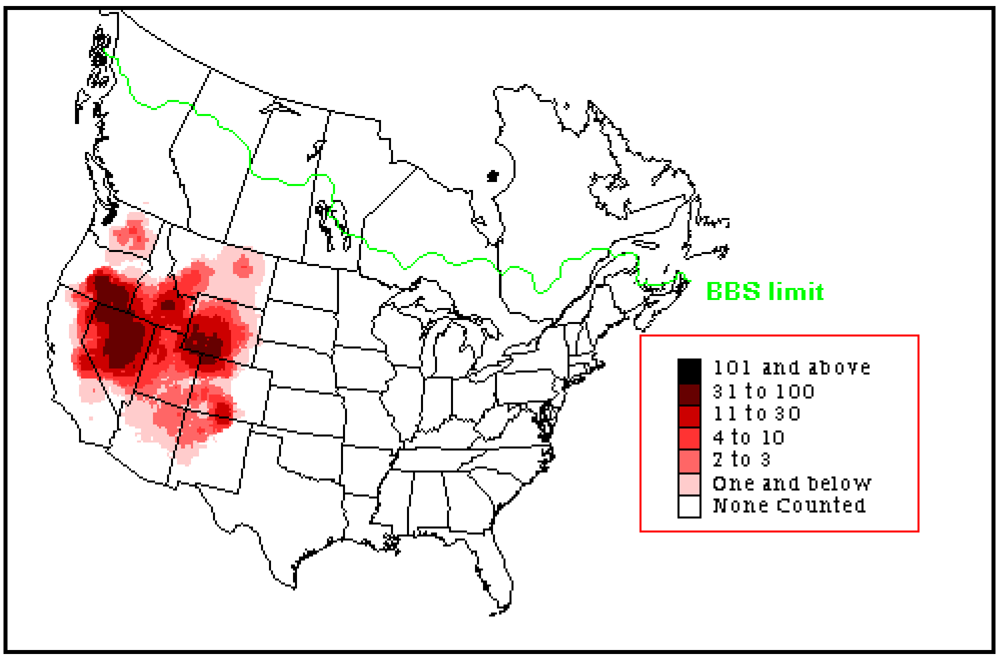

Figure 1. Sage thrasher breeding season abundance (Sauer *et al.* 2003).

3.2.2.2 Non-breeding

Sage thrashers are found in central California, southern Nevada, northern Arizona, central New Mexico, and central Texas south to southern Baja California, northern Sonora, Chihuahua, Durango, Guanajuato, northern Nuevo Leon, and northern Tamaulipas (AOU 1983; Reynolds *et al.* 1999) (Figure 2).

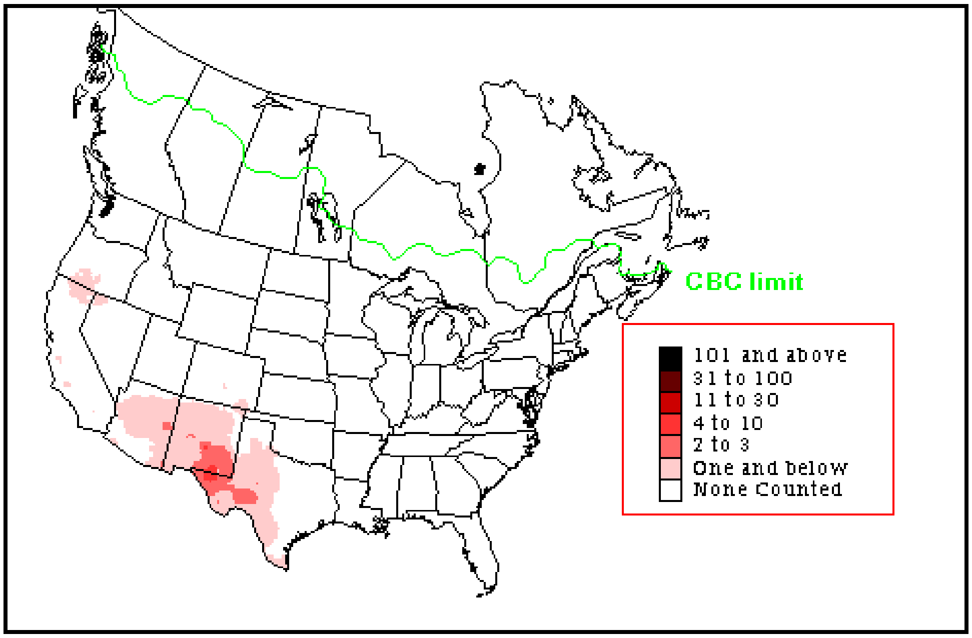

Figure 2. Sage thrasher winter season abundance (Sauer *et al.* 2003).

4.0 Sage Thrasher Status and Abundance Trends

4.1 Status

The sage thrasher is considered a 'state candidate' species by the Washington Department of Fish and Wildlife. In Canada, sage thrashers are on the British Columbia Environment Red List (review for endangered and threatened status). They are considered a priority species by the Oregon-Washington Chapter of Partners in Flight and are on the Audubon Society Watch List for Washington State. Sage thrashers are listed as a species of high management concern by the Interior Columbia River Basin Ecosystem Management Project (Saab and Rich 1997).

4.2 Trends

North American Breeding Bird Survey data (1966-1996) show a non-significant sage thrasher survey-wide increase (n = 268 survey routes) (Figure 3). There have been increasing trends in all areas except Idaho (-1.0 average decline per year, non-significant, n = 29) and the Intermountain Grassland physiographic region (-4.0 average decline per year, significant, n = 26) for 1966-1996. BBS data indicate a significant decline in Intermountain Grassland for 1980-1996 (-8.8 average per year decrease, n = 22). Significant long-term increases in sage thrashers are evident in Colorado (4.4% average per year, n = 24) and Oregon (2.6% average per year, n = 28), 1966-1996. The sample sizes are small or trends are not significant in other states. The BBS data (1966-1996) for the Columbia Plateau are illustrated in Figure 4.

Christmas Bird Count (CBC) show stable trends for the period 1959-1988 (0.0% average annual change, n = 161 survey circles) survey-wide, but a significant decline in Texas (-2.8% average annual decline, n = 59) and a significant increase in New Mexico (2.4% average per year, n = 19). Sage thrasher winter abundance is highest in west Texas and southeastern New Mexico (Sauer *et al.* 1996).

Sage thrasher is positively correlated with the presence of Brewer's sparrow, probably due to similarities in habitat relations (Wiens and Rotenberry 1981), and does not exhibit the steep and widespread declines evident from BBS data for Brewer's sparrow (Sauer *et al.* 1997).

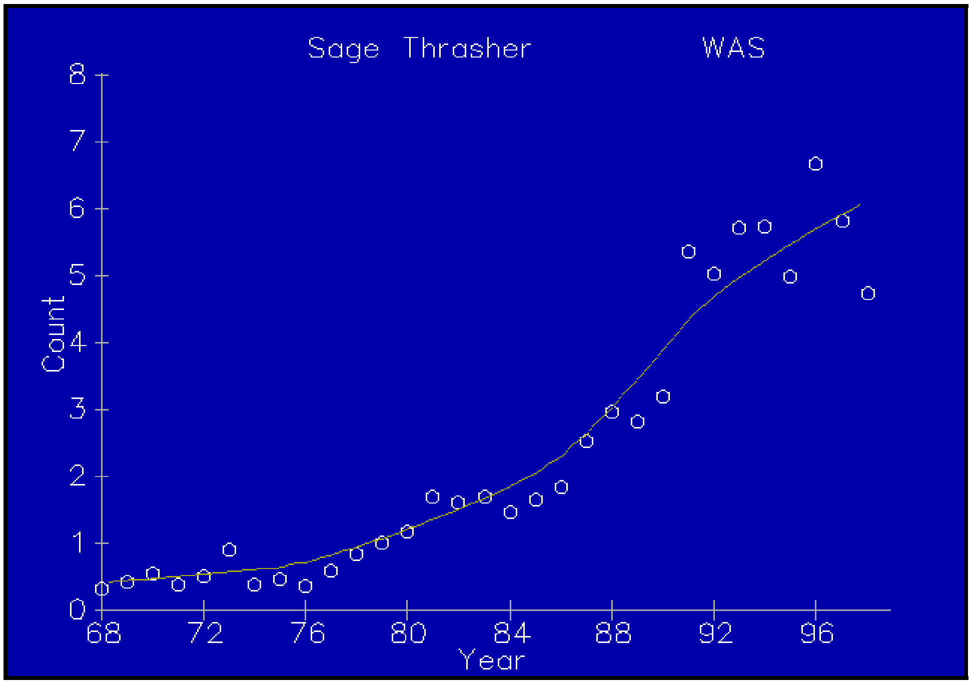

Figure 3. Sage thrasher trend results, Washington (Sauer *et al.* 2003).

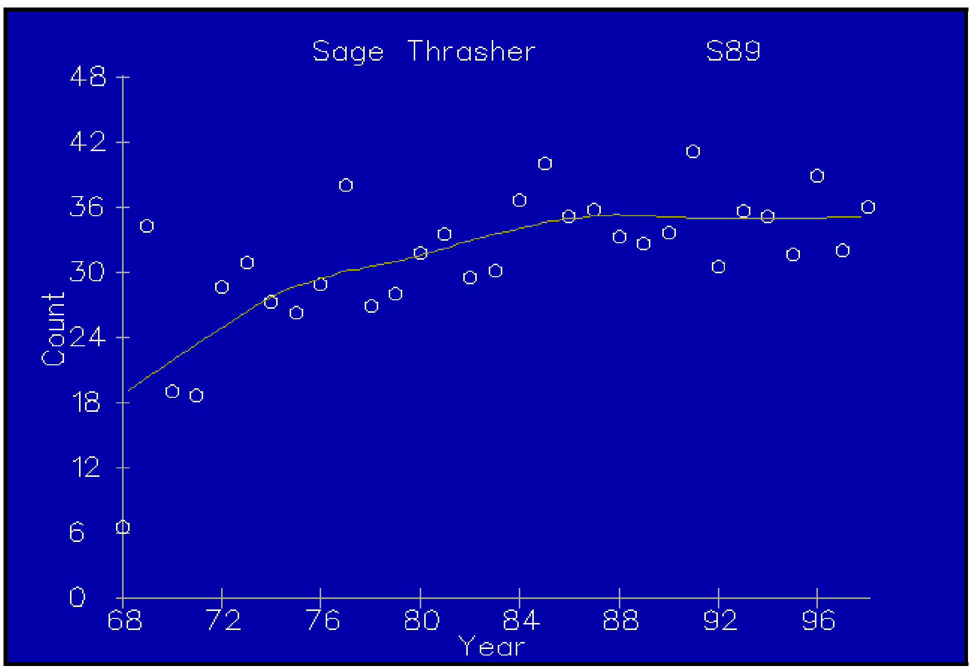

Figure 4. Sage thrasher trend results, Columbia Plateau (Sauer *et al.* 2003).

5.0 Factors Affecting Sage Thrasher Populations and Ecological Processes

5.1 Habitat Loss and Fragmentation

Removal of sagebrush and conversion to other land uses is detrimental (Castrale 1982). Large-scale reduction and fragmentation of sagebrush habitats is occurring in many areas due to land conversion to tilled agriculture, urban and suburban development, and road and powerline right-of-ways. Range management practices such as mowing, burning, herbicide treatments, and residential and agricultural development have reduced the quantity and quality of sagebrush habitat (Braun *et al.* 1976; Cannings 1992; Reynolds *et al.* 1999). Range improvement programs remove sagebrush (particularly once grazed sagebrush becomes overly dense) by burning, herbicide application, and mechanical treatment, replacing sagebrush with annual grassland to promote forage for livestock. Burning can result in longer-lasting sagebrush control than chaining (Castrale 1982).

In Washington, the conversion of native shrubsteppe to agriculture has resulted in a 50% loss in historic breeding habitat. Concomitant with habitat loss has been fragmentation of remaining shrubsteppe. Research in Washington suggests that sage thrashers may be less sensitive to habitat fragmentation than other shrubsteppe obligates as birds were found to nest in shrubsteppe patches <10 ha (24 ac) (Vander Haegen *et al.* 2000). However, birds nesting in small habitat fragments may experience higher rates of nest predation than birds nesting in larger areas of contiguous habitat (Vander Haegen 2003).

Recommended habitat conditions for sage thrashers include areas of shrubsteppe >16 ha (40 ac) where average sagebrush cover is 5-20 % and height is >80 cm (31 in), sagebrush should be patchily distributed rather than dispersed, and mean herbaceous cover 5-20% with <10% cover of non-native annuals (Altman and Holmes 2000).

According to the ICBEMP terrestrial vertebrate habitat analyses, historical source habitats for sage thrasher occurred throughout most of the three ERUs within our planning unit (Wisdom *et al.* in press). Declines in source habitats were moderately high in the Columbia Plateau (40%), but relatively low in the Owyhee Uplands (15%) and Northern Great Basin (5%). However, declines in big sagebrush (e.g., 50% in Columbia Plateau ERU), which is likely higher quality habitat, are masked by an increase in juniper sagebrush (>50% in Columbia Plateau ERU), which is likely reduced quality habitat. Within the entire Interior Columbia Basin, over 48% of watersheds show moderately or strongly declining trends in source habitats for this species (Wisdom *et al.* in press).

5.2 Grazing

Although sage thrashers are found on grazed range land, the effects of long-term grazing by livestock are not known. The response by sage thrashers to grazing is mixed as studies have reported both positive and negative population responses to moderate grazing of big sage/bluebunch wheatgrass communities (Saab *et al.* 1995). There is some evidence that sage thrasher density may be lower in grazed habitats as the average distance between neighboring nests was found to be significantly lower in ungrazed vs. grazed shrubsteppe habitats in south-central Idaho, 64 m (209 ft) and 84 m (276 ft) respectively (Reynolds and Rich 1978). Altman and Holmes (2000) suggest maintaining >50% of annual vegetative growth of perennial bunchgrasses through the following growing season.

Grazing can increase sagebrush density, positively affecting thrasher abundance. Dense stands of sagebrush, however, are considered degraded range for livestock and may be treated to reduce or remove sagebrush. Grazing may also encourage the invasion of non-native grasses, which escalates the fire cycle and converts shrublands to annual grasslands. West (1988, 1996) estimates less than 1% of sagebrush steppe habitats remain untouched by livestock; 20% is lightly grazed, 30% moderately grazed with native understory remaining, and 30% heavily grazed with understory replaced by invasive annuals. The effects of grazing in sagebrush habitats are complex, and depend on intensity, season, duration and extent of alteration to native vegetation.

5.3 Invasive Grasses

Cheatgrass readily invades disturbed sites, and has come to dominate the grass-forb community of more than half the sagebrush region in the West, replacing native bunchgrasses (Rich 1996). Cheatgrass can create a more continuous grass understory than native bunchgrasses. Dense cheatgrass cover can possibly affect foraging ability for ground foragers, and more readily carries fire than native bunchgrasses. Crested wheatgrass and other non-native annuals have also altered the grass-forb community in many areas of sagebrush shrubsteppe.

5.4 Fire

Cheatgrass has altered the natural fire regime on millions of acres in the western range, increasing the frequency, intensity, and size of range fires. Fire kills sagebrush and where non-native grasses dominate, the landscape can be converted to annual grassland as the fire cycle escalates (Paige and Ritter 1998).

5.5 Predation

Sage thrashers are preyed upon by loggerhead shrikes (*Lanius ludovicianus*); predation can be a major factor in breeding success of sagebrush birds (Reynolds 1979).

5.6 Brood parasitism

Sage thrashers coexist with brown-headed cowbirds (*Molothrus ater*) at various points throughout their range and have been observed to reject cowbird eggs by ejecting eggs from the nest (Rich and Rothstein 1985).

6.0 Out-of-Subbasin Effects and Assumptions

No data could be found on the migration and wintering grounds of the sage thrasher. It is a short distance migrant, wintering in the southwestern U.S. and northern Mexico, and as a result faces a complex set of potential effects during it annual cycle. Habitat loss or conversions is likely happening along its entire migration route (H. Ferguson, WDFW, personal communication, 2003). Management requires the protection shrub, shrubsteppe, desert scrub habitats, and the elimination or control of noxious weeds. Migration routes, corridors, and wintering grounds need to be identified and protected just as its breeding areas.

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Brewer's Sparrow
(*Spizella breweri*)

1.0 Introduction

Although not currently listed, Brewer's sparrows have significantly declined across their breeding range in the last 25 years, a cause for concern because this species is one of the most widespread and ubiquitous birds in shrubsteppe ecosystems (Saab *et al.* 1995). Brewer's sparrow is a sagebrush obligate where sagebrush cover is abundant (Altman and Holmes 2000). However, in recent decades many of the shrubsteppe habitats in Washington have changed as a result of invasion by exotic annuals, especially cheatgrass. Cheatgrass-dominated areas have an accelerated fire regime that effectively eliminates the sagebrush shrub component of the habitat, a necessary feature for Brewer's sparrows (Vander Haegen *et al.* 2000).

Conservation practices that retain deep-soil shrubsteppe communities, reduce further fragmentation of native shrubsteppe, and restore annual grasslands and low-productivity agricultural lands are all important (Vander Haegen *et al.* 2000). A patchy distribution of sagebrush clumps is more desirable than dense uniform stands. Removal of sagebrush cover to <10% has a negative impact on populations (Altman and Holmes 2000). Recommended habitat objectives include the following: patches of sagebrush cover 10-30%, mean sagebrush height > 64cm (24 in), high foliage density of sagebrush, average cover of native herbaceous plants > 10%, bare ground >20% (Altman and Holmes 2000).

2.0 Brewer's Sparrow Life History and Habitat Requirements

2.1 Life History

2.1.1 Diet

Brewer's sparrows forage by gleaning a wide variety of small insects from the foliage and bark of shrubs. Occasionally, seeds are taken from the ground. They will drink free-standing water when available but are physiologically able to derive adequate water from food and oxidative metabolism (Rotenberry *et al.* 1999). Lepidopterans (butterflies and moths, 90% larvae), araneans (spiders), hemipterans (bugs), and homopterans (hoppers, aphids, etc.) make up 72 % of the nestling diet (Petersen and Best 1986).

2.1.2 Reproduction

Breeding begins in mid-April in the south to May or early June in the north. Clutch size is usually three to four. Nestlings are altricial. Brewer's sparrow reproductive success is correlated with climatic variation and with clutch size; success increasing in wetter years (Rotenberry and Wiens 1989, 1991).

Brewer's sparrows are able to breed the first year following hatch and may produce two broods a year. In southeastern Idaho, the probability of nest success was estimated at 9% (n = 7; Reynolds 1981). In eastern Washington 31 of 59 (53%) pairs were unsuccessful, 25 (42%) fledged one brood, 3 (5%) fledged two broods (Mahony *et al.* 2001). The probability of nest success was an estimated 39% for 495 nests monitored in eastern Washington; reproductive success was lower in fragmented landscapes (Vander Haegen unpubl. data in Altman and Holmes 2000). The number of fledglings produced/nest varies geographically and temporally. The average number of fledglings/nest range from 0.5-3.4 but may be zero in years with high nest predation (Rotenberry *et al.* 1999).

2.1.3 Nesting

Brewer's sparrow pair bonds are established soon after females arrive on breeding areas, usually in late March but pair formation may be delayed by colder than average spring weather. Not all males successfully acquire mates. In Washington, 51% of 55 males monitored in the breeding season were observed incubating eggs, especially during inclement weather (Mahony *et al.* 2001). Pairs may start a second clutch within 10 days after fledging the young from their first brood (Rotenberry *et al.* 1999).

Brown-headed cowbirds (*Molothrus ater*) are known to lay eggs in Brewer's sparrow nests; parasitized nests are usually abandoned (Rich 1978; Biermann *et al.* 1987; Rotenberry *et al.* 1999). Parasitism of Brewer's sparrows nest by cowbirds is only about 5% in eastern Washington (Altman and Holmes 2000).

Both parents feed the nestlings, 90% of foraging trips are < 50 m (164 ft) from the nest site. Fledglings are unable to fly for several days after leaving the nest and continue to be dependent upon the parents. During this period they remain perched in the center of a shrub often < 10 m (33 ft) from the nest and quietly wait to be fed (Rotenberry *et al.* 1999).

2.1.4 Migration

Brewer's sparrow is a neotropical migrant. Birds breed primarily in the Great Basin region and winter in the southwestern U.S., Baja, and central Mexico. North-south oriented migration routes are through the Intermountain West. Brewer's sparrows are an early spring migrant. Birds arrive in southeastern Oregon by mid-late March. The timing of spring arrival may vary among years due to weather conditions. Birds generally depart breeding areas for winter range in mid-August through October (Rotenberry *et al.* 1999).

2.1.5 Mortality

Nest predators include gopher snake (*Pituophis catenifer*), western rattlesnake (*Crotalus viridis*), common raven (*Corvus corax*), black-billed magpie (*Pica pica*), loggerhead shrike (*Lanius ludovicianus*), long-tailed weasel (*Mustela frenata*), Townsend's ground squirrel (*Spermophilus townsendii*), and least chipmunk (*Tamias minimus*). Predators of juvenile and adult birds include loggerhead shrike, American kestrel (*Falco sparverius*), sharp-shinned (*Accipiter striatus*) and Cooper's (*A. cooperi*) hawks (Rotenberry 1999).

2.2 Habitat Requirements

In eastern Washington, abundance of Brewer's sparrows (based on transect surveys) was negatively associated with increasing annual grass cover; higher densities occurred in areas where annual grass cover was <20% (Dobler 1994). Vander Haegen *et al.* (2000) determined that Brewer's sparrows were more abundant in areas of loamy soil than areas of sandy or shallow soil, and on rangelands in good or fair condition than those in poor condition. Additionally, abundance of Brewer's sparrows was positively associated with increasing shrub cover. In southwestern Idaho, the probability of habitat occupancy by Brewer's sparrows increased with increasing percent shrub cover and shrub patch size; shrub cover was the most important determinant of occupancy (Knick and Rotenberry 1995).

2.2.1 Nesting

Brewer's sparrows construct an open cup shaped nest generally in a live big sagebrush shrub (Petersen and Best 1985, Rotenberry *et al.* 1999). In southeastern Idaho, mean sagebrush height (54 cm, 21 in) and density (29% cover) were significantly higher near Brewer's sparrow nest sites than the habitat in general while herbaceous cover (8%) and bare ground (46%) were significantly lower (Petersen and Best 1985). The average height of nest shrubs in southeastern

Idaho was 69 cm (27 in). Ninety percent (n = 58) of Brewer's sparrows nests were constructed at a height of 20-50 cm (8-20 in) above the ground (Petersen and Best 1985).

2.2.2 Breeding

Brewer's sparrow is strongly associated with sagebrush over most of its range, in areas with scattered shrubs and short grass. They can also be found to a lesser extent in mountain mahogany, rabbit brush, bunchgrass grasslands with shrubs, bitterbrush, ceonothus, manzanita and large openings in pinyon-juniper (Knopf *et al.* 1990; Rising 1996; Sedgwick 1987; USDA Forest Service 1994). In Canada, the subspecies *taverneri* is found in balsam-willow habitat and mountain meadows.

The average canopy height is usually < 1.5 meter (Rotenberry *et al.* 1999). Brewer's sparrow is positively correlated with shrub cover, above-average vegetation height, bare ground, and horizontal habitat heterogeneity (patchiness). They are negatively correlated with grass cover, spiny hopsage, and budsage (Larson and Bock 1984; Rotenberry and Wiens 1980; Wiens 1985; Wiens and Rotenberry 1981). Brewer's sparrows prefer areas dominated by shrubs rather than grass. They prefer sites with high shrub cover and large patch size, but thresholds for these values are not quantified (Knick and Rotenberry 1995). In Montana, preferred sagebrush sites average 13 percent sagebrush cover (Bock and Bock 1987). In eastern Washington, Brewer's sparrow abundance significantly increased on sites as sagebrush cover approached historic 10 percent level (Dobler *et al.* 1996). Brewer's sparrows are strongly associated throughout their range with high sagebrush vigor (Knopf *et al.* 1990).

Adults are territorial during the breeding season. Territory size is highly variable among sites and years. In central Oregon and northern Nevada, territory size was not correlated with 17 habitat variables but was negatively associated with increasing Brewer's sparrow density. The average size of territories ranges from 0.5-2.4 ha (1.2-5.9 ac, n = 183) in central Oregon. The reported territory size in central Washington is much lower, 0.1 ha (0.2 ac) (Rotenberry *et al.* 1999).

2.2.3 Non-breeding

In migration and winter, Brewer's sparrows use low, arid vegetation, desert scrub, sagebrush, creosote bush (Rotenberry *et al.* 1999).

3.0 Brewer's Sparrow Population and Distribution

3.1 Population

3.1.1 Historic

Information for this section is unavailable.

3.1.2 Current

Brewer's sparrows can be abundant in sagebrush habitat and will breed in high densities (Great Basin and Pacific slopes), but densities may vary greatly from year to year (Rotenberry *et al.* 1999). Dobler *et al.* (1996) reported densities of 50-80 individuals/km^2 in eastern Washington. In the Great Basin, density usually ranged from 150-300/km^2, sometimes exceeding 500/km^2 (Rotenberry and Wiens 1989). Brewer's sparrow breeding density ranges from 0.08 to 0.10 individuals/ha in shadscale habitat in eastern Nevada (Medin 1990). Breeding territory usually averages between 0.6-1.25 hectares and will contract as densities of breeding birds increase (Wiens *et al.* 1985).

In southeastern Oregon, densities have ranged from 150-300 birds/km^2 (390-780/mi^2), but can exceed 500/km^2 (1,295/mi^2) (Weins and Rotenberry 1981; Rotenberry and Weins 1989).

3.2 Distribution

3.2.1 Historic

Jewett *et al.* (1953) described the distribution of the Brewer's sparrow as a fairly common migrant and summer resident at least from March 29 to August 20, chiefly in the sagebrush of the Upper Sonoran Zone in eastern Washington. They describe its summer range as north to Brewster and Concully; east to Spokane and Pullman; south to Walla Walla, Kiona, and Lyle; and west to Wenatchee and Yakima. Jewett *et al.* (1953) also noted that Snodgrass (1904: 230) pointed out its rarity in Franklin and Yakima counties. Snodgrass also reported that where the vesper sparrow was common, as in Lincoln and Douglas counties, the Brewer's sparrow was also common (Jewett *et al.* 1953). Hudson and Yocom (1954) described the Brewer's sparrow as an uncommon summer resident and migrant in open grassland and sagebrush. They also reported occupied nests near Pullman.

Undoubtedly, the Brewer's sparrow was widely distributed throughout the lowlands of southeast Washington when it consisted of vast expanses of shrubsteppe habitat. Large scale conversion of shrubsteppe habitat to agriculture has resulted in populations becoming localized in the last vestiges of available habitat (Smith *et al.* 1997). A localized population existed in small patches of habitat in northeast Asotin County. Brewer's sparrow may also occur in western Walla Walla County, where limited sagebrush habitat still exists.

3.2.2 Current

Washington is near the northwestern limit of breeding range for Brewer's sparrows. Birds occur primarily in Okanogan, Douglas, Grant, Lincoln, Kittitas, and Adams Counties (Smith *et al.* 1997).

There is high annual variation in breeding season density estimates. A site may be unoccupied one year and have densities of up to 150 birds/km^2 the next. Because of this variation, short-term and/or small scale studies of Brewer's sparrow habitat associations must be viewed with caution (Rotenberry *et al.* 1999).

3.3 Breeding

The subspecies *breweri* is found in southeast Alberta, southwestern Saskatchewan, Montana, and southwestern North Dakota, south to southern California (northern Mojave Desert), southern Nevada, central Arizona, northwestern New Mexico, central Colorado, southwestern Kansas, northwestern Nebraska, and southwestern South Dakota (AOU 1983; Rotenberry *et al.* 1999) (Figure 1). The subspecies *taverneri* is found in southwest Alberta, northwest British Columbia, southwest Yukon, and southeast Alaska (Rotenberry *et al.* 1999).

3.4 Non-breeding

During the non-breeding season, Brewer's sparrows are found in southern California, southern Nevada, central Arizona, southern New Mexico, and west Texas, south to southern Baja California, Sonora, and in highlands from Chihuahua, Coahuila, and Nuevo Leon south to northern Jalisco and Guanajuato (Terres 1980; AOU 1983; Rotenberry *et al.* 1999).

4.0 Brewer's Sparrow Status and Abundance Trends

4.1 Status

Brewer's sparrow is often the most abundant bird species in appropriate sagebrush habitats. However, widespread long-term declines and threats to shrubsteppe breeding habitats have placed it on the Partners in Flight Watch List of conservation priority species (Muehter 1998). Saab and Rich (1997) categorize it as a species of high management concern in the Columbia River Basin.

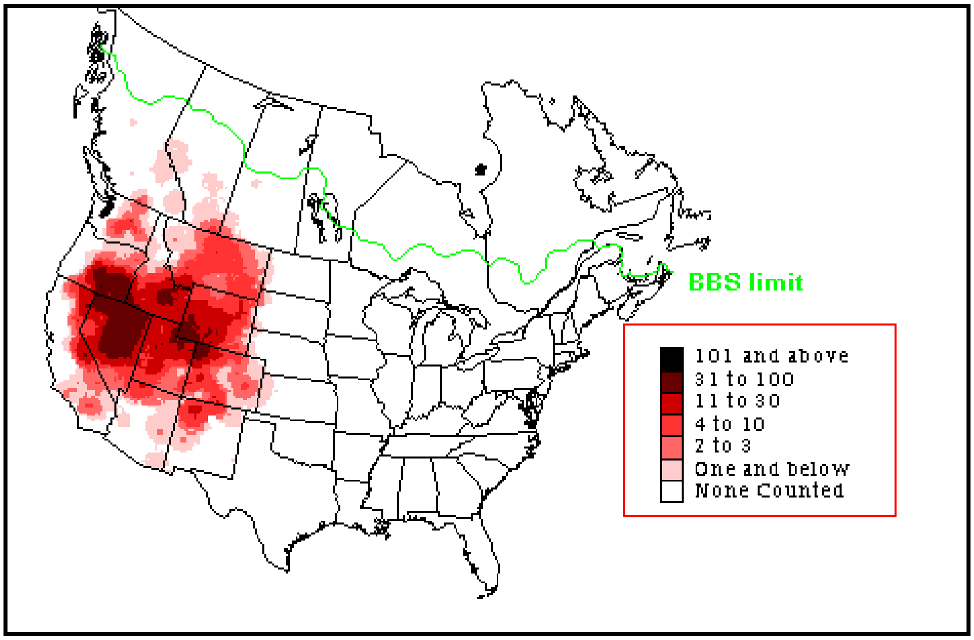

Figure 1. Brewer's sparrow breeding season abundance (Sauer *et al.* 2003).

Considered a shrubsteppe obligate, the Brewer's sparrow is one of several species closely associated with landscapes dominated by big sagebrush (*Artemisia tridentate*) (Rotenberry 1999; Paige and Ritter 1999). Historically, the Brewer's sparrow may have been the most abundant bird in the Intermountain West (Paige and Ritter 1999) but Breeding Bird Survey trend estimates indicate a range-wide population decline during the last twenty-five years (Peterjohn *et al.* 1995). Brewer's sparrows are not currently listed as threatened or endangered on any state or federal list. Oregon-Washington Partners in Flight consider the Brewer's sparrow a focal species for conservation strategies for the Columbia Plateau (Altman and Holmes 2000).

4.2 Trends

Breeding Bird Survey (BBS) data for 1966-1996 show significant and strong survey-wide declines averaging -3.7 percent per year (n = 397 survey routes) (Figure 2). The BBS data (1966-1996) for the Columbia Plateau are illustrated in Figure 3. Significant declines in Brewer's sparrow are evident in California, Colorado, Montana, Nevada, Oregon, and Wyoming, with the steepest significant decline evident in Idaho (-6.0 percent average per year; n = 39). These negative trends appear to be consistent throughout the 30-year survey period. Only Utah shows an apparently stable population. Sample sizes for Washington are too small for an accurate estimate. Mapped BBS data show centers of summer abundance in the Great Basin and Wyoming Basin (Sauer *et al.* 1997).

Christmas Bird Count (CBC) data for the U.S. for the period 1959-1988 indicate a stable survey-wide trend (0.2 percent average annual increase; n = 116 survey circles), and a significantly positive trend in Texas (6.7 percent average annual increase; n = 33). Arizona shows a non-significant decline (-1.4 percent average annual decline; n = 34). Mapped CBC data show highest wintering abundances in the U.S. in the borderlands of southern Arizona, southern New Mexico, and west Texas (Sauer *et al.* 1996).

Note that although positively correlated with presence of sage thrashers (*Oreoscoptes montanus*), probably due to similarities in habitat relations (Wiens and Rotenberry 1981), thrashers are not exhibiting the same steep and widespread declines evident in BBS data (see Sauer *et al.* 1997).

According to the ICBEMP terrestrial vertebrate habitat analyses, historical source habitats for Brewer's sparrow occurred throughout most of the three ERUs within our planning unit (Wisdom *et al.* in press). Declines in source habitats were moderately high in the Columbia Plateau (39%), but relatively low in the Owyhee Uplands (14%) and Northern Great Basin (5%). However, declines in big sagebrush (e.g., 50% in Columbia Plateau ERU), which is likely higher quality habitat, are masked by an increase in juniper sagebrush (>50% in Columbia Plateau ERU), which is likely reduced quality habitat. Within the entire Interior Columbia Basin, over 48% of watersheds show moderately or strongly declining trends in source habitats for this species (Wisdom *et al.* in press) (from Altman and Holmes 2000).

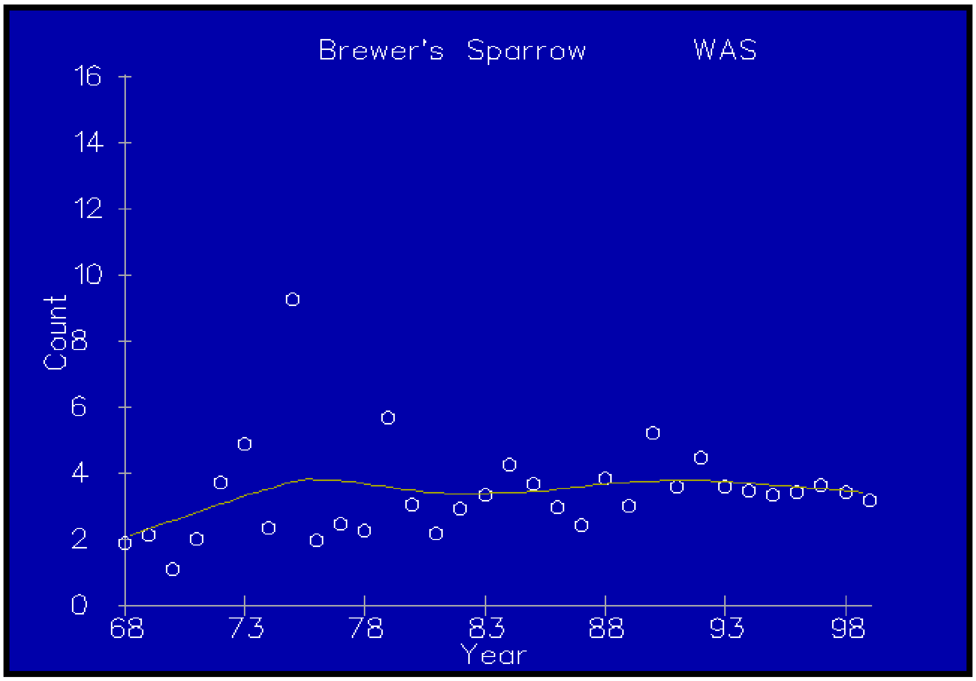

Figure 2. Brewer's sparrow trend results, Washington (Sauer *et al.* 2003).

5.0 Factors Affecting Brewer's Sparrow Populations and Ecological Processes

5.1 Habitat Loss and Fragmentation

Large scale reduction and fragmentation of sagebrush habitats occurring due to a number of activities, including land conversion to tilled agriculture, urban and suburban development, and road and power-line rights of way. Range improvement programs remove sagebrush by burning, herbicide application, and mechanical treatment, replacing sagebrush with annual grassland to promote forage for livestock.

5.2 Grazing

Rangeland in poor condition is less likely to support Brewer's sparrows than rangeland in good and fair condition. Grazing practices that prevent overgrazing, reduce or eliminate invasion of exotic annuals, and restore degraded range are encouraged (Vander Haegen *et al.* 2000). Brewer's sparrow response to various levels of grazing intensity is mixed. Brewer's sparrows respond negatively to heavy grazing of greasewood/great basin wild rye and low sage/Idaho fescue communities; they respond positively to heavy grazing of shadscale/Indian ricegrass, big sage/bluebunch wheatgrass, and Nevada bluegrass/sedge communities; they respond

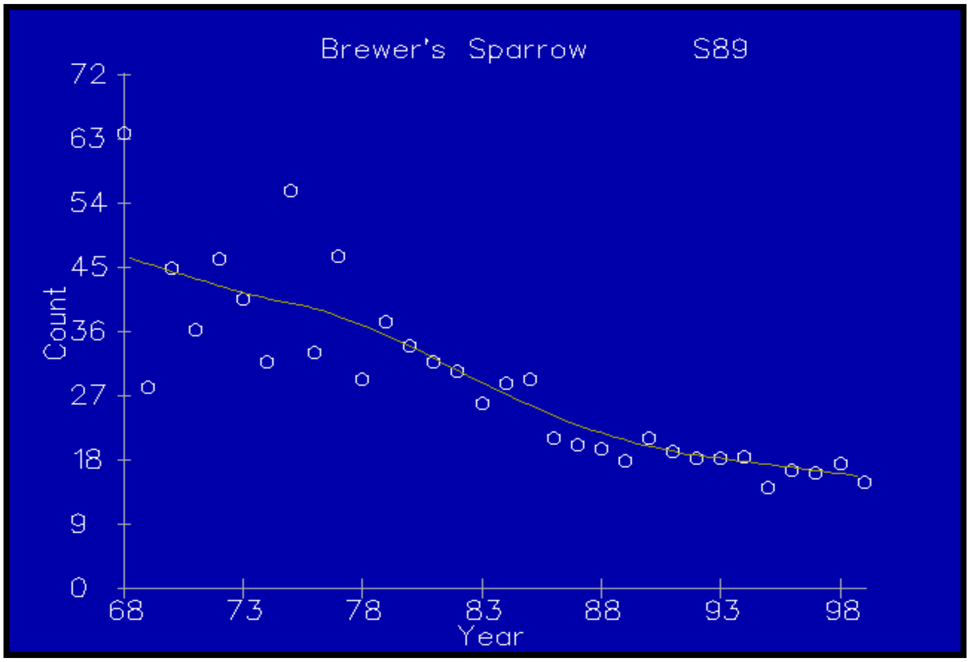

Figure 3. Brewer's sparrow trend results for the Columbia Plateau (Sauer *et al.* 2003).

negatively to moderate grazing of big sage/bluebunch wheatgrass community; and they respond negatively to unspecified grazing intensity of big sage community (see review by Saab *et al.* 1995).Grazing can trigger a cascade of ecological changes, the most dramatic of which is the invasion of non-native grasses escalating the fire cycle and converting sagebrush shrublands to annual grasslands. Historical heavy livestock grazing altered much of the sagebrush range, changing plant composition and densities. West (1988, 1996) estimates less than 1 percent of sagebrush steppe habitats remain untouched by livestock; 20 percent is lightly grazed, 30 percent moderately grazed with native understory remaining, and 30 percent heavily grazed with understory replaced by invasive annuals. The effects of grazing in sagebrush habitats are complex, depending on intensity, season, duration and extent of alteration to native vegetation.

5.3 Invasive Grasses

Cheatgrass readily invades disturbed sites, and has come to dominate the grass-forb community of more than half the sagebrush region in the West, replacing native bunchgrasses (Rich 1996). Crested wheatgrass and other non-native annuals have also fundamentally altered the grass-forb community in many areas of sagebrush shrubsteppe, altering shrubland habitats.

5.4 Fire

Cheatgrass has altered the natural fire regime in the western range, increasing the frequency, intensity, and size of range fires. Fire kills sagebrush and where non-native grasses dominate, the landscape can be converted to annual grassland as the fire cycle escalates, removing preferred habitat (Paige and Ritter 1998).

5.5 Brood Parasitism

Brewer's sparrow nests are an occasional host for brown-headed cowbird (*Molothrus ater*); nests usually abandoned, resulting in loss of clutch (Rotenberry *et al.* 1999). Prior to European-American settlement, Brewer's sparrows were probably largely isolated from cowbird parasitism, but are now vulnerable as cowbird populations increase throughout the West and where the presence of livestock and pastures, land conversion to agriculture, and fragmentation of shrublands creates a contact zone between the species (Rich 1978, Rothstein 1994).

Frequency of parasitism varies geographically; the extent of impact on productivity unknown (Rotenberry *et al.* 1999). In Alberta, in patchy sagebrush habitat interspersed with pastures and riparian habitats, a high rate of brood parasitism reported. Usually abandoned parasitized nests and cowbird productivity was lower than Brewer's (Biermann *et al.* 1987). Rich (1978) also observed cowbird parasitism on two nests in Idaho, both of which were abandoned.

5.6 Predators

Documented nest predators (of eggs and nestlings) include gopher snake (*Pituophis melanoleucus*), Townsend's ground squirrel (*Spermohpilus townsendii*); other suspected predators include loggerhead shrike (*Lanius ludovicianus*), common raven (*Corvus corax*), black-billed magpie (*Pica pica*), long-tailed weasel (*Mustela frenata*), least chipmunk (*Eutamias minimus*), western rattlesnake (*Crotalus viridis*), and other snake species. Nest predation significant cause of nest failure. American kestrel (*Falco sparverius*), prairie falcon (*Falco mexicanus*), coachwhip (*Masticophis flagellum*) reported preying on adults (Rotenberry *et al.* 1999). Wiens and Rotenberry (1981) observed significant negative correlation between loggerhead shrike and Brewer's sparrow density.

5.7 Pesticides/Herbicides

Aerial spraying of the herbicide 2,4-D did not affect nest success of Brewer's sparrows during the year of application. However, bird densities were 67% lower one year, and 99% lower two years, after treatment. Birds observed on sprayed plots were near sagebrush plants that had survived the spray. No nests were located in sprayed areas one and two years post application (Schroeder and Sturges 1975).

6.0 Out-of-Subbasin Effects and Assumptions

No data could be found on the migration and wintering grounds of the Brewer's sparrow. It is a short-distance migrant, wintering in the southwestern U.S. and northern Mexico, and as a result faces a complex set of potential effects during it annual cycle. Habitat loss or conversions is likely happening along its entire migration route (H. Ferguson, WDFW, personal communication, 2003). Management requires the protection shrub, shrubsteppe, desert scrub habitats, and the elimination or control of noxious weeds. Wintering grounds need to be identified and protected just as its breeding areas. Migration routes and corridors need to be identified and protected.

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Rocky Mountain Mule Deer
(*Odocoileus hemionus hemionus*)

1.0 Introduction
Mule deer have been an important member of eastern Washington's landscape, serving as a food and clothing source for Native Americans prior to settlement by Euro-Americans. Today mule deer remain an important component of the landscape, providing recreational opportunities for hunters and wildlife watchers, and tremendous economic benefits to local communities and the state of Washington. Mule deer range throughout southeast Washington, occupying various habitats from coniferous forest at 6,000 feet in the Blue Mountains, to the farmlands and shrubsteppe/grassland habitats along the breaks of the Snake River.

2.0 Mule Deer Life History and Habitat Requirements
2.1 Life History
Mule deer fawns are born from late May through mid June following a gestation of approximately 203 days, with does having 1 to 2 fawns. Does require nutritious forage and water while nursing fawns. Fawns need good hiding cover to protect them from predators. The breeding season occurs in the late fall and early winter (Novemer –early December) across eastern Washington, with mule deer becoming sexually mature as yearlings. During the fall season, high quality forage should be available to allow does to recover from the rigors of nursing fawns and prepare for the leaner winter months. In southeast Washington, late summer/fall rains that create a greenup are very important for mule deer. The fall greenup provides the nutrition necessary to improve body condition for the coming winter, and maintain the fertility of does that breed in late fall. A late summer/fall drought can result in increased winter mortality of adults and fawns, lower fertility rates for does, and poor fawn production and survival. Good spring range conditions are important because they provide the first opportunity for mule deer to reverse the energy deficits created by low quality forage and winter weather. Winter is a difficult time for mule deer; forage quality and availability are limited, and does that are carrying developing fetuses are under significant stress. Ideally, mule deer winter range should be free of disturbance and contain abundant, high quality forage. Poor winter range conditions and sever winter weather in the form of deep snow and cold temperatures can result in high mortality, especially among the old and young.

2.1.1 Diet
Mule deer diets are as varied as the landscapes they inhabit. Kufeld *et al.* (1973) have identified 788 plant species that have been eaten by mule deer; this list includes 202 trees and shrubs, 484 forbs, and 84 grasses, rushes, and sedges. Diets vary by season, age, and sex. Mule deer occupying the farmlands and breaks of the Snake River in southeast Washington rely heavily on the fall greenup of winter wheat and cheatgrass to improve body condition for the winter months, and to provide forage during the winter.

2.1.2 Reproduction
Mule deer in eastern Washington typically mate between late October and December with the peak of the rut occurring in mid November. Bucks are polygamous. Following a gestation of approximately 203 days, single or twin fawns are born (Zeigler 1978). Mule deer become sexually mature as yearlings. In 1990, a three point regulation and nine day season was implemented in an effort to s improve post-season buck/doe ratios and increase the number of adult bucks available for breeding. From 1990 to 1998, the percentage of adult mule deer bucks in the post-hunt population increased by 600%, compared to the pre-three point era (Bender 1999).

2.1.3 Migration

Most mule deer that summer at high elevation in the Cascades and Okanogan Highlands migrate to lower elevations to winter (Zeigler 1978). Some mule deer have been observed to migrate considerable distances (up to 80 km) between summer and winter ranges. Mule deer in the Blue Mountains of Washington do not normally migrate long distances to winter range, but move from higher elevations (6,000 ft) to the foothills to winter. Some migration from the foothills or farmland areas to the Snake River breaks may also occur, but no research has been conducted to verify this movement.

2.1.4 Mortality

Observed deaths of mule deer have resulted from a variety of sources. These include legal hunting, poaching, predation by cougars, bobcats, coyotes, and black bears, disease and parasites, starvation, automobiles, and other accidents (Zeigler 1978).

2.2 Habitat Requirements

Mule deer need the same basic elements for life as other organisms. However, mule deer occupy a variety of cover types across eastern Washington. Consequently, habitat requirements vary with vegetative and landscape components contained within each herd range. Forested habitats provide mule deer with forage as well as snow intercept, thermal, and escape cover. Mule deer occupying mountain-foothill habitats live within a broad range of elevations, climates, and topography which includes a wide range of vegetation; many of the deer using these habitats are migratory. Mule deer are found in the deep canyon complexes along the major rivers and in the channeled scablands of eastern Washington; these areas are dominated by native bunch grasses or shrubsteppe vegetation. Mule deer also occupy agricultural areas which once where shrubsteppe.

3.0 Mule Deer Population and Distribution

3.1 Population

3.1.1 Historic

Information for this section is not available.

3.1.2 Current

Information for this section is not available.

3.2 Distribution

3.2.1 Historic

Information for this section is not available.

3.2.2 Current

Information for this section is not available.

4.0 Mule Deer Status and Abundance Trends

4.1 Status

Information for this section is not available.

4.2 Trends

Information for this section is not available.

5.0 Factors Affecting Mule Deer Population Status

5.1 Key Factors Inhibiting Populations and Ecological Processes

Mule deer and their habitats are being impacted in a negative way by dam construction, urban and suburban developement, road and highway construction, over-grazing by livestock, inappropriate logging operations, competition by other ungulates, drought, fire, over-harvest by hunters, predation, disease and parasites.

5.1.1 Weather

Weather conditions can play a major role in the productivity and abundance of mule deer. Drought conditions can have a severe impact on mule deer because forage does not replenish itself on summer or winter range, and nutritional quality is low. Drought conditions during the summer and fall can result in low fecundity in does, and poor physical condition going into the winter months. Severe winter weather can cause result in high mortality depending on severity. Severe weather can result in mortality of all age classes, but the young, old, and mature bucks usually sustain the highest mortality. If mule deer are subjected to drought conditions in the summer and fall, followed by a severe winter, the result can be high mortality rates and low productivity the following year.

5.1.2 Habitat

The conversion of shrubsteppe and grassland habitat to agricultural croplands has resulted in the loss of hundreds of thousands of acres of deer habitat in eastern Washington. However, this has been mitigated to some degree by the implementation of the Conservation Reserve Program. Approximately 400,000 acres have been converted to CRP in southeast Washington. Noxious weeds have invaded many areas of southeast Washington resulting in a tremendous loss of good habitat for mule deer.

5.1.3 Fire Suppression

Fire suppression has resulted in a decline of habitat conditions. Browse species need to be regenerated by fire in order to maintain availability and nutritional value to big game. Lack of fire has allowed many browse species to grow out of reach for mule deer (Leege 1968; 1969; Young and Robinette 1939).

5.1.4 Development

Subdivisions have resulted in the loss of thousands of acres of habitat and mule deer populations in those areas have declined accordingly.

5.1.5 Hunter Harvest

The deer harvest by licensed hunters is restricted to bucks with a minimum of three points on one side, while the antlerless harvest is generally regulated by special permit. This system allows for harvesting deer at optimum levels, while preventing overharest. However, in order to maintain buck survival at management objective, hunting opportunity needs to be strictly regulated.

5.1.6 Hydroelectric Dams

The reservoirs created by Columbia River dams inundated thousands of acres of prime, riparian habitat that supported many species of wildlife, including mule deer. This riparian zone provided high quality habitat (forage/cover), especially during the winter months. The loss of this important habitat and the impact it has had on the mule deer population along the breaks of the Columbia River may never be fully understood.

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Grasshopper Sparrow
(*Ammodramus savannarum perpallidus*)

1.0 Introduction

Grassland ecosystems that were prominent in the Columbia Basin have suffered the greatest losses of any habitats in the Columbia Plateau (Kagan *et al.*1999). The Palouse Prairie has been identified as the most endangered ecosystem in the United States (Noss *et al.* 1995). Land conversion and livestock grazing coupled with the rapid spread of cheatgrass (*Bromus tectorum*) and a resulting change in the natural fire regime has effectively altered much of the grassland habitats to the effect that it is difficult to find stands which are still in relatively natural condition (Altman and Holmes 2000).

As a result, many of these steppe grassland species are declining in our area. BBS data (Robbins *et al.* 1986) have shown a decreasing long-term trend for the grasshopper sparrow (1966-1998) (Sauer *et al.* 1999). Throughout the U.S., this sparrow has experienced population declines throughout most of its breeding range (Brauning 1992; Brewer *et al.* 1991; Garrett and Dunn 1981). In 1996, Vickery (1996) reported that grasshopper sparrow populations have declined by 69% across the U.S. since the late 1960s. In Washington, the grasshopper sparrow is considered a state candidate species. In Oregon, it is considered a naturally rare, vulnerable species, and a state Heritage program status as imperiled.

2.0 Focal Species Life History and Habitat Requirements

2.1 Life History

2.1.1 Diet

Grasshopper sparrows are active ground or low shrub searchers. Vickery (1996) states that exposed bare ground is the critical microhabitat type for effective foraging. Bent (1968) observed that grasshopper sparrows search for prey on the ground, in low foliage within relatively dense grasslands, and sometimes scratch in the litter.

Grasshopper sparrows eat mostly insects, primarily grasshoppers, but also other invertebrates and seeds. In one study, grasshoppers formed 23% of the grasshopper sparrows' diet during 8 months of the year; 60% of their diet in Jan., and 37% from May to Aug. From Feb. to Oct., 63% of food taken was animals, 37% vegetable. Insects comprised 57% total food; spiders, myriapods, snails and earthworms made up 6%. Of the insects, "harmful" beetles (click beetles (*Clateridae*), weevils (Sitones *et al.*), and smaller leaf beetles (*Systens* spp.) made up 8%, caterpillars (cutworms) made up 14%. Vegetable matter eaten included waste grain, grass, weed and sedge seeds (Smith 1968; Terres 1980).

Their diet varies by season. Spring diet 60% invertebrates, 40% seeds (n=28); summer diet 61% invertebrates, 39% seeds (n=100); fall diet 29% invertebrates, 71% seeds (n=17), and no data for winter (Martin *et al.* 1951 in Vickery 1996).

2.1.2 Reproduction

Grasshopper sparrows are monogamous throughout the breeding season (Ehrlich 1988). Grasshopper sparrows nest in semi-colonial groups of 3-12 pairs (Ehrlich 1988). Smith (1963) recorded breeding densities that ranged from 0.12 to 0.74 males per hectare in Pennsylvania and Collier (1994) observed breeding densities of 0.55 males per hectare in California. Clutch size ranges from 2 to 6, with 4 most frequently (Smith 1963). The female alone has a brood patch and incubates eggs (Smith 1963; Ehrlich 1988; Harrison 1975). During incubation, the male defends the pair's territory (Smith 1963).

Incubation period is from 11 to 13 days (Smith 1963; Ehrlich 1988; Harrison 1975), with a nestling period of 6 to 9 days after hatching (Harrison 1975; Hill 1976; Kaspari and O'Leary 1988). Hatchlings are blind and covered with grayish-brown down (Smith 1968).

Throughout most of their range, grasshopper sparrows can produce two broods, one in late May and a second in early July (George 1952, Smith 1968, Vickery 1996). However, in the northern part of its range, one brood is probably most common (Vickery *et al.* 1992; Wiens 1969). Grasshopper sparrows frequently renest after nest failure, and if unsuccessful in previous attempts, may renest 3-4 times during the breeding season (Vickery 1996).

After the young hatch, both parents share the responsibilities of tending the hatchlings and seem more concerned over human intrusion into their territory than before (Smith 1963). Kaspari and O'Leary (1988) observed cooperative breeding by non-parental attendants ("defined as birds bringing food to the nest"). Unrelated juveniles and adults from adjacent territories made 9-50% of the provisioning visits to four of twenty-three nests. Parents facilitated visits from non-parental attendants by moving off the nest yet unrelated birds that did not bring food to the nest were vigorously chased away. Kaspari and O'Leary (1988) suggested that non-parental attendants, rare among the population observed, are likely cases of "misdirected parental care."

2.1.3 Nesting

Grasshopper sparrows arrive on the breeding grounds in mid-April and depart for the wintering grounds in mid-September (George 1952; Bent 1968; Smith 1968; Harrison 1975; Stewart 1975; Laubach 1984; Vickery 1996). In Saskatchewan and Manitoba, they arrive later (mid-May) and leave earlier (August) (Knapton 1979). Grasshopper sparrows may be site faithful (Skipper 1998).

With few exceptions, nests are built on the ground, near a clump of grass or base of a shrub, "domed" with overhanging vegetation (Vickery 1996). Female grasshopper sparrows build a cup nest in two or three day's time. Domed with overhanging grasses and accessed from one side, the rim of the nest is flush with the ground; the slight depression inside fashioned such that the female's back is nearly flush with the ground while brooding (Dixon 1916; Pemberton 1917; Harrison 1975; Ehrlich 1988; and Vickery 1996).

Male grasshopper sparrows establish territories promptly upon arrival to the breeding grounds and rigidly maintain them until the young hatch. Territorial defense then declines and considerable movement across territory boundaries may occur. It appears that fledglings frequently flutter into adjoining territories and the parent birds follow in answer to the feeding call. A sharp increase in territorial behavior is exhibited during the two or three days prior to re-nesting (Smith 1963). Collier (1994 in Vickery 1996) observed grasshopper sparrow territory sizes of 0.37 0.16 (SD) ha (n=41) in southern California. In other states, territories have been observed to range in size from 1.4 ha (n=6) in Michigan (Kendeigh 1941) to 0.19 - 0.13 (SD) ha (n=20: Piehler 1987) in western Pennsylvania.

Although average territory size for grasshopper sparrows is small (<2 ha) (George 1952, Wiens 1969, 1970, Ducey and Miller 1980, Laubach 1984, Delisle 1995), grasshopper sparrows are area sensitive, preferring large grassland areas over small areas (Herkert 1994a,b; Vickery *et al.* 1994; Helzer 1996). In Illinois, the minimum area on which grasshopper sparrows were found was 10-30 ha (Herkert 1991), and the minimum area needed to support a breeding population may be >30 ha (Herkert 1994b). In Nebraska, the minimum area in which grasshopper sparrows were found was 8-12 ha, with a perimeter-area ratio of 0.018 (Helzer 1996; Helzer and Jelinski 1999). Occurrence of grasshopper sparrows was positively correlated with patch area and inversely correlated with perimeter-area ratio (Helzer and Jelinski 1999).

2.1.4 Migration

In spring, the grasshopper sparrow is a notably late migrant, arriving in southern B.C. in early to late May (Vickery 1996). Grasshopper sparrows arrive in Colorado in mid May and remain through September. They initiate nesting in early June, and most young fledge by the end of July. They winter across the southern tier of states, south into Central America.

This species generally migrates at night, sometimes continuing into morning. Mechanisms surrounding migration are not known but probably involve similar mechanisms as in savannah Sparrow, which include magnetic, stellar, and solar compasses (Moore 1980; Able and Able 1990a, b). While in migration the grasshopper sparrow does not form large conspecific flocks; individuals are found in mixed-species flocks with other sparrows and appear to migrate in small numbers, traveling more as individuals (Vickery 1996).

Data regarding the movements of grasshopper sparrows outside of the breeding season is scarce due to their normally secretive nature (Zeiner *et al.*1990). Although diurnally active, grasshopper sparrows are easily overlooked as "they seldom fly, preferring to run along the ground between and beneath tufts of grass" (Pemberton 1917). Because of their secretive nature the northern limits of their winter range is poorly known. Migratory individuals have been recorded casually south to w. Panama (Ridgely and Gwynne 1989) and (in winter) north to Maine (PDV), New Brunswick, Minnesota (Eckert 1990), and w. Oregon (Vickery 1996).

2.1.5 Mortality

Nest predators cited include: raccoons (*Procyon lotor*), red fox (*Vulpes vulpes*), northern black racers (*Coluber constrictor constrictor*), blue jays (*Cyanocitta cristata*), and common crows (*Corvus brachyrhynchos*) (Johnson and Temple 1990; Wray *et al.* 1982). Loggerhead shrikes (*Lanius ludovicianus*) commonly take grasshopper sparrows as prey in Oklahoma and Florida (Stewart 1990, Vickery 1996). Many other species, especially those not dependent upon sight to find nests, are likely to be predators. Seasonal flooding in some areas may be a source of mortality during the nesting season (Vickery 1996).

Mowing and haying operations be the source of mortality for grasshopper sparrows directly and indirectly. Haying may reduce height and cover of herbaceous vegetation, destroy active nests, kill nestlings and fledglings, cause nest abandonment, and increase nest exposure and predation levels (Bollinger *et al.* 1990).

2.2 Habitat Requirements

Grasshopper sparrows prefer grasslands of intermediate height and are often associated with clumped vegetation interspersed with patches of bare ground (Bent 1968; Blankespoor 1980; Vickery 1996). Other habitat requirements include moderately deep litter and sparse coverage of woody vegetation (Smith 1963; Bent 1968; Wiens 1969, 1970; Kahl *et al.* 1985; Arnold and Higgins 1986). In east central Oregon grasshopper sparrows occupied relatively undisturbed native bunchgrass communities dominated by *Agropyron spicatum* and/or *Festuca idahoensis*, particularly north-facing slopes on the Boardman Bombing Range, Columbia Basin (Holmes and Geupel 1998). Vander Haegen *et al.* (2000) found no significant relationship with vegetation type (i.e., shrubs, perennial grasses, or annual grasses), but did find one with the percent cover perennial grass.

In portions of Colorado, Kansas, Montana, Nebraska, Oklahoma, South Dakota, Texas, Wisconsin, and Wyoming, abundance of grasshopper sparrows was positively correlated with percent grass cover, percent litter cover, total number of vertical vegetation hits, effective vegetation height, and litter depth; abundance was negatively correlated with percent bare ground, amount of variation in litter depth, amount of variation in forb or shrub height, and the amount of variation in forb and shrub heights (Rotenberry and Wiens 1980).

Grasshopper sparrows have also been found breeding in Conservation Reserve Program (CRP) fields, pasture, hayland, airports, and reclaimed surface mines (Wiens 1970, 1973; Harrison 1974; Ducey and Miller 1980; Whitmore 1980; Kantrud 1981; Renken 1983; Laubach 1984; Renken and Dinsmore 1987; Bollinger 1988; Frawley and Best 1991; Johnson and Schwartz 1993; Klute 1994; Berthelsen and Smith 1995; Hull *et al.* 1996; Patterson and Best 1996; Delisle and Savidge 1997; Prescott 1997; Koford 1999; Jensen 1999; Horn and Koford 2000). In Alberta, Manitoba, and Saskatchewan, grasshopper sparrows are more common in grasslands enrolled in the Permanent Cover Program (PCP) than in cropland (McMaster and Davis 1998). PCP was a Canadian program that paid farmers to seed highly erodible land to perennial cover; it differed from CRP in that haying and grazing were allowed annually in PCP.

Grasshopper sparrows occasionally inhabit cropland, such as corn and oats, but at a fraction of the densities found in grassland habitats (Smith 1963; Smith 1968; Ducey and Miller 1980; Basore *et al.* 1986; Faanes and Lingle 1995; Best *et al.* 1997).

Grasshopper sparrows are also included as members of shrub-steppe communities, occupying the steppe habitats having the habitat features shown in Table 1 (Altman and Holmes 2000).

Table 1. Key habitat relationships required for breeding grasshopper sparrows (Altman and Holmes 2000).

Conservation Focus	**Key Habitat Relationships**			
	Vegetative Composition	**Vegetation Structure**	**Landscape/ Patch Size**	**Special Considerations**
native bunchgrass cover	native bunchgrasses	bunchgrass cover >15% and >60% total grass cover; bunchgrass >25 cm tall; shrub cover <10%	>40 ha (100 ac)	larger tracts better; exotic grass detrimental; vulnerable in agricultural habitats from mowing, spraying, etc.

3.0 Focal Species Population and Distribution

3.1 Population

3.1.1 Historic

According to the ICBEMP terrestrial vertebrate habitat analyses, historical source habitats for grasshopper sparrow within our planning unit occurred primarily along the eastern portions of the Columbia Plateau Ecological Reporting Unit (ERU) and the northern portion of the Owyhee Uplands ERU with a small amount in the northern portion of the Great Basin (Wisdom *et al.* 2000). Within this core of historical habitat, the current amount of source habitat has been reduced dramatically from historical levels by 91% in the Columbia Plateau and 85% in the Owyhee Uplands. Within the entire Interior Columbia Basin, overall decline in source habitats for this species (71%) was third greatest among 91 species of vertebrates analyzed (Wisdom *et al.* 2000).

Wing (1941) described the grasshopper sparrow as occupies the edge between the *Agropyron-Poa* type and the *Festuca-Agropyron* type. Jewett *et al.* (1953) gave its distribution in summer as north to Sprague, east to Pullman, south to Anatone and Prescott, and west to Toppenish.

3.1.2 Current

Information for this section is not available.

3.2 Distribution

Grasshopper sparrows are found from North to South America, Ecuador, and in the West Indies (Vickery 1996; AOU 1957). They are common breeders throughout much of the continental United States, ranging from southern Canada south to Florida, Texas, and California. Additional populations are locally distributed from Mexico to Colombia and in the West Indies (Delany *et al.* 1985; Delany 1996a; Vickery 1996) (Figure 1).

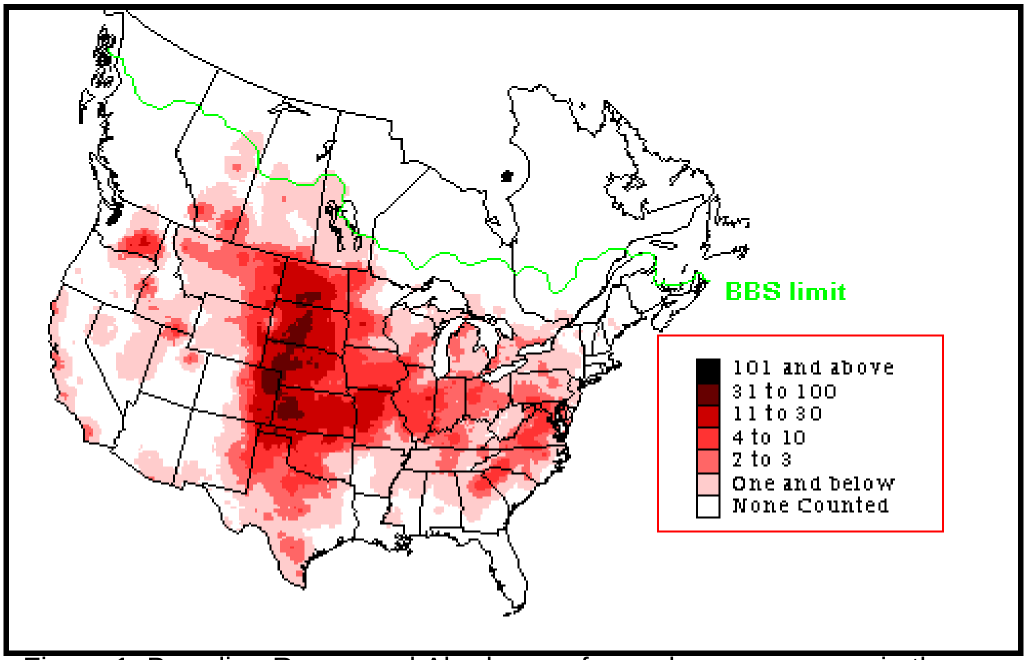

Figure 1. Breeding Range and Abudance of grasshopper sparrow in the U.S., 1985-2001 (Sauer 2003).

The subspecies breeding in eastern Washington is *Ammodramus savannarum perpallidus* (Coues) which breeds from northwest California, where it is uncommon, into eastern Washington, northeast and southwest Oregon, where it is rare and local, into southeast B.C., where it is considered endangered, east into Nevada, Utah, Colorado, Oklahoma, Texas, and possibly to Illinois and Indiana (Vickery 1996).

3.2.1 Historic

Larrison (1981) called it a local irregular summer resident and/or migrant mostly through the arid interior of the Northwest and rare west of the Cascades in southwestern B.C. and Oregon. In Idaho, it was considered an uncommon irregular summer resident and migrant in the northern portion (Larrison 1981).

Jewett *et al.* (1953) classified the grasshopper sparrow as a rare summer resident between May and probably August or September locally in the bunch-grass associations of the lower Transition Zone of eastern Washington, occurring locally in the Upper Sonoran also.

3.2.2 Current

Grashopper sparrows have a spotty distribution at best across eastern Washington. Over the years they have been found in various locales including CRP. They appear to utilize CRP on a consistent basis in southeast Washington. See Figure 1 for current distribution map.

4.0 Focal Species Status and Abundance Trends

4.1 Status

Information for this section is not available.

4.2 Trends

Throughout the U.S., this sparrow has experienced population declines throughout most of its breeding range (Brauning 1992; Brewer *et al.* 1991; Garrett and Dunn 1981). In 1996, Vickery (1996) reported that grasshopper sparrow populations have declined by 69% across the U.S. since the late 1960s.

Approximately 6 million hectares of shrubsteppe have been converted to wheat fields, row crops, and orchards in the interior Columbia Basin (Quigley and Arbelbide 1997). In Washington over 50% of historic shrub-steppe has been converted to agriculture (Dobler *et al.* 1996).

Accordingly, Breeding Bird Survey data show long term declines from 1980 through 2002 of –3.0, -1.6 and –10.7 for Washington, Oregon and Idaho, respectively (Table 2). The entire Intermountain Grassland area shows large decrease of –12.4 over this same time period.

Table 2. Trends for grasshpper sparrow from BBS data 1980-2002 (Sauer *et al.* 2003).

State	1996- 2002 Trend	1980-2002 Trend
Washington	-4.9	-3.0
Idaho	-7.4	-10.7
Oregon	-4.4	-1.6
Intermountain Grassland	-13.0	-12.4

Washington, Oregon and the entire Intermountain Grassland area show an increasing negative trend when looking at the more recent time period 1996-2002 time period indicating the populations have increase even more over this time period (Sauer *et al.* 2003).

5.0 Factors Affecting Focal Species Population Status

5.1 Key Factors Inhibiting Populations and Ecological Processes

5.1.1 Habitat Loss and Fragmentation

The principal post-settlement conservation issues affecting bird populations include: habitat loss and fragmentation resulting from conversion to agriculture; and habitat degradation and alteration from livestock grazing, invasion of exotic vegetation, and alteration of historic fire regimes. Conversion of shrub-steppe lands to agriculture adversely affects landbirds in two ways: 1) native habitat is in most instances permanently lost, and 2) remaining shrub-steppe is isolated and embedded in a highly fragmented landscape of multiple land uses, particularly agriculture. Fragmentation resulting from agricultural development or large fires fueled by cheatgrass can have several negative effects on landbirds. These include: insufficient patch size for area-dependent species, and increases in edges and adjacent hostile landscapes, which can result in reduced productivity through increased nest predation, nest parasitism, and reduced pairing success of males. Additionally, fragmentation of shrub-steppe has likely altered the dynamics of dispersal and immigration necessary for maintenance of some populations at a regional scale. In a recent analysis of neotropical migratory birds within the Interior Columbia Basin, most species identified as being of "high management concern" were shrub-steppe species (Saab and Rich 1997) which includes the grasshopper sparrow.

Approximately 6 million hectares of shrub-steppe have been converted to wheat fields, row crops, and orchards in the interior Columbia Basin (Quigley and Arbelbide 1997). In Washington over 50% of historic shrub-steppe has been converted to agriculture (Dobler *et al.* 1996).

Large scale reduction and fragmentation of sagebrush habitats have occurred due to a number of activities, including land conversion to tilled agriculture, urban and suburban development, and road and power-line rights of way. Range improvement programs remove sagebrush by burning, herbicide application, and mechanical treatment, replacing sagebrush with annual grassland to promote forage for livestock.

Making this loss of habitat even more severe is that the grasshopper sparrow like other grassland species shows a sensitivity to the grassland patch size (Herkert 1994; Samson 1980; Vickery 1994a, b; Bock *et al.* 1999). Herkert (1991) in Illinois, found that grasshopper sparrows were not present in grassland patches smaller than 30 hectares (74 acres) despite the fact that their published average territory size is only about 0.3 ha (0.75 acres). Vickery *et al.* (1994) found the minimum requirement to be 100 hectares and Samson (1980) found the minimum to be 20 ha in Missouri. Differences in minimum area requirements may be explained by the effect of relative population level on the selectivity of individuals, as has been shown for many species of birds (Vickery *et al.* 1994). Minimum requirement size in the Northwest is unknown.

5.1.2 Grazing

Grazing can trigger a cascade of ecological changes, the most dramatic of which is the invasion of non-native grasses escalating the fire cycle and converting sagebrush shrublands to annual grasslands. Historical heavy livestock grazing altered much of the sagebrush range, changing plant composition and densities. West (1988, 1996) estimates less than 1 percent of sagebrush steppe habitats remain untouched by livestock; 20 percent is lightly grazed, 30 percent moderately grazed with native understory remaining, and 30 percent heavily grazed with understory replaced by invasive annuals. The effects of grazing in sagebrush habitats are complex, depending on intensity, season, duration and extent of alteration to native vegetation.

Extensive and intensive grazing in w. North America has had negative impacts on this species (Bock and Webb 1984).

The legacy of livestock grazing in the Columbia Plateau has had widespread and severe impacts on vegetation structure and composition. One of the most severe impacts in shrub-steppe has been the increased spread of exotic plants (Altman and Holmes 2000; Weddell 2001)

For instance, the grasshopper sparrow has been found to respond positively to light or moderate grazing in tallgrass prairie (Risser *et al.*1981). However, it responds negatively to grazing in shortgrass, semi-desert, and mixed grass areas (Bock *et al.* 1984).

5.1.3 Invasive Grasses

Cheatgrass readily invades disturbed sites, and has come to dominate the grass-forb community of more than half the sagebrush region in the West, replacing native bunchgrasses (Rich 1996). Crested wheatgrass and other non-native annuals have also fundamentally altered the grass-forb community in many areas of sagebrush shrubsteppe, altering shrubland habitats.

The degree of degradation of terrestrial ecosystems is often diagnosed by the presence and extent of alien plant species (Andreas and Lichvar 1995); frequently their presence is related to soil disturbance and overgrazing. Increasingly, however, aggressive aliens are becoming established even in ostensibly undisturbed bunchgrass vegetation, wherever their seed can reach. The most notorious alien species in the Palouse region are upland species that can dominate and exclude perennial grasses over a wide range of elevations and substrate types (Weddell 2001).

5.1.4 Fire

Cheatgrass has altered the natural fire regime in the western range, increasing the frequency, intensity, and size of range fires. Fire kills sagebrush and where non-native grasses dominate, the landscape can be converted to annual grassland as the fire cycle escalates, removing preferred habitat (Paige and Ritter 1998).

The historical role of fire in the steppe and meadow steppe vegetation of the Palouse region is less clear (Weddell 2001). Daubenmire (1970) dismissed it as relatively unimportant, whereas others conclude that fires were probably more prevalent in the recent past than at present (Morgan *et al.* 1996). The lack of information about the pre-settlement fire frequency of steppe and meadow steppe ecosystems makes it difficult to emulate the natural fire regime in restored communities.

Studies on the effects of burns on grassland birds in North American grasslands have shown similar results as grazing studies: namely, bird response is highly variable. Confounding factors include timing of burn, intensity of burn, previous land history, type of pre-burn vegetation, presence of fire-tolerant exotic vegetation (that may take advantage of the post-burn circumstances and spread even more quickly) and grassland bird species present in the area. It should be emphasized that much of the variation in response to grassland fires lies at the level of species, but that even at this level results are often difficult to generalize. For instance, Mourning Doves have been found to experience positive (Bock and Bock 1992, Johnson 1997) and negative (Zimmerman 1997) effects by fire in different studies. Similarly, grasshopper sparrow have been found to experience positive (Johnson 1997), negative (Bock and Bock 1992; Zimmerman 1997; Vickery *et al.* 1999), and no significant (Rohrbaugh 1999) effects of fire. Species associated with short and/or open grass areas will most likely experience short-term benefits from fires. Species that prefer taller and denser grasslands most likely will demonstrate a negative response to fire (CPIF 2000).

Avoid burning during breeding season. Encroachment of woody vegetation in grassland areas wll be detrimental to most grassland species. For instance, grasshopper sparrows have been found to be absent from areas with greater than 30% shrub cover. In areas of good grassland bird diversity and productivity, efforts should be made to keep woody vegetation from reducing open grassland habitat (CPIF 2000).

5.1.5 Mowing/Haying

Mowing and haying affects grassland birds directly and indirectly. It may reduce height and cover of herbaceous vegetation, destroy active nests, kill nestlings and fledglings, cause nest abandonment, and increase nest exposure and predation levels (Bollinger *et al.* 1990). Studies on grasshopper sparrow have indicated higher densities and nest success in areas not mowed until after July 15 (Shugaart and James 1973; Warner 1992). Grasshopper sparrows are vulnerable to early mowing of fields, while light grazing, infrequent and post-season burning or mowing can be beneficial (Vickery 1996).

5.1.6 Brood Parasitism

Grasshopper sparrows may be multiply-parasitized (Elliott 1976, 1978; Davis and Sealy 2000). In Kansas, cowbird parasitism cost grasshopper sparrows about 2 young/parasitized nest, and there was a low likelihood of nest abandonment occurring due to cowbird parasitism (Elliott 1976, 1978). In Manitoba, mean number of host young fledged from successful, unparasitized nests was significantly higher than from successful, parasitized nests; cowbird parasitism cost Grasshopper Sparrows about 1.3 young/successful nest (Davis and Sealy 2000).

5.1.7 Predators

Predators of the grasshopper sparrow are hawks, loggerhead shrikes, mammals and snakes (Vickery 1996).

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Columbian Sharp-tailed Grouse
(*Tympanuchus phasianellus columbianus*)

1.0 Introduction

The Columbian sharp-tailed grouse (CSTG) is 1 of 6 subspecies of sharp-tailed grouse and the only one found in Washington. The range of the Columbian sharp-tailed grouse is the inter-mountain region including western Montana, Idaho, southern British Columbia, eastern Washington, eastern Oregon, northeastern California, northern Utah, western Colorado, and western Wyoming (Aldrich 1963). Relatively stable populations are present in Idaho, Colorado, and British Columbia; remnant populations are found in Washington, Montana, Utah, Wyoming, and northeastern Oregon.

There has been a clear decline in CSTG abundance and distribution within the state of Washington (Yocom 1952; Buss and Dziedzic 1955; Hays *et al.* 1998; Schroeder *et al.* 2000). The long-term decline in the status of sharp-tailed grouse has been attributed to the dramatic alteration of native habitat from agricultural conversion, degradation from overgrazing, and invasion of noxious weeds (Buss and Dziedzic 1955; McDonald and Reese 1998). Native habitats important for CSTG include grass-dominated nesting habitat and deciduous shrub-dominated wintering habitat, both of which are critical for sharp-tailed grouse (Giesen and Connelly 1993; Connelly *et al.* 1998). In southeast Washington, the last known sighting of a sharp-tailed grouse was in 1947 (P. Fowler, personal communication, 2003). Ancedotal information indicates that several sharp-tailed grouse were observed in the Asoptin subbasin as late as 2000 (M. Schroeder, WDFW, personal communication, 2003).

2.0 Columbian Sharp-tailed Grouse Life History and Habitat Requirements

2.1 Life History

2.1.1 Diet

Food items in the spring and summer include wild sunflower (*Helianthus* spp.), chokecherry (*Prunus virginiana*), sagebrush (*Artemisia* spp.), serviceberry (*Amelanchier* spp.), salsify (*Tragopogon* spp.), dandelion (*Taraxacum* spp.), bluegrass (*Poa* spp.), and brome (*Bromus* spp.) (Marshall and Jensen 1937; Hart *et al.* 1952; Jones 1966; Parker 1970). Although juveniles and adults consume insects, chicks eat the greatest quantity during the first few weeks of life (Parker 1970; Johnsgard 1973). In winter, CSTG commonly forage on persistent fruits and buds of chokecherry (*Prunus virginiana*), serviceberry (*Amelanchier* spp.), hawthorn (*Crataegus* spp.), snowberry (*Symphoricarpos* spp.), aspen (*Populus tremuloides*), birch (Betula spp.) willow (*Salix* spp.) and wild rose (*Rosa* spp.) (Giesen and Connelly 1993, Schneider 1994).

2.1.2 Reproduction

Breeding Display Grounds (leks)

During spring males congregate on display sites (leks) to breed with females. Leks are usually within 1.2 miles of nesting, brood-rearing, and wintering habitat (Marks and Marks 1988, Giesen and Connelly 1993); distances appear to be larger in degraded habitat. Most leks are located on knolls and ridges with relatively sparse vegetation (Hart *et al.* 1952; Rogers 1969; Oedekoven 1985).

2.1.3 Nesting

Residual grasses and forbs are necessary for concealment and protection of nests and broods during spring and summer (Hart *et al.* 1952, Parker 1970, Oedekoven 1985, Marks and Marks 1988, Meints *et al.* 1991, Giesen and Connelly 1993). Preferred nest sites are on the ground in relatively dense cover provided by clumps of shrubs, grasses, and/or forbs (Hillman and Jackson 1973; Meints *et al.* 1992). Fields enrolled in agricultural set-aside programs are often preferred. After hatching, hens with broods move to areas where succulent vegetation and insects can be found (Hamerstrom 1963; Bernhoft 1967; Sisson 1970; Gregg 1987; Marks and Marks 1987; Klott and Lindzey 1990). In late summer, riparian areas and mountain shrub communities are preferred (Giesen 1987).

2.1.4 Migration

Suitable winter habitat is critical to the annual survival of all grouse. During a mild winter, Ulliman (1995) observed that CSTG in Idaho used CRP and remnant sagebrush patches, likely because of the proximity of these habitats to leks, availability of forage, and structural cover. Proximity to leks may reduce stress and predation associated with longer migration movements to unfamiliar winter habitat, whereas the availability of forage and cover reduces the need to move between cover types in search of food. In northwestern Colorado, Boisvert (2002) observed that most leks are located within 1 km of suitable winter habitat, but the average movement to a wintering area exceeded 12 km. An explanation for this is lacking, and warrants further investigation.

In severe winters CSTG are generally forced to move to habitats at higher elevations containing "budding" trees and shrubs such as riparian, mountain shrub, and aspen (*Populus tremuloides*) (Schneider 1994). Most literature suggests that grouse generally leave summer and fall ranges in search of denser tree and/or shrub cover when they become more conspicuous due to snow cover (Bergerud 1988b). However, in a severe winter in Idaho, Ulliman (1995) found that 4 radio-marked grouse remained in a valley despite heavy snowfall, subsisting largely on midge galls (*Rhopalomyia* spp.) and Russian olive (*Eleagnus angustifolia*) berries.

2.1.5 Survival

Columbian sharp-tailed grouse are subject to variable mortality rates, depending on season, sex, habitat, and weather. Females are most vulnerable to predation during the nesting and brooding seasons, while males suffer the highest mortality during the lekking period. Differences in severity of winter from year to year can also cause marked differences in over-winter survival (Ulliman 1995).

Annual survival of grouse in mine reclamation and CRP habitats in northwestern Colorado was quite low (20%) (Boisvert 2002). Grouse captured in mine reclamation lands had a relatively higher annual survival rate (28%, n = 73) compared to birds captured in CRP (14%, n = 73). Braun (1975) speculated that 50-70% annual mortality is natural in Colorado. Meints (1991) reported annual survival rates in 2 areas of Idaho to be 66% (n = 28) and 44% (n = 24). Schroeder (1994) observed a 53% annual survival in Washington, while McDonald reported 55% (n = 38) (1998).

A wide array of predators are known to prey upon Columbian sharp-tailed grouse. Some prey mainly on eggs, such as the striped skunk (*Mephitis mephitis*), ground squirrel (*Spermophilus* spp.), badger (Taxidea taxus), American magpie (*Pica hudsonia*), American crow (*Corvus branchyrynchos*), and common raven (*C. corax*). Nest predation is quite common because nests are on the ground (Bergerud 1988a). Various species of snakes likely take eggs or young chicks, but the extent of snake predation is unknown due to difficulty of documentation and a resulting paucity of reporting in the literature.

Other species may prey upon eggs, chicks, and/or adults. These include coyote (*Canis latrans*), weasel (*Mustela* spp.), red fox (*Vulpes vulpes*), red-tailed hawk (*Buteo jamaicensis*), northern goshawk (*Accipiter gentilis*), peregrine falcon (*Falco perigrinus*), gyrfalcon (*Falco rusticolus*), prairie falcon (*Falco mexicanus*), great horned owl (Bubo virginianus), long-eared owl (Asio otus), and northern harrier (*Circus cyaneus*) (Marshall and Jensen 1937, Schiller 1973). Cattle have also been documented stepping on nests of CSTG in southern Idaho (T. Apa, personal communication).

2.1.6 Harvest

In 1933, a moratorium was placed on sharp-tailed grouse hunting statewide. In 1953, a 2-day season on sharp-tailed grouse was re-opened in three counties with daily and possession limits of one and two, respectively. Harvest data for sharp-tailed grouse were never tallied separately from other grouse species, so harvest figures are unavailable. In 1954, the daily limit increased to two, the possession limit increased to four, and in Okanogan County, the season increased to 8 days. The illegal kill of sharptails by hunters seeking other species, and by orchardists may have been significant during this period. All of eastern Washington was reopened for sharptail hunting in 1965 and daily and possession limits remained at two and four until 1976. Possession limits were reduced to two in 1977. All counties except Lincoln were closed to sharptail hunting in 1985 because of population declines. Continuing declines in the sharp-tailed grouse population resulted in a statewide season closure in 1988.

2.2 Habitat Requirements

2.2.1 Nesting

Females likely select a nest site before visiting a lek to copulate (Johnsgard 1983; Bergerud and Gratson 1988). Before lek visitation, hens search large areas that are reported to be twice as large as late winter/early spring ranges (Gratson 1988). Large pre-laying ranges may reflect the female sampling a large number of males at different leks, or searching throughout a patchy habitat for suitable nest sites before copulation.

Columbian sharp-tailed grouse select different habitats for nesting throughout their range (Giesen 1997). Previous studies have documented a variety of habitats used for nesting by Columbian sharp-tailed grouse, including native shrubsteppe, mountain shrub, grassland, CRP, agricultural fields, and mine reclamation (Marks and Marks 1987; Meints 1991; Apa 1998; McDonald 1998).

Females prefer nest sites with an overhead canopy of grasses, shrubs, or both (Giesen and Connelly 1993). They are able to tolerate considerable variation in the proportion of grasses and shrubs that comprise suitable nesting habitat, but the most important factor is that a certain height and density of vegetation is required. Canopy coverage and visual obstruction are greater at nest sites than at independent sites (Kobriger 1980; Marks and Marks 1987; Meints 1991). Giesen (1987) reported density of shrubs < 1 m tall was 5 times higher at nest sites than at random sites or sites 10 m from the nest. Meints (1991) found that mean grass height at successful nests averaged 26.8 cm, while 18.4 cm was the average at unsuccessful nests. Hoffman (2001) recommended that the minimum height for good quality nesting and brood-rearing habitat is 20 cm, with 30 cm being preferred. Bunchgrasses, especially those with a high percentage of leaves to stems like bluebunch wheatgrass (*Agropyron smithii*), are preferred by nesting sharp-tailed grouse over sod-forming grasses such as smooth brome (*Bromus inermis*).

Marks and Marks (1987) reported mean distance moved from lek of capture to nest and renests for radio-marked hens as 0.5 km in Idaho, whereas Meints (1991) reported an average distance of just over 1 km, and Apa (1998) reported 1.4 km. Gratson (1988) found that nests averaged 998+ 329 m from the nearest lek in Wisconsin, and hypothesized that hens nest relatively far away from leks to avoid increased predation pressures caused by displaying males. Apa's work in Idaho supports this theory.

Once a specific nest site is selected, the hen scrapes out a rudimentary nest bowl on the ground and lines it with grass, herbaceous plant materials, and breast feathers. There is an average of 1-3 days between copulation and laying of the first egg (Schiller 1973), with subsequent eggs laid every 1-2 days. For first nests only, Meints (1991) found the mean clutch size in Idaho to be 11.9 eggs (range 10-13, n=18), Hart *et al.* (1952) reported 10.9 in Utah (range 3-17, n=127), McDonald reported 12.2 in Washington (range 11-14, n=17), and Giesen (1987) reported 10.8 in Colorado (range 8- 14). Hens may re-nest if the first nest is unsuccessful, with adult hens showing a tendency to re-nest more often than yearlings.

Native habitats would be expected to contribute to higher nest success than non-native habitats, however Meints (1991) found that hens nesting in non-native habitats in southeastern Idaho had a significantly higher success rate than hens nesting in native uplands. Svedarsky (1988) also found this to be the case for greater prairie chickens (*T. cupido pinatus*); 86% versus 53%. Boisvert (2002), found nest success in mine reclamation to be 81% compared to 22% for native shrubsteppe in Colorado. These results are contrary to the findings of Hart *et al.* (1952) in Utah, who found nest success in alfalfa and wheat stubble to be 47% and 18% respectively, compared to 70% in native rangeland, Apa (1998) in Idaho who observed 40% nest success in non-native sites and 36% in native sites, and McDonald (1998) in Washington who observed 39% and 100% nest success in two native sites and 0% and 18% in two CRP sites.

Nest success varies widely throughout the range of the CSTG, and may also vary in the same location from year to year. Overall nest success was reported as 46% (n=65) (Boisvert 2002) and 61% (n=13) (Giesen 1987) in Colorado, 51% (n=47) (Apa 1998), 72% (n=25) (Meints 1991), and 56% (n=9) (Marks and Marks 1987) in Idaho, and 41% in Washington (n=37) (McDonald 1998).

The incubation period ranges from 21-23 days and only the female incubates the eggs. She leaves the eggs to forage in the morning and evening (Hart *et al.* 1952; Schiller 1973). The chicks hatch precocious and nidifugious, and are usually brooded near the nest for 1-2 days.

2.2.2 Brooding

Columbian sharp-tailed grouse broods are known to use a variety of habitats typically described as shrubsteppe vegetation dominated by sagebrush and other shrubs including rabbitbrush (*Chrysothamnus* spp.), antelope bitterbrush (*Purshia tridentata*), and common chokecherry (*Prunus virginiana*), with a diversity of forbs and bunchgrasses (Marks and Marks 1987). These areas often contain an abundance of insects necessary for the chicks' robust protein requirements (Connelly *et al.* 1998), as well as a high interspersion of cover types (Klott and Lindzey 1990). In the first 2 weeks after hatching, chicks require microhabitats with warm temperatures to offset an inability to thermo-regulate, and a plant structure that provides concealment but does not hinder movement (Bergerud 1988). Brood use sites are generally located within 1.6 km of the lek where the hen bred (Parker 1970; Bredehoft 1981; Oedekoven 1985).

Klott and Lindzey (1990) found that CSTG broods used mountain shrub and sagebrush-snowberry (*Artemisia/Symphoricarpos* spp.) habitats more often than expected based on their availability in Wyoming. Total shrub cover at brood use sites was higher than expected based on availability. Apa (1998) found that CSTG broods in Idaho used sites with more vertical cover, higher visual obstruction, and taller forbs than at independent sites. Meints (1991) also found that greater cover occurred at brood use sites than at random sites. In general, CSTG brood use sites have a higher diversity of forbs and more grass cover than random sites (Klott 1987; Klott and Lindzey 1990). Chicks can fly short distances at 7-10 days (Hart *et al.* 1950; Pepper

1972), reach half of adult body mass at 8 weeks, and become fully independent by 12 weeks of age, when brood breakup occurs (Gratson 1988).

2.2.3 Non-breeding

2.2.3.1 Fall

After brood breakup occurs, young males may be recruited to the breeding population by joining adult males in displaying at leks (Hamerstrom and Hamerstrom 1951; Moyles and Boag 1981). Not all leks are thought to be active in the fall, and no breeding takes place at this time as virtually no females attend leks, but juvenile males may attempt to establish a peripheral territory on a lek, an advantage the following spring when seniority at the lek is important. The sooner a young male begins to display at the lek, the sooner he may become a central territory holder. Moyles and Boag (1981) found that most (68%) new territories at spring leks were actually established the previous fall. In autumn, juvenile females join flocks of other adult and yearling females, and non-lekking males.

2.2.3.2 Winter

Suitable winter habitat is critical to the annual survival of all grouse. During a mild winter, Ulliman (1995) observed that CSTG in Idaho used CRP and remnant sagebrush patches, likely because of the proximity of these habitats to leks, availability of forage, and structural cover. Proximity to leks may reduce stress and predation associated with longer migration movements to unfamiliar winter habitat, whereas the availability of forage and cover reduces the need to move between cover types in search of food. In northwestern Colorado, Boisvert (2002) observed that most leks are located within 1 km of suitable winter habitat, but the average movement to a wintering area exceeded 12 km. An explanation for this is lacking, and warrants further investigation.

In severe winters CSTG are generally forced to move to habitats at higher elevations containing “budding” trees and shrubs such as riparian, mountain shrub, and aspen (*Populus tremuloides*) (Schneider 1994). Most literature suggests that grouse generally leave summer and fall ranges in search of denser tree and/or shrub cover when they become more conspicuous due to snow cover (Bergerud 1988). However, in a severe winter in Idaho, Ulliman (1995) found that 4 radio-marked grouse remained in a valley despite heavy snowfall, subsisting largely on midge galls (*Rhopalomyia* spp.) and Russian olive (*Eleagnus angustifolia*) berries.

In winter, CSTG commonly forage on persistent fruits and buds of chokecherry (*Prunus virginiana*), serviceberry (*Amelanchier* spp.), hawthorn (*Crataegus* spp.), snowberry, aspen, birch (*Betula* spp.) willow (*Salix* spp.) and wild rose (*Rosa* spp.) (Giesen and Connelly 1993; Schneider 1994). Like other species of grouse, CSTG may use snow burrows during day and night in winter to conserve heat and avoid predators (Marks and Marks 1987). In Washington, CSTG were found to require at least 28 cm of soft snow for burrowing (McDonald 1998).

3.0 Columbian Sharp-tailed Grouse Population and Distribution

3.1 Population

3.1.1 Historic

Historically, the Columbian sharp-tailed grouse was an important game bird in eastern Washington (Cooper 1860; Suckley 1860; Darwin 1918; Buss and Dziedzic 1955). Settlers harvested wagon loads of sharptails in a single day in the 1880's and 1890's, presumably in highconcentration areas (Larrison and Sonnenberg 1968). Sharp-tailed grouse were common in shrub/meadow steppe bordering river tributaries of eastern Washington. They were less common throughout the shrub-steppe region, although sharptails were abundant in Yakima

County (Dawson and Bowles 1909; Myers 1948; Oliver 1983). Sharptails also inhabited the sagebrushforest transition zone as summarized by Merker (1988):

> *Within the transition zone forest of northeastern Washington, sharptail habitat had probably always been limited to the valleys and low foothills (Bendire 1892). Douglas (1829) reported that sharptails were a principal food item near Kettle Falls, Stevens County. Early grain fields and cut-over land may well have been beneficial (Yocom 1952, Jewett et al. 1953). In this zone in Spokane County, sharptails were "common" in the Turnbull Slough area (now a national wildlife refuge) in the 1930's (Yocom 1952). The Deer Park airport supported a lek for many years and the associated grouse often used adjacent logged-over habitat (L. Wadkins, pers. comm.). As many as 50 grouse were present on this lek in 1959 (Ziegler 1979). However, the last confirmed sighting in Spokane County was in 1964. The latest records for this area of the transition zone are the personal reports of S. Judd on the eastern Colville Indian Reservation. He recalls them as an "abundant game bird" through the 1940s. Coveys were known through the 1970's, but now the bird is believed extirpated from this portion of the reservation.*

In summary, historical accounts of tens of thousands of sharp-tailed grouse, declines in the number of males per lek, reductions of 63-72 percent in the number of active leks, and a range reduction of approximately 97 percent indicate a persistent downward trend in the sharptail population in Washington (Hays *et al.* 1998).

3.1.2 Current

The 1997 breeding population of sharp-tailed grouse in Washington has been estimated through lek counts and a population model. During spring surveys, 358 grouse were counted on 44 leks in 3 counties (Table 1). A model based on scientific literature, input and survey data from WDFW biologists, and current research in Washington was used to estimate the size of the 1997 breeding population.

Table 1. Results of 1997 sharp-tailed grouse lek counts in Washington (Hays *et al.* 1998).

County	Birds	Leks	Birds/lek
Okanogan	169	17	9.9
Lincoln	88	10	8.8
Okanogan (off Colville Reservation)	59	9	6.5
Douglas	42	8	5.3
TOTAL	**358**	**44**	**8.1**

The model assumed all leks were known and surveyed, all males were on leks during counts, and the male to female sex ratio was 1:1. This model would underestimate actual population size if some leks were not located, if all males were not on leks during counts, if the sex ratio was not 1:1, and if surveys were flawed (e.g., bad weather, incomplete counts, etc.). The model would overestimate actual population size if lek counts included females (which are difficult to distinguish). The population estimate based on the model is 716 sharp-tailed grouse in Washington in 1997 (Table 2). Allowing for additional unsurveyed habitat, M. Schroeder (pers. comm.) suggests as many as 1000 sharp-tailed grouse may remain in Washington.

Table 2. Estimated size of the Washington sharp-tailed grouse breeding population in 1997 (Hays *et al.* 1998).

Sex	Population Estimate	Estimate Source
Male	358	Statewide lek counts
Female	358	1:1 sex ratio
TOTAL	**716**	**Males + Females**

The remaining sharp-tailed grouse in Washington are distributed in eight fragmented subpopulations. Of these, the subpopulation on the Colville Indian Reservation is the largest remaining in the state (Table 1). It is estimated to include about 352 grouse and is considered self-sustaining. Of the subpopulations outside of the Reservation, the largest population is in western Lincoln County (177 birds). The subpopulation south of Bridgeport in Douglas County contains about 31 birds. Outside the reservation, Okanogan County supports a total of only 138 birds. This includes four subpopulations that each support fewer than 25 grouse and they are likely unstable and near extirpation. Sharp-tailed grouse in each of the eight geographic areas appear to be isolated (Schroeder 1996).

3.1.3 Captive Breeding Programs, Transplants, Introductions

3.1.3.1 Historic

Information for this section is not available.

3.1.3.2 Current

Recent transplants near Enterprise, Oregon and Jackpot, Nevada have reestablished small populations in those areas (Snyder *et al.* 1999). CSTG in the Scotch Creek population of northcentral Washington benefited from a 3-year translocation of 43 birds starting in 1998. The population went from 2 known birds to 52 in 2003 (Schroeder 2003). Washington State is currently planning to translocate additional CSTG from British Columbia into the state.

3.2 Distribution

3.2.1 Historic

Sharp-tailed grouse have occupied the western and northern United States and Canada since at least the late Pleistocene Epoch, based on fossil records (Snyder 1935; AOU 1957). Historically, sharptails ranged from Canada and Alaska, south to New Mexico, east to Hudson and James bays, and west to northeastern California and Nevada (Aldrich and Duvall 1955; Evans 1968; Johnsgard 1973) (Figure 1). Their historic range encompassed 6 Canadian provinces, 2 territories, and 21 states (Aldrich 1963; Johnsgard 1973). Sharp-tailed grouse have declined in western North America since the early 1900s (Hart *et al.* 1950; Miller and Graul 1980; Kessler and Bosch 1982), and have disappeared from 8 of the 21 states they formerly occupied (Johnsgard 1973; Miller and Graul 1980).

Historically, the Columbian subspecies ranged from central British Columbia south across eastern Washington, Oregon, Idaho, and northwestern Montana, south into northern California and Nevada, and east into Utah, western Wyoming and Colorado (Aldrich and Duvall 1955, Aldrich 1963, Miller and Graul 1980).

3.2.1.1 Washington

Historically, Columbian sharp-tailed grouse ranged from the Canadian border at Oroville, south to the Oregon border, west to the eastern Cascade foothills, and east to the Idaho border in Whitman County (Figure 2). Sharptails were plentiful in eastern Washington, inhabiting most of the prairies in the Columbia Plateau and the stream valleys emptying into the Columbia River (Dawson and Bowles 1909; Darwin 1918; Yocom 1952). By the 1950s, Columbian sharp-tailed

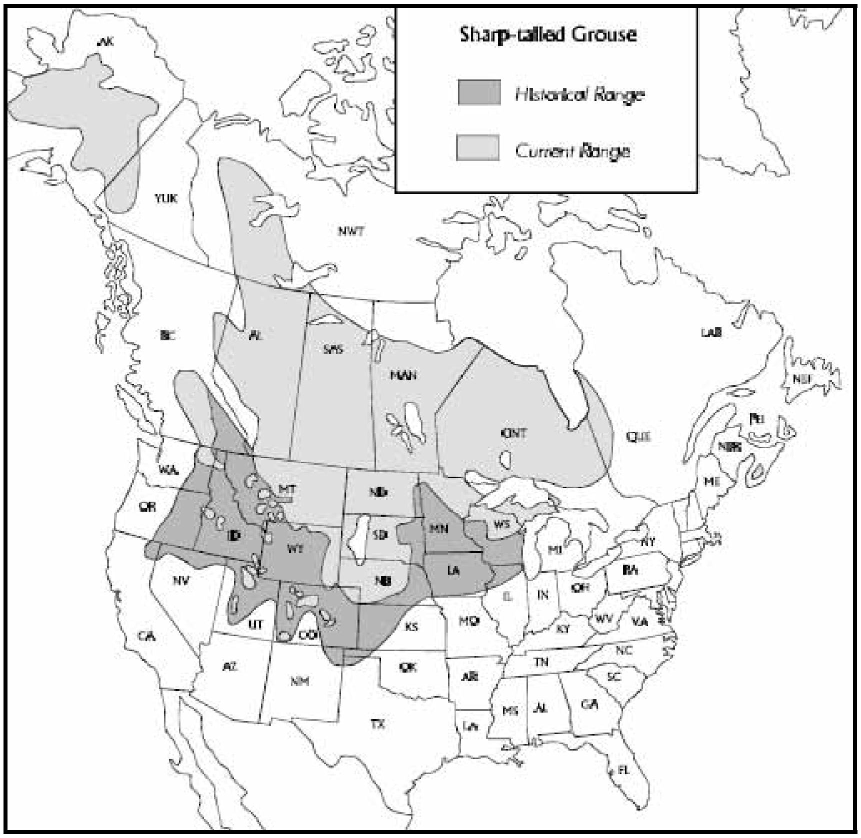

Figure 1. Historic and current range of sharp-tailed grouse in North America (Johnsgard 1973).

grouse were extirpated from six counties formerly having breeding populations (Yocom 1952; Buss and Dziedzic 1955). Yocom (1952:187) reported the following range for Columbian sharptailed grouse in Washington:

> *Near the international boundary of Canada and the United States at Oroville, Washington, on the Okanogan River; southwesterly along the breaks of the Columbia River to Waterville, Douglas County; east along Crab Creek, Lincoln County, to the vicinity of Harrington; thence to the breaks of the Spokane and Columbia rivers to Lincoln County. This vast area is not a continuous range for this species. Actually the population centers are quite scattered.*

Isolated sightings were also reported in Adams, Asotin, Klickitat, Spokane, Stevens, and Whitman Counties (Yocom 1952; Weber and Larrison 1977). The depiction of historical sharp-tailed grouse range in Jewett *et al.* (1953) is more inclusive than that in Yocom (1952); sharp-tails currently inhabit about 2.8 percent of their historic range (M. Schroeder, pers. comm., Jewett *et al.*1953).

The current range of Columbian sharp-tailed grouse in Washington consists of eight small, severely fragmented populations in Douglas, Lincoln, and Okanogan Counties (Figure 2). Sightings of sharptails were reported in Asotin County in the mid-1980s; however, the Idaho Department of Fish and Game transplanted sharptails in Idaho at that time, and some probably dispersed to Asotin County. Sharp-tailed grouse found outside Douglas, Lincoln, and Okanogan

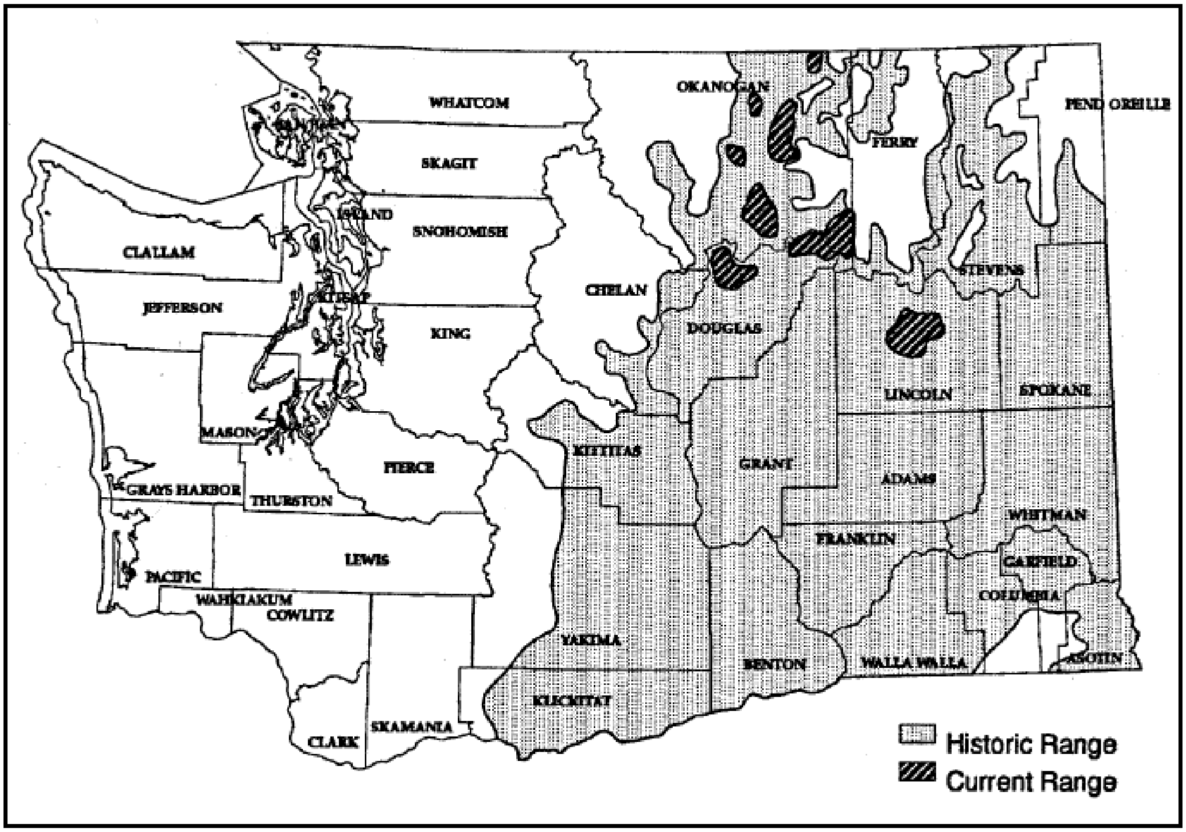

Figure 2. Historic and current range of sharp-tailed grouse, Washington (Hays *et al.* 1998).

Counties are likely transient birds that periodically occupy pockets of remaining shrub/meadow steppe. They contribute little to the statewide population in terms of reproduction or genetics.

3.2.2 Current

Currently, Columbian sharptails occupy <10 percent of their historic range in Idaho, Montana, Utah, Wyoming, and Washington; approximately 50 percent in Colorado, and 8 percent in British Columbia (Oedekoven 1985; Sullivan 1988; Ritcey 1995). Columbian sharp-tailed grouse are extirpated from California and possibly Oregon and Nevada (Wick 1955; Evanich 1983; Oedekoven 1985). Possible sightings in Nevada (Goose Creek south of Twin Falls, Idaho) and Oregon (Baker County) were recently reported (Braun 1991). Columbian sharptails are being reintroduced in Oregon (Starkey and Schnoes 1979; Crawford 1986).

4.0 Sharp-tailed Grouse Status and Abundance Trends

4.1 Status

Sharp-tailed grouse are listed as a game species in Washington by the WDFW, although the season has been closed since 1988. By policy, sharptails have also been considered a Candidate species by the WDFW since 1991. Sharp-tailed grouse are designated a priority species and their habitat a priority habitat by the WDFW Priority Habitats and Species (PHS) Program. The U.S. Fish and Wildlife Service (USFWS) considers the Columbian sharp-tailed grouse to be a species of concern.

4.2 Trends

See Current Population, above.

5.0 Out-of-Subbasin Effects and Assumptions

If CSTG can become reestablished in one or all of these subbasins, habitat manipulations will need to continually occur. Noxious weeds have already become established in most areas that were historically used by CSTG, but new species of weeds are continually being found.

Healthy populations of any species usually require some (although minimal) amount of gene flow. The establishment or maintenance of CSTG populations in adjacent subbasins would increase the possibility of interpopulation movements and reduce the risks associated with small isolated populations (genetically or extirpation).

6.0 Factors Affecting Sharp-tailed Grouse Population Status

6.1 Key Factors Inhibiting Populations and Ecological Processes

The primary factors affecting the continued existence of sharp-tailed grouse in Washington relate to habitat loss and alteration and the precarious nature of small, geographically isolated subpopulations. Three of the major factors that contributed to the decline of sharp-tailed grouse and their habitat in Washington are still threats today: conversion to agriculture, conversion to pastureland for livestock, and overgrazing. The removal of shrubs as part of agricultural practices reduces the quantity and quality of winter habitat, and the degradation of shrub and meadow steppe habitat as a result of livestock management reduces the quality of breeding habitat. The remaining subpopulations are small and isolated from one another, which increases the risk of extirpation.

6.1.1 Population Isolation

Population isolation is potentially a major factor influencing the continued existence of sharptailed grouse in Washington. As grouse populations naturally fluctuate due to environmental conditions, the lower the population level, the greater the risk of extirpation. The isolation of populations may have important ramifications for their genetic quality and recruitment (Lacy 1987). It may require human transport of individuals to counteract loss of fitness due to genetic drift.

It is not clear if the Washington populations are declining due to their isolation or because of a combination of other factors. Initial evidence (M. Schroeder, pers. comm.) indicates that most movements of radio-marked birds are insufficient to allow interchange of individuals among populations in north-central Washington. Although current estimates of the total population range up to 1000 individuals, it is divided among 8 small isolated subpopulations. Four of these populations are estimated to contain fewer than 25 birds. These populations are under immediate threat of extirpation (Reed *et al.* 1986). Near-term extirpation risks due to population size are present for two of three other populations remaining outside the Colville Indian Reservation (Gilpin 1987), as less than 100 individuals are estimated at each site (M. Schroeder, WDFW, personal communication, 2003). These populations are likely much less tolerant of environmental changes, such as habitat degradation and weather extremes, than populations in Lincoln County and the Colville Indian Reservation. Predation is more of a concern for these very small populations than it would be for larger populations in good habitat.

A wide variety of genetic problems can occur with small populations, and these genetic problems can interact with demographic and habitat problems and lead to extinction (Gilpin and Soule 1986). Overall threats to sharp-tailed grouse are greater with individuals spread through small subpopulations than one larger population.

Sharptails in Douglas and Okanogan Counties, and to a lesser degree in Lincoln County, are now restricted to high-elevation areas, specifically those areas that have both shrubs and grasses (Schroeder 1996). High winter mortality resulting from declining quantity and quality of winter habitat is likely the most significant factor causing the decline in the sharptail population in Washington (Schroeder 1996). Protecting and enhancing high quality habitat where sharptails continue to concentrate, and restoring key low-elevation winter sites is vital to conservation of sharp-tailed grouse in Washington.

Habitat quality overall is improving for sharp-tailed grouse in Lincoln County, where WDFW and the Bureau of Land Management are actively managing habitat for sharp-tailed grouse. Continuation of lands enrolled in the Conservation Reserve Program is also important to improve habitat quality in Lincoln and Douglas Counties. WDFW acquisition of lands in Okanogan County near Tunk Valley, Chesaw and Conconully should also result in improving habitats. Private and tribal lands with sharp-tailed grouse that are grazed change in habitat quality with the intensity of grazing. Trends on these grazed lands are not predictable.

6.1.2 Grazing

Increases in grazing pressure on currently occupied sharp-tailed grouse habitat is a principal threat to the continued existence of populations. In general, when grazing by livestock reduces the grass and forb component, sharp-tailed grouse are excluded (Hart *et al.* 1950; Brown 1966b; Parker 1970; Zeigler 1979). Loss of deciduous cover is especially severe near riparian areas that attract livestock in summer because of water and shade; this cover provides critical foraging areas and escape cover for sharptails throughout the year (Zeigler 1979; Marks and Marks 1987a). Trampling, browsing, and rubbing decrease the annual grass and forbs, deciduous trees, and shrubs needed for food and shelter in winter (Parker 1970; Kessler and Bosch 1982; Marks and Marks 1987a). Mattise (1978) found overgrazing very detrimental in nesting and brood-rearing habitat.

In Montana, Brown (1968) reported that the reduction in habitat due to intensive livestock grazing resulted in the elimination of sharptails in particular areas. Sharptails were observed shifting use to ungrazed areas following livestock use of traditional sites (Brown 1968). Marks and Marks (1988) also found sharptails in western Idaho selecting home ranges that were least modified by livestock grazing.

The effects of grazing on sharp-tailed grouse reported vary and appear to depend primarily on intensity, duration of grazing, kind of livestock, site characteristics, precipitation levels, and past and present land-use practices. Grazing systems currently used in range management include seasonal, deferred, and rotation grazing (Stoddard *et al.* 1975). Hart *et al.* (1950) found light to moderate grazing benefitting landowners and sharptails on the foothills and benchlands of Utah. Weddell (1992) concluded that rest rotation and deferred grazing were less detrimental to sharptailed grouse than season-long grazing, and suggested the disadvantages of increasing grazing under any of these systems outweigh the advantages for sharp-tailed grouse. Even light to moderate grazing can be detrimental in areas with a history of overgrazing, because it may prevent recovery of the native vegetation.

Kessler and Bosch (1982) surveyed sharp-tailed grouse management practices and concluded that grazing and the resulting habitat loss are the most serious threats to sharp-tailed grouse survival. Their survey of states and provinces with past or present Columbian sharp-tailed grouse populations found respondents regarded low intensity grazing as beneficial and high intensity grazing to be negative in its effects on sharptails (Kessler and Bosch 1982). Twenty percent more respondents found moderate grazing negative in its effects and twice as many preferred deferred and rest rotation over continuous grazing. Five of the seven states or provinces with Columbian sharp-tailed grouse listed overgrazing as a major issue/problem related to maintaining this species and its habitat (Braun 1991).

Grazing is a continuing threat to sharp-tailed grouse because of unpredictable changes in land ownership, grazing economics, and the needs of private landowners. Grazing pressure is increasing in several important sharptail areas in Washington (M. Schroeder, pers. comm.).

6.1.3 CRP Removal

The removal of CRP habitat in Lincoln, Douglas, and Okanogan Counties could cause further declines in sharp-tailed grouse numbers. Contracts for approximately 318,000 ha expired in 1997. Washington farmers submitted applications for new contracts on 239,000 ha and nearly 196,000 ha were accepted. CRP lands placed back into grain production could cause further declines in the number of sharp-tailed grouse, depending upon how sharp-tailed grouse use these areas. CRP land and other habitat enhancement areas must be near existing sharptail populations to be beneficial (Meints *et al.* 1992). Although the WDFW is assisting landowners in applying for CRP funding, the long-term status of these areas is uncertain.

6.1.4 Herbicides

The loss of deciduous trees and shrubs by chemical control was associated with declining sharptail populations in Washington (Zeigler 1979) and Utah (Hart *et al.* 1950). Chemical treatment of vegetation in sharp-tailed grouse habitat is detrimental due to the direct loss of vegetation (McArdle 1977; Blaisdell *et al.* 1982; Oedekoven 1985; Klott 1987). Kessler and Bosch (1982) found most biologists regarded chemical brush control as a negative management practice for sharptails. However, in Michigan, herbicidal treatment was used to open dense areas and provide more adequate sharp-tailed grouse habitat (Van Etten 1960). In Washington, continued use of herbicides to control sagebrush and other vegetation may cause additional reductions in sharp-tailed grouse habitat.

6.1.5 Fire

Fire is a continual threat to sharp-tailed grouse populations. Fire has become a major tool for altering large blocks of sagebrush rangelands. In Lincoln County, three large prescribed fires and one chemical control of sagebrush in the 1980s in areas containing active leks, were believed to be directly responsible for the decline of both sharp-tailed and sage grouse populations (Merker 1988). McArdle (1977) found less use by sharptails in burned areas compared to other vegetation manipulations. Likewise, Hart *et al.* (1950) reported Columbian sharptails abandoning a lek site following a fire which also caused accelerated erosion, loss of nests, and loss of winter food and cover.

Under some circumstances, burning can help improve sharp-tailed grouse habitat. Burning dense sagebrush and thickly wooded areas was found to improve sharp-tailed grouse habitat in Utah (Hart *et al.* 1950), North Dakota (Kirsh *et al.* 1973), Colorado (Rogers 1969), and Wyoming (Oedekoven 1985). In Manitoba and British Columbia, a large movement of sharptailed grouse occurred from a high-use lek site to a burned area following a fire that eliminated all residual grass and forbs but did not greatly affect shrub or tree cover. Modern fire suppression policies have allowed conifers to invade bunchgrass-prairie habitats in some areas to the detriment of sharp-tailed grouse populations. In these situations, prescribed burning may be effective in maintaining suitable habitats (Giesen and Connelly 1993). In Washington, prescribed fire is not recommended in shrub/meadow steppe but may be acceptable for creating habitat where conifers have invaded traditional shrub/meadow steppe areas.

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Sage Grouse
(*Centrocercus urophasianus phaios*)

1.0 Introduction

The sage grouse was listed by the state of Washington as a threatened species in 1998. In May 2001, the Washington population of the sage grouse also became a Candidate for listing under the federal Endangered Species Act when the U.S. Fish and Wildlife Service found that listing as Threatened was warranted but precluded by higher priority listing activities. This Recovery Plan summarizes the state of knowledge of sage grouse in Washington and outlines strategies to increase their population size and distribution in order to ensure the existence of a viable population of the species in the state.

The sage grouse has been declining in Washington and many parts of its range in North America. The reduction in sage grouse numbers and distribution in Washington is primarily attributed to loss of habitat through conversion to agriculture and degradation of habitat by historic overgrazing and the invasion by cheatgrass and noxious weeds. Sage grouse occur on only about 8% of their historical range in the state. The population is estimated to have declined 77% from 1960 to 1999. Local extirpations have been noted as recently as the 1980s. The statewide breeding population of sage-grouse in Washington in 2003 is estimated to be 1,017 birds. This estimate is based on leks counts of males, and probably is an underestimate.

A breeding population of about 632 sage grouse is located in Douglas County where a large amount of agricultural lands are enrolled in the Conservation Reserve Program (CRP) and shrubsteppe remnants exist where rocky soil and rugged terrain have precluded agricultural conversion. The other population of about 385 birds is located in Kittitas and Yakima Counties in contiguous shrubsteppe that has been maintained on the Yakima Training Center (YTC), a U.S. Army training facility. Neither of the 2 isolated grouse populations is large enough for long-term viability. A recent investigation indicated reduced genetic diversity in both the YTC and Douglas County populations. The polygamous mating system and fluctuations of sage grouse populations over time reduce the effective population size and increase the population size needed to be viable.

Major threats to the Washington populations include fires and continued conversion of shrubsteppe to cropland or development; additional factors affecting sage grouse include the impacts of military training and past and ongoing grazing practices. The Douglas County population is dependent on voluntary enrollment of private lands in CRP, a program that may not always be funded by Congress. Maintenance of the YTC population requires frequent rehabilitation of damage to vegetation caused by military training. Wind energy developments may pose a threat to recovery if sage grouse avoid nesting and brood rearing within 1 mile of wind turbines, as has been predicted for prairie chickens. One win energy project that has been approved may effectively eliminate 43 mi^2 of recovery area from use by breeding sage grouse; a second proposal may affect suitability of habitat in an important corridor between the 2 existing populations. Remaining habitat has been degraded by fragmentation, historic overgrazing, fires, and the invasion by cheatgrass, medusahead, and other exotic weeds. Disease is a potential new threat to the population. In August 2003, West Nile Virus began killing sage grouse in Wyoming, Montana, and Alberta. The implications of the added source of mortality for more robust populations are not yet known, but it may pose a serious threat to Washington's small populations.

The small size and continued threats to the 2 populations suggest that the long-term persistence of sage grouse in Washington will depend on protecting and enhancing suitable shrubsteppe habitat and on reestablishing additional populations and expanding existing populations outside the current occupied areas. The minimum viable population for sage grouse in Washington is estimated at 3,200 birds. The recovery objective to down-list the sage grouse from Threatened to Sensitive status is an average breeding season population of at least 3,200 birds for a period of 10 years and there are active lek complexes in 6 or more Sage grouse Management Units. The recovery plan outlines strategies to increase population numbers and distribution. A study is underway to evaluate the feasibility of reestablishing a sage grouse population on the Yakama Reservation through reintroductions, and a proposal to translocate additional birds into existing populations to reduce genetic risks is being developed.

Sage grouse recovery will require protecting remaining shrubsteppe habitat from fires, harmful grazing, conversion, and development. Some areas of degraded shrubsteppe will need to be restored in order to support nesting sage grouse. The structure of older CRP fields increasingly resembles shrubsteppe and provides important habitat. New programs in the 2002 Farm Bill may benefit sage grouse by providing funding for habitat improvements, protection, and the acquisition of perpetual conservation easements, but CRP does not guarantee long-term protection of habitat. Washington Department of Fish and Wildlife, the Bureau of Land Management (BLM), and the Nature Conservancy have recently acquired lands where shrubsteppe will be protected, or can be restored but restoration may take a long period ot time. The success of sage grouse recovery, however, may depend on cooperative efforts by private landowners, tribes, and agencies that manage public lands in recovery areas, or influence agricultural practices on private lands. These agencies include the U.S. Army, WDFW, BLM, U.S. Fish and Wildlife Service, U.S. Department of Energy, Washington Department of Natural Resources, Washington State Parks, and the Natural Resources Conservation Service. A multi-agency conservation agreement for sage grouse that will outline more specific actions, responsibilities and timelines may be completed by the Washington Sage Grouse Working Group in 2004.

Maintaining a population of sage grouse in Washington will depend on protecting remaining habitat, restoring degraded habitat, and re-establishing populations outside their current range. Sage grouse recovery in Washington will take a sustained cooperative effort by many agencies and individuals for a long period of time. Successful recovery of sage grouse will result in benefits to many other shrubsteppe species that have also declined dramatically in the state.

2.0 Sage Grouse Life History and Habitat Requirements

2.1 Life History

2.1.1 Diet

Sagebrush, grasses, forbs, and insects comprise the annual diet of sage-grouse. Sagebrush comprises 60 to 80% of the yearly diet of adult sage-grouse (Patterson 1952, Wallestad *et al.* 1975, Rasmussen and Griner 1938, Remington and Braun 1985), and as much as 95 to 100% of the winter diet (Roberson 1984). Forbs appear to be important to nesting hens in the pre-laying period. Barnett and Crawford (1994) reported that forbs contributed 20-50% of the diet of pre-laying hens in southeastern Oregon with hawksbeard (*Crepis* spp), desert parsley (*Lomatium* spp.), long-leaf phlox (*Phlox longifolia*), mountaindandelion(*Agoseris* spp.), everlasting (*Antennaria* spp.), clover (*Trifolium* spp.), milk-vetches (*Astragalus* spp), and buckwheat (*Eriogonum* spp.) among the most important forbs. Forage species used by adult sage-grouse in Montana included dandelions (*Taraxacum officianale*), common salsify (*Tragopogon dubius*), prairie pepperweed (*Lepidium densiflorum)*, prickly lettuce (*Lactuca serriola*), alfalfa (*Medicago sativa*), curlcup gumweed (*Grindelia squarrosa*), fringed sagewort (*Artemisia frigida*), yarrow (*Trifolium repens*), sweet clover (*Melilotus officinalis*), western wormwood (*Artemisia ludoviciana*), silver sage (*Artemisia cana*), asters (*Aster* spp.), as well as grasshoppers, ants, and beetles (Wallestad *et al.* 1975). Eberhardt and Hofmann (1991) reported sagebrush constituted >90% of the diet during fall, winter, and much of the spring on the YTC, although they used analysis of fecal pellets which probably biases the data toward sagebrush. In June and July, sage-grouse also ate rabbitbrush and forbs, but sagebrush was still 43-68% of their diet.

2.1.2 Reproduction

The mating season generally begins at about the same time each year, but can vary depending on weather and vegetative conditions. In Douglas and Grant counties, most birds return to breeding areas in late February or March (Schroeder 1994), and Pedersen (1982) recorded the highest number of male and female sage grouse on leks from mid-March to mid-April. On the YTC, males return to the vicinity of leks in February and females return in March (M. Livingston, pers. comm.), and the annual peak of male attendance has ranged from 7 March to 25 April (U.S. Army 2002). Mating begins after males and females congregate on a lek. Hens form clusters near a few centrally-located, dominant males (Hartzler and Jenni 1988), and these dominant males participate in most of the mating (Eng and Schladweiler 1972). Males spend early morning and late evening at leks and remain nearby the rest of the day (Batterson and Morse 1948, Wallestad and Schladweiler 1974). After mating, males spend the summer alone or in small flocks. In Washington, males began to leave leks in late April and early May and move to summer habitat (Pedersen 1982, Cadwell *et al.* 1994). Average date of nest initiation was 22 April (range: 1 Apr - 26 May) for 182 nesting attempts in northcentral Washington, 1992-1996 (Schroeder 1997). First nests were generally initiated in April, and renestings after predation or other failure were initiated in May. Yearlings nested an average of 9.4 days later than adult females. The mean duration of incubation for 66 successful nests was 26.8 days (range: 25-28) (Schroeder 1997).

2.1.3 Nesting

After mating, females devote most of their time to building nests, laying eggs, and raising chicks; males do not assist in these activities (Rasmussen and Griner 1938; Patterson 1952; Harrison 1978). Females build nests within 7 - 10 days after mating (Autenrieth 1981; Call and Maser 1985). Nests are typically located 2 to 6 km (1-4 mi) from leks (Gill 1965, Martin 1970, Jarvis 1974; Wallestad and Pyrah 1974; Petersen 1980; Pedersen 1982; Berry and Eng 1985; Eberhardt and Hofmann 1991; Wakkinen *et al.* 1992; Fischer *et al.* 1993). In Washington, nests were <1 to 19 km (0.62-12 mi) from leks on the YTC (Cadwell *et al.* 1994). In Douglas County, the first nests of 82 females (n=204 nests) averaged 7.3 km from the lek where she was captured, and 5.1 km from the nearest lek (Schroeder 2001). Nest placement likely depends on habitat quality and not distance to the lek (Wakkinen *et al.* 1992). In California, hens chose nest sites before they chose a lek, they traveled farther from winter grounds to select a nest site than to select a lek, and after mating, they nested on the chosen site rather than nesting around the lek (Bradbury *et al.* 1989b). Hens return to the same nesting area each year, but the nest is typically 500-700 m from the previous year's nest bush (Fischer *et al.* 1993; Berry and Eng 1985). Exceptions do occur, as one female in Washington nested 32 km from her previous season's nest (Schroeder *et al.* 1999), and there have been similar observations in Idaho. The average clutch size for greater sage-grouse from 10 studies was 7.5 eggs (range 6.6-9.1 eggs; Schroeder 2000b), and both the lowest and the highest means reported were studies in Washington (Sveum 1995; Schroeder 1997) (Table 1). Wallestad and Pyrah (1974) reported that clutch size was higher for adult than yearling females in Montana (2.1 egg difference) and Peterson (1980) reported a 0.6 egg difference. Wakkinen (1990) and Schroeder (1997) did not detect a difference in clutch size by hen age. Re-nests may have a smaller clutch than first nests, as observed in Washington (0.9 fewer eggs) (Schroeder 1997), Alberta (2.6 fewer) (Aldridge 2000), and Colorado (0.2 fewer) (Petersen 1980). Annual variation in clutch size suggests that variation in habitat conditions due to weather and management may affect the nutritional state of hens and ultimately clutch sizes. The level of protein in the diet affects clutch size and chick viability in captive ruffed grouse (*Bonasa umbellus*) (Beckerton and Middleton 1982) and willow ptarmigan (*Lagopus lagopus*) (Hanssen *et al.* 1982). Barnett and Crawford (1994) reported a decrease in forbs eaten and decrease in nutrient content of the diet of sage grouse when precipitation was 40% below normal in Oregon. They reported a corresponding decline in sage-grouse productivity as measured by chicks/hen and average brood size, but did not have data on clutch size. Aldridge and Brigham (2001) did not think that clutch size was affected by the flush of new growth in Alberta because egg-laying began prior to spring plant growth. The proportion of eggs hatching in successful nests, in 8 studies averaged 94.3% (range 85.5%-98.1%). About half of eggs that do not hatch are infertile (56.4%: Patterson 1952; 42.9 %: Petersen 1980; 68.2%: Schroeder 1997). Low hatchability (.70%), apparently related to reduced genetic heterogeneity in a small population, has been reported for greater prairie chickens (Bouzat *et al.* 1998; Westemeier *et al.* 1998).

2.1.4 Mortality

Sage grouse can survive at least 9 years in the wild (Zablan 1993), and may be able to live 14 or 15 years as reported in blue grouse and white-tailed ptarmigan (Zwickel *et al.* 1992; Braun *et al.* 1993). In Washington, the annual survival rate for adult males was 56.9% (n = 29) and 72.5% for adult females (n=88). Survival data suggest that 6 - 32 % of one-year old birds will live to the age of 5, if survival of breeding age birds is 50-75 % (Schroeder 2000b). In a population with 75% annual survival of females, 10% of the females would be alive at age 8.

2.1.5 Migration

Seasonal movements may be influenced by topography, vegetative cover, abnormally dry spring or summer conditions, winter weather, and availability of winter food (Beck 1975; Fischer *et al.* 1996a; Schroeder *et al.* 1999). In southeast Idaho, sage grouse moved each summer to agricultural fields along the traditional migration routes or to foothills where riparian areas and meadows were present (Wakkinen 1990; Fischer and Reese 1996). The majority of females began migration when the moisture content of vegetation declined to 60% water (Fischer *et al.* 1996a). Females also initiated migration earlier in dry years and in a wet year some did not migrate. In Douglas County, most sage grouse of both sexes migrated between breeding areas and winter areas which were more or less distinct (Schroeder 1994). The sage grouse in Douglas County are more migratory than the birds on the YTC, possibly because the winter range is not used for nesting due to its general lack of herbaceous vegetation. Adult sage grouse often return to specific wintering areas.

Sage grouse occupying sagebrush communities at low elevation may not migrate (Wallestad 1975), and those inhabiting mountain valleys or areas with distinct elevation gradients are typically migratory (Dalke *et al.* 1960; Connelly *et al.* 1988). Migratory sage grouse generally move >16 km (Berry and Eng 1985). Migrations of 80 to 160 km from wintering areas to leks (Pyrah 1954; Dalke *et al.* 1963) and 81 km from leks to winter range (Connelly and Markham 1983) have been reported, but shorter distances are more common (Bradbury *et al.* 1989a). On the YTC in Washington, males moved to summer habitat that averaged 12.6 km from leks, while females ranged 6-7 km from the lek of capture (Cadwell *et al.* 1994). Males shifted back toward the leks during the fall and winter. Migratory movements in north-central Washington are comparable in distance, but the movements clearly follow the major intact shrubsteppe corridors (Schroeder, in prep.).

2.2 Habitat Requirements

2.2.1 General

Sage grouse inhabit shrubsteppe and meadow steppe, and as their name implies they are closely associated with sagebrush. Shrubsteppe is a descriptive term for plant communities consisting of one or more layers of perennial grass with a conspicuous, but discontinuous, layer of shrubs above (Daubenmire 1970). Elevations range from 100 to 4,000 feet. Mean monthly temperatures range from 23.5°F in January in Ellensburg to 75.6°F in July at Kenniwick. Average January minimum is 15.3°F at Ellensburg, and average July maximum is 91.9°F at Kennewick. Average annual precipitation is 7.5 inches at Kennewick and 9.1 inches at Ellensburg (Franklin and Dyrness 1973). Average precipitation ranges from 4.7 inches at the Columbia River up to 21.6 inches where steppe transitions to forest at the northeast part of the Columbia Basin (Daubenmire 1970; Rickard *et al.* 1988). Forest vegetation is generally absent. Shrubsteppe communities in Washington typically contain bunchgrasses and shrubs such as big sagebrush, three-tipped sagebrush (*A. tripartita*), and bitterbrush (*Purshia tridentata*), and a variety of forbs. Meadow steppe communities are dense at ground level, supporting many grasses and forbs with broad leaves and have few shrubs. Meadow steppe is barely dry enough to exclude trees and generally has meadow characteristics (Franklin and Dyrness 1973; Daubenmire 1970). Sage grouse populations are found in areas of the *Artemisia tridentata - Agropyron spicatum* and the *Artemisia tripartita - Festuca idahoensis* vegetative units as described by Daubenmire (1970).

Sage grouse have adapted to seasonal use of altered habitats (e.g., alfalfa fields), but that use generally depends on the proximity to native steppe habitat (Schroeder *et al.* 1999). Low rolling hills and adjacent valleys provide the best topography for sage grouse (Call and Maser 1985). Sage grouse prefer slopes <30% (Call and Maser 1985). In Colorado, they preferred south-facing slopes year round (Rogers 1964). On the YTC, habitat that contained successful nests was more likely to be on northeast aspects than on south or southwest aspects (Cadwell *et al.* 1997). Habitat consists of sagebrush/bunchgrass stands having medium to high canopy cover (10-35%) of sagebrush in a variety of height classes (Table 1) and a diverse grass and forb understory (Peterson 1970; Wallestad 1971; Eng and Schladweiler 1972). In Washington, sage grouse on the YTC were found at elevations of 1,650 to 2,970 feet and on slopes less than 16° (Cadwell *et al.* 1997).

Table 1. Vegetation characteristics of productive sage grouse habitats (modified from Connelly *et al.* 2000b).

	Breeding		**Brood-rearing**		**Winter**[a]	
	Height (cm)	**Canopy (%)**	**Height (cm)**	**Canopy (%)**	**Height (cm)**	**Canopy (%)**
Sagebrush	30-80[b]	15-25	40-80	10-25	25-35	10-30
Grass-forb	>18[c]	>25[d]	Variable	>15	--	--

[a] Above snow
[b] For more mesic sites, the height is 40-80 cm.
[c] Measured as droop height; the highest naturally growing portion of the plant.
[d] For arid sites, the canopy is ≥ 15%.

2.2.2 Spring

2.2.2.1 Leks

Leks are the focal point of the breeding season and range in size from 0.1-99 ac (Scott 1942; Call 1979; Call and Maser 1985). Leks are often near nesting habitat and between areas used in winter and summer (Wallestad 1975; Klebenow 1985; Connelly *et al.* 1988). They are found in gravel pits, burned areas, cultivated fields, air strips, abandoned homesteads, roads, bare ridges, grassy swales, natural and irrigated meadows devoid of grass, knolls, small buttes, openings in sagebrush stands, dry-lake beds, and areas denuded of vegetation by livestock (Roberson 1984; Call and Maser 1985; Schroeder *et al.* 1999). Given the diverse habitats where leks are placed, lek habitat availability is likely not a limiting factor for sage grouse.

Most leks contain a central area that is barren and a surrounding area containing shrubs (Klebenow 1985; Ellis *et al.* 1989; Klott and Lindzey 1989). However, in Washington, some active leks are devoid of surrounding shrubs (Schroeder 1994). Most active leks on the YTC are on lithosol soils surrounded by a cover of stiff sagebrush (*Artemisia rigida*) and a few ac in size. Visibility is important on a lek and is necessary for females to observe displaying males and for all sage grouse to observe predators (Gill 1965; Wiley 1973).

Shrubs surrounding leks are used extensively by sage grouse. Males use shrubs ≤ 0.6 miles from a lek for foraging, loafing, and shelter (Rothenmaier 1979; Emmons and Braun 1984; Autenrieth 1981). Shrub stands with medium to very high shrub cover are primarily used by sage grouse for foraging and loafing (Autenrieth 1981; Emmons and Braun 1984; Roberson 1984). Males select shrub stands 7-15 in high (Call and Maser 1985; Rothenmaier 1979) with a canopy coverage of 20 to 50% (Wallestad and Schladweiler 1974; Autenrieth 1981; Ellis *et al.* 1989).

2.2.3 Nesting Habitat

After mating, sage grouse hens leave the lek to nest. Most hens build nests under shrubs (Jarvis 1974; Wallestad and Pyrah 1974; Roberson 1984), specifically in areas with medium to high shrub cover and residual grass (dry grass from the previous growing season) (Schoenberg 1982; Gregg 1991; Sime 1991). However, females occasionally nest in grassland (Sveum 1995), cultivated fields that contain abundant insects for chicks after hatching (Autenrieth 1981), or in idle cropland, such as land enrolled in the Conservation Reserve Program (CRP) (Schroeder 1994). Sage grouse may require a balance of shrubs and grasses for greatest nest success (Sveum 1995). Shrubs located in nesting habitat act as an umbrella, which helps shield the nest from weather and predators and increases nest success (Autenrieth 1981; Connelly *et al.* 1991; Gregg *et al.* 1994). In Washington, big sagebrush/bunchgrass is the predominant habitat selected for nesting (Schroeder 1994, Sveum 1995). Livingston and Nyland (2002) reported that females on the YTC preferred nesting under big sagebrush and selected big sagebrush-three-tipped sagebrush cover types. In other states, additional species used for nesting include rabbitbrush (*Chrysothamnus* sp.), bitterbrush, three-tipped sagebrush, silver sagebrush (*A. cana*), and mountain big sagebrush (Gregg 1991; Sime 1991; Gregg *et al.* 1994).

Tall, dense vegetation provides visual, scent, and physical barriers between predators and the nests of ground-nesting birds (Redmond *et al.* 1982; Sugden and Beyersbergen 1986, 1987; Crabtree *et al.* 1989; Sveum 1995). The presence of grass, especially tall grass, and forbs interspersed with sagebrush increases nest success (Autenrieth 1981; Wakkinen 1990; Gregg 1991; Sveum 1995). Grass may increase nest success by hiding the nest from ground predators and forming a microclimate that is warmer than the air above (Autenrieth 1981:20). Areas with successful nests on the YTC were characterized by a more even mixture of grass and shrubs in contrast to areas where unsuccessful nests occurred (Cadwell *et al.* 1997). In Oregon, a study of both real sage grouse nests and artificial nests found that nests placed in tall grass >6 in and medium high shrubs 16-32 in had the least predation (Crawford and DeLong 1993). A separate study in Oregon also found that sage grouse nests placed in medium high shrubs had the least predation (Gregg *et al.* 1994). Non-depredated nests had higher grass canopy coverage (18% vs. 5%) and higher shrub coverage (41% vs. 29%) than depredated nests within 3 ft of the nest

(Gregg *et al.* 1994). Table 2 summarizes characteristics of sage grouse nest sites in the region.Both sagebrush and tall grasses are important at nest sites (Sveum 1995). In Washington, most females nested in areas with medium to very high canopy coverage of sagebrush and grass (20% and 51%, respectively) (Schroeder 1994). Grass cover at 10 - 30 cm may be critical because sagebrush, which tends to be taller in Washington than in other study areas, does not provide the needed low cover.

Table 2. Vegetation cover characteristics at sage grouse nests in Washington, Oregon and Idaho (Stinson *et al.* 2003).

State	Sagebrush		Grass		Number of nests (n)	Reference
	Nest shrub height (cm)[a]	Cover[b] %	Height (cm)	Cover %		
WA	124[c]	20	108[c]	51	78	Schroeder (1995)[d]
	59	51	-	34	35	Sveum et al (1998)[e]
	63	59	-	44	58	Sveum *et al.* (1998)[e]
	76	59	30	16	20	Livingston & Nyland (2002)[e]
OR	-	44	22	15	20	Hanf *et al.* (1994)[e]
ID	57-80	23-38	-	-	307	Autenrieth (1981)[f]
	72	29	20	7	71	Connelly *et al.* (1994); pre-burn[g]
	59	40	16[g]	30	67	Connelly *et al.* (1994); post-burn[e]

[a] Mean height of nest bush.
[b] Mean canopy coverage of the sagebrush surrounding the nest.
[c] Tallest within 5.6m radius plot.
[d] Plot size was 5.6m radius centered at nest.
[e] 1 m2 plot, except as noted.
[f] 3.6m radius plot.
[g] 20m plot radius.

2.2.4 Brood-rearing Habitat

Early brood rearing generally occurs in upland sagebrush areas near nest sites, ideally with abundant and diverse forbs and insects (Drut *et al.* 1994; Connelly *et al.* 2000b). Broods are found in a wide variety of habitats during summer including sagebrush, wet meadows, cropland, and irrigated fields adjacent to sagebrush (Connelly *et al.* 2000b). Brood rearing areas in Idaho had more abundant forbs, ants, and beetles than unused sites (Fischer *et al.* 1996b; Apa 1998). When sagebrush habitats dry out, grouse may move to moister areas with succulent forbs.

2.2.5 Summer and Fall

During summer in Washington, Pedersen (1982) observed sage grouse moving from sagebrush communities to wet areas that contained annual forbs in fallow fields. Sage grouse on the YTC did not frequent springs, nor did they prefer major streams and associated riparian areas for water and food (Cadwell *et al.* 1994). Sage grouse broods used both big sagebrush-bunchgrass and grasslands of bunchgrasses and rabbitbrush where that sagebrush had been eliminated by fires on the YTC (Sveum 1995). In Oregon, sage grouse were generally observed feeding on forbs near playas, water holes, and meadows in summer (Willis *et al.* 1993). Males and broodless hens used a greater diversity of cover types than hens with broods in Oregon (Wallestad and Schladweiler 1974; Gregg *et al.* 1993).

Fall habitat use reflects the transition from a diet rich in forbs, to one composed almost entirely of sagebrush. Grouse in Idaho move slowly from summer to winter habitat from August to December, but most birds had abandoned summer areas by early October (Connelly and Markham 1983).

2.2.6 Winter Habitat

Sage grouse are relatively well adapted to survive winter conditions and in good habitat gain weight during winter (Patterson 1952). Sagebrush constitutes nearly 100% of the winter diet. The height and canopy coverage of sagebrush are important, particularly when snow depth exceeds 12 in (Autenrieth 1981; Hupp and Braun 1989; Willis 1991). Deep snow limits food availability and may prevent a flock from using a site in winter. Winter habitat is often the most limited seasonal habitat throughout their range because sagebrush tall enough to protrude above snow is limited (Patterson 1952; Eng and Schladweiler 1972; Beck 1977, Connelly *et al.* 2000b). Most studies report grouse using areas with >20% canopy coverage of sagebrush (Table 3). Beck (1977) reported that grouse foraged in the tallest sagebrush with the highest canopy cover. Robertson (1991) reported that sage grouse selected areas having taller and denser stands of sagebrush than randomly available. Sites with taller sagebrush offered some protection from the wind. The percent canopy cover of Wyoming big sagebrush was the most important variable; grouse selected sites with 8-12% coverage regardless of snow depth. Wyoming big sage was more important than three-tip sage during winter on the Big Desert in Idaho possibly because it is taller. Robertson (1991:56) recommended managers in southeastern Idaho, “strive for at least 10% canopy coverage of big sagebrush (with exposed height of at least 30 cm in years of moderate snowfall) in order to attain a total shrub canopy coverage of 20% on areas used in winter.” Remington and Braun (1985) found Wyoming big sagebrush the preferred winter food in Colorado, but Welch *et al.* (1991) found captive grouse preferred mountain big sagebrush over Wyoming big sagebrush.

Table 3. Sagebrush characteristics in winter sage grouse use areas (modified from Connelly *et al.* 2000b).

State	Canopy coverage (%) of sagebrush above snow	Shrub height (cm) above snow	Reference
CO	-	24-36 (males), 20-30 (hens)	Beck (1977)
CO	37 (males), 43 (hens)	34 (males), 26 (hens)	Schoenberg (1982)
ID	26 (males), 25 (hens)	29 (males), 26 (hens)	Connelly (1982)
ID	15 (total shrub 20)	46	Robertson (1991)
MT	27	25	Eng & Schladweiler (1972)
MT	>20	-	Wallestad (1975)
OR	12-17	-	Hanf *et al.* (1994)

In Douglas and Grant Counties, sage grouse were observed feeding on steep (>15%) south-facing slopes and roosting on gradual slopes (15%) and ridgetops during winter (M. Schroeder, pers. obs). On the YTC, males used areas with more grass and less shrub cover in winter when compared with nest sites (Cadwell *et al.* 1997). The best wintering sites are often located at the lowest elevations (Rogers 1964) in areas having flat or gentle slopes with <15% gradient (Jarvis 1974; Beck 1977; Autenrieth 1981). Winter sites typically face south or west, possibly because less snow accumulates than on north or east aspects (Beck 1977; Autenrieth 1981; Hupp and Braun 1989). Drainage basins with abundant sagebrush (Pedersen 1982; Schoenberg 1982; Hupp and Braun 1989), or dry areas that may be unsuitable other times of the year, are often used during winter.

3.0 Sage Grouse Population and Distribution

3.1 Population

3.1.1 Historic

Sage grouse numbers in Washington declined from the late 1800s to the early 1900s because of habitat conversion, overgrazing, and unrestricted hunting (Yocom 1956). In the 1920s and 1930s, grazing restrictions and the change from horse-drawn plow to tractor farming reduced overgrazing by horses and allowed some recovery of rangeland (Yocom 1956). This resulted in more grouse during the 1940s and 1950s (Yocom 1956). However, the population likely remained depressed in comparison to historic descriptions.

When the Washington Department of Game (WDFW) was created in 1933, a moratorium was placed on sage grouse hunting. In 1950, a 2-day sage grouse hunting season was re-opened in the Badger Pocket area of Kittitas County, with a daily and possession limit of one bird. The 1950 hunt resulted in the harvest of an estimated 2,700 sage grouse. From 1951 to 1973, the season varied from 2 to 11 days throughout eastern Washington, with daily and possession limits of one or two. Due to declining harvest and lek counts after 1973, the season was shortened to 2 days with a daily limit of one and possession limit of two. Possession limits for hunting were further reduced to one in 1977 and the area open for hunting was reduced in 1978. Continuing declines in the sage grouse population and the lack of sufficient biological information resulted in a statewide harvest closure in 1988. Harvest figures show a marked decline in the number of sage grouse harvested from 1951 to 1987. In just 7 years, between 1974 and 1980, hunter success was cut nearly in half, from 0.43 grouse/hunter to 0.23 grouse/hunter. During this time, the hunting season was primarily 2 days/year. Harvest estimates were derived from the Washington Department of Wildlife (WDFW) Annual Game Harvest Questionnaire and wing envelopes (Pedersen 1982). Autenrieth *et al.* (1981) discussed the inadequacy of harvest questionnaires that sampled <25 to 30% of all hunters, which tend to overestimate harvest. Overestimates of $100% may result when sampling 1 to 10% of a state's hunters (Pedersen 1982), so Washington sampling may not have been adequate. Furthermore, season restrictions could be partly responsible for harvest declines, but despite sampling limitations and season changes, a declining trend in the sage grouse harvest in Washington from 1950 to 1987 was clear.

In Yakima, Benton, and Kittitas Counties, hunters took approximately 900 sage grouse annually between 1967 and 1972. Limited lek counts began in 1971. These intensified to encompass all known leks on the Yakima Training Center (YTC) in 1989. With more intensive survey effort conducted on the YTC since 1989, use of maximum counts from leks likely resulted in some double counting of males (because males may attend different leks on different days). A more conservative population estimate is obtained by counting all the leks during a single day, as is now done at the YTC.

A trend toward a greater number of active leks with fewer males per lek is evident from survey data on the YTC. Numbers of males counted since 1989 declined from a high of 168 in 1991 to 76 in 1996, and increased to 158 in 1997 (S. Kruger, pers. comm.). Similarly, the average number of males per lek declined from 28 in 1991 to 7.6 in 1996, then increased to 14 in 1997 (S. Kruger, pers. comm.). The total number of active leks has increased from 5 in 1989 to 11 in 1997. The small population on the YTC is the only known population remaining in Yakima and Kittitas Counties.

The sage grouse population on the Fitzner and Eberhardt Arid Lands Ecology Reserve at Hanford (Hanford Site) in Benton County has been extirpated because of habitat degradation, development, powerline construction, and wildfires (C. Braun, letter dated 4 March 1992 to D.

Ware; L. Fitzner pers. comm.). It is unknown when grouse were abundant at the Hanford site, but there were few grouse present after 1978 (L. Cadwell, pers. comm.). Three historic leks are recorded from Benton County. One, near the southern edge of the Hanford reservation, was last known to be active in 1991.

A viable population of sage grouse no longer inhabits the Badger Pocket area of Kittitas County. This area, adjacent to the YTC, was known to support large numbers of sage grouse historically (L. Stream, pers. comm.), and hunters took 2,700 grouse there in 1950. Sage grouse persisted at the site until 1987. During the 1970s and 1980s much of the native shrub steppe habitat in the area was converted to agriculture.

In summary, the sage grouse population in Washington has declined substantially. This assessment is based on: historical measures of abundance; a decline of 88.5% in harvest from 1974 to 1984 with a corresponding steep decline in hunter success; a decline in the number of males per lek; the absence of grouse on all traditional leks in Lincoln County; a range reduction of approximately 90-92%.

3.1.2 Current

Connelly and Braun (1997) estimated declines of 17- 47% since 1985 in breeding populations of sage grouse for states with sufficient data. The population in Washington continued a steady decline during that period. The historical population of sage grouse in Washington, past harvest, and declines are discussed in greater detail in the *Washington State Status Report for the Sage Grouse* (Hays *et al.* 1998).

3.1.3 The Decline of Sage Grouse in Washington

Meriwether Lewis reported sage grouse “in great abundance” in 1806 in an area that would become Benton and Klickitat Counties (Zwickel and Schroeder 2003). Sage grouse numbers in Washington declined from the late 1800's to the early 1900's because of habitat conversion, overgrazing, and weak hunting regulations (Yocom 1956). Sage grouse historically ranged from the Columbia River in Klickitat County, north to Oroville, west to the foothills of the Cascades, and east to the Spokane River (Figure 1). As early as 1860, sage grouse had declined and were rarely seen in some areas that had formerly contained numerous birds. In 1897, the hunting season for sage grouse extended from 15 August – 1 December, with a bag limit of 10 birds/day. By the early 1900s, sage grouse had been extirpated from Spokane, Columbia, and Walla Walla counties and perhaps other counties that historically contained small populations. In 1922 the sage grouse season was closed in all counties except Benton and Franklin Counties, where the season was limited to 2-6 September with daily bag of 3. The season was closed in all counties in 1923, and remained closed statewide until 1950. Sage grouse numbers increased somewhat in some areas with the change from horse-drawn to mechanized farming, and protection from hunting from 1933-1949. Sage grouse were apparently abundant enough to be causing damage to alfalfa and potatoes in the Badger Pocket area of Kittitas County when the first hunting season since 1932 was opened in 1950 (Yocum 1956). The recovery was temporary, however, as more and more shrubsteppe was converted to agriculture within the Columbia Basin Irrigation Project.

The sage grouse population on the Fitzner and Eberhardt Arid Lands Ecology Reserve (FEALE) unit of Hanford Reach National Monument, (formerly part of the Department of Energy’s Hanford site), in Benton County was evidently extirpated, probably due to catastrophic fires in 1981 and 1984. No sage grouse populations have been found there in recent surveys, although individual birds are sighted on rare occasions. The breeding population in Lincoln County was essentially eliminated by 1985 because of habitat alteration. The Badger Pocket area, southeast

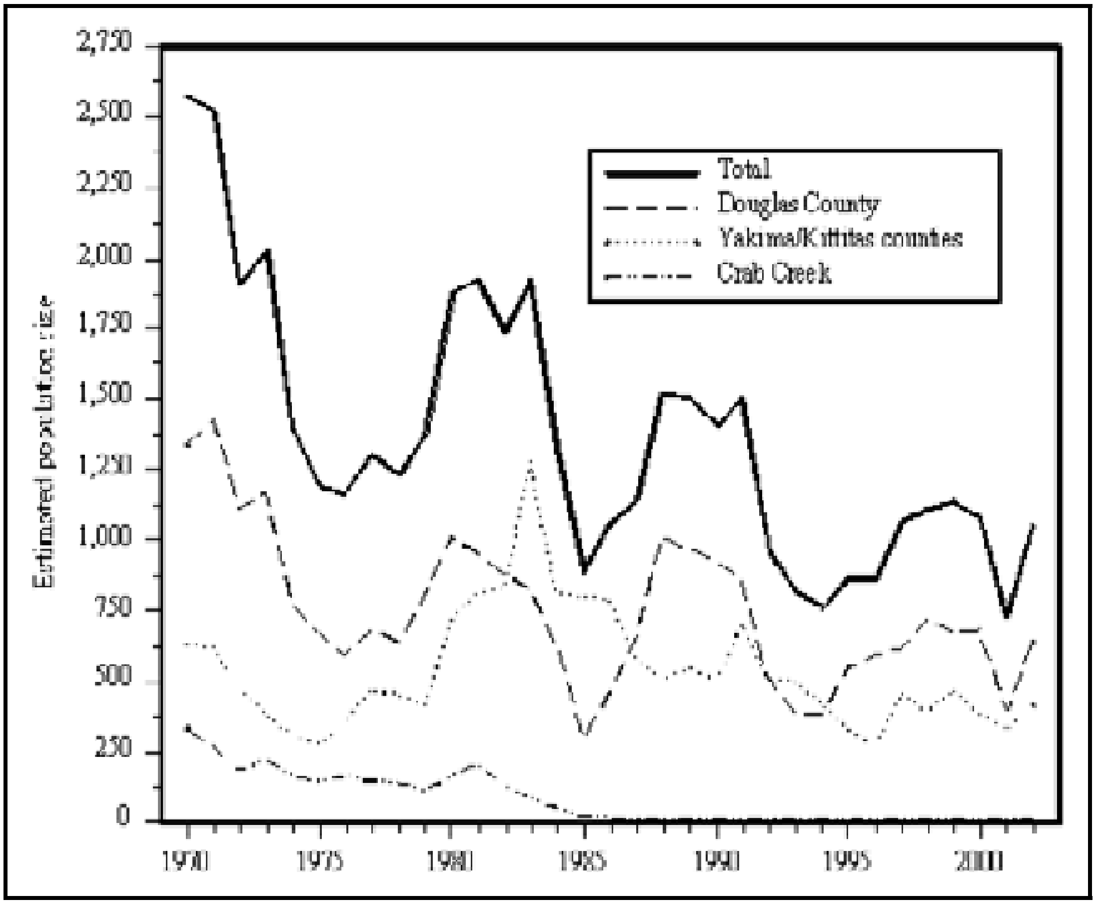

Figure 1. Estimated breeding population of sage grouse in Washington, 1970-2002 (Stinson *et al.* 2003).

of Ellensburg in Kittitas County, historically supported large numbers of sage grouse, but they were extirpated by 1987 due to conversion of shrubsteppe to agriculture in the 1970 s and 1980s.

While habitat loss was probably the most important factor in the elimination of sage grouse from most of their range in Washington, over-harvest may have exacerbated the impacts of habitat fragmentation and accelerated local extirpations. New management guidelines state that where sage grouse populations are hunted, harvest rates should be 10% or less of the estimated fall population (Connelly *et al.* 2000b), although this recommended harvest rate was not based on research experiments. An accurate accounting of historical harvests is impossible, and may have been over-estimated by up to 100% because it was based on surveys of ≤10% of hunters (Pedersen 1982). There is also uncertainty in the estimates of the historical population (Schroeder *et al.* 2000). The fall populations may have been significantly higher, perhaps 30% higher than the spring populations, assuming reproductive success of 50%, production of 4 chicks per successful hen, and 25% chick survival to fall (Schroeder 2000b). Nonetheless, past harvest rates in Washington greatly exceeded 10% of the estimated spring population in some years. For example, in 1954, an estimated 2,700 birds were killed in Kittitas County, when the statewide breeding population may have been around 9,000 birds; 3,300 hunters killed an estimated 2,065 birds in 1970 when the spring population may have been only about 3,800 birds (Hays *et al.* 1998). Excessive harvest occurred in part because it was assumed that hunting mortality of less than 30% of the population was compensatory (Autenrieth *et al.* 1982).

Also, harvest was assumed to be more or less self-limiting by what Leopold (1933) called the "law of diminishing returns" meaning that hunters stop hunting when game becomes scarce. Despite the season closure in 1988, the sage grouse population stayed at low levels or continued to decline (Figure 1), probably due to the dramatic reduction in habitat, deterioration and fragmentation of the remaining habitat, and isolation and small size of the remaining populations. Sage grouse have survived in Washington largely because portions of the land in Douglas County are poorly suited to agriculture, and in part because U.S. Army ownership of the YTC prevented agricultural conversion and most other development.

3.2 Distribution

3.2.1 Historic

Historically, sage grouse ranged from the southern portion of the Columbia River to Oroville inthe north, west to the Yakima River and east to the Spokane River (Yocom 1956) Lewis and Clark described large numbers of sage grouse near the mouth of the Snake River in 1805 (Jewett *et al.* 1953). Early explorers also reported sage grouse in the Priest Rapids, Pine Creek, Alder Creek, Horse Heaven Sand Hills, the Blue Mountains area, the sagebrush areas surrounding the Columbia River, and the Yakima and Simcoe Valley from 1840 to 1900 (Baird *et al.* 1874; Royal Historical Soc. 1914; Ballou 1938 in Yocom 1956). Sage grouse also inhabited the Okanagan Valley in British Columbia and areas bordering the Palouse, Snake, Touchet, and Walla Walla rivers (Yocom 1956). Rare but resident sage grouse were found in Asotin County. Sage grouse occurred in 16 counties, with the largest concentrations likely in Adams, Douglas, Yakima, Franklin, Grant, and Lincoln counties. These counties encompassed the vast sagebrush areas in the Big Bend, Moses Coulee, Grand Coulee, and Crab Creek drainages southward to the Snake and Columbia rivers (Yocom 1956). By 1860, sage grouse had declined and were rarely seen on areas that had formerly contained numerous birds (Cooper 1869; Cleman 1918 in Jewett *et al.* 1953). By the early 1900s, sage grouse had been extirpated from areas that historically contained small populations, such as Spokane, Columbia, and Walla Walla Counties (Jewett *et al.* 1953; Yocum 1956).

3.2.2 Current

3.2.2.1 North America

Sage grouse occur only in western North America. Historically, greater sage grouse were distributed throughout much of the western United States in 13 states and along the southern border of three western Canadian provinces (Patterson 1952; Braun 1993) (Figure 2). Gunnison sage grouse were found in south western Colorado, southeastern Utah, northern New Mexico and in western Oklahoma and Kansas (Young *et al.* 2000). Sage grouse range followed the distribution of sagebrush (*Artemisia* spp.) north to British Columbia, south to Arizona, east into Nebraska, and west to California (Aldrich 1963; Guiquet 1970). Lewis and Clark first reported sage grouse at the head of the Missouri River and on the plains of the Columbia; they were particularly abundant at the mouth of the Snake River (Coues 1893). Historical reports describe large numbers of sage grouse throughout their range (Escalante 1776; Coues 1893; Huntington 1897; Burnett 1905; Wilhelm 1970). Sage grouse populations declined throughout North America from 1900 to 1940 primarily due to habitat loss, extreme overgrazing, drought, and excessive hunting mortality (Patterson 1952; Jewett *et al.* 1953). Currently, greater sage grouse occur in 11 states and 2 provinces ranging from southeastern Alberta and southwestern Saskatchewan, south to northwestern Colorado, and west to eastern California and central Oregon and Washington. Within these outer margins, sage grouse occur in southern Idaho, northern Nevada, Utah, Wyoming, central and eastern Montana, and extreme western North and South Dakota (Schroeder *et al.* 1999). Greater sage grouse have been extirpated from Arizona, Nebraska, and British Columbia (Braun 1998); Gunnison sage grouse have been extirpated from New Mexico, Kansas, and Oklahoma (Young *et al.* 2000).

Figure 2. Historic and currently occupied range of the greater sage grouse (Stinson *et al.* 2003).

3.2.2.2 Oregon

Sage grouse were distributed throughout central and eastern Oregon, except for Wallowa County, in sagebrush dominated areas until the early 1900s (Gabrielson and Jewett 1940). By 1920, sage grouse populations had decreased and were considered scarce except for areas in southeastern Oregon (Gabrielson and Jewett 1940; Meyers 1946). Sage grouse distribution in Oregon declined by approximately 50% from 1900 to 1940 (Crawford and Lutz 1985). By 1955, the northern parts of the state, including Jefferson, Wasco, Sherman, Morrow, and Umatilla counties, and sizeable portions of Lake County in south-central and Grant County in northeastern Oregon were devoid of sage grouse (Figure 2) (Masson and Mace 1962; Drut 1994). Further declines in sage grouse distribution and abundance likely continued to the mid-1980s (Crawford and Lutz 1985). In 1992 there were estimated to be 28,000 - 66,000 breeding birds in Oregon (Willis *et al.* 1993).

3.2.2.3 Washington

The estimated historical distribution of sage grouse in Washington spanned 57,741 km^2 (Figure 3). Sage grouse inhabited the shrubsteppe and meadow steppe of the Columbia Basin region of eastern Washington. There are now 2 relatively isolated sage grouse populations remaining in Washington. Their range has been reduced about 92% to 4,683 km^2 (Schroeder *et al.* 2000). One population is found in Douglas and Grant counties, predominantly on private land. The other population is found on the Yakima Training Center (YTC), a U.S. Army training facility in Kittitas and Yakima Counties. These sage grouse populations are isolated from one another, as well as surrounding populations in Idaho and Oregon.

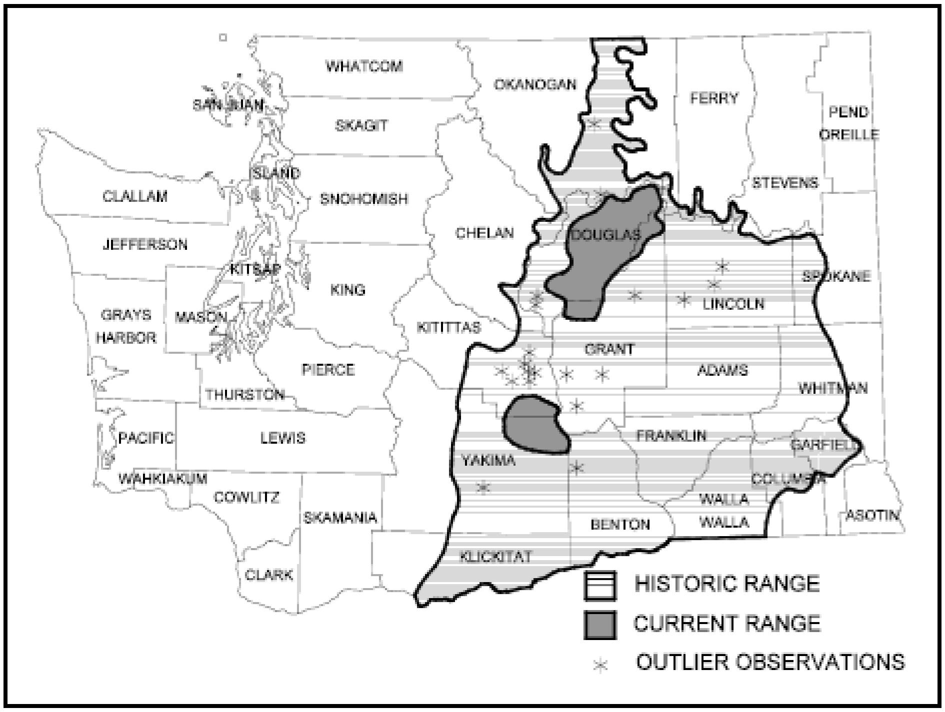

Figure 3. Historic and current sage grouse range in Washington (Stinson *et al.* 2003).

4.0 Sage Grouse Status and Abundance Trends

4.1 Status

The statewide breeding population of sage grouse in Washington in 2003 was conservatively estimated to be approximately 1,017 birds in two populations: about 632 in the Douglas-Grant Counties population and 385 in Kittitas-Yakima Counties population on the YTC (Figure 4). These 2 populations are separated by about 50-60 km. The statewide breeding population declined from about 1,080 in 2000 to 730 birds in 2001, but seemed to rebound to 1,040 in 2002 (Schroeder, unpubl.data). These estimates are probably underestimates. The population declined an average of 0.7% /year (SE = 3.5%) from 1970-2001 (Schroeder 2002). Schroeder *et al.* (2000) estimated a decline of 77% between 1960 and 1999, but indicated that the estimate would be closer to 95% if an additional 16 leks for which there was no early count data were assumed to have been of average size in 1960 and were included in the estimate. The Yakima-Kittitas population estimate ranged from 166-421 during 1989-2002 and averaged 306 birds (U.S. Army 2002). Although the Yakima-Kittitas population has fluctuated over the years, the average estimate is higher for the most recent half of the period (326 for 1996-2002; 285 for 1989-95). The average annual percent change (+6.84%) indicates a slight increase overall since 1989 (U.S. Army 2002). Based on occasional sightings, a few scattered sage grouse may occur on the periphery of the current range but are not believed to play a significant role in the dynamics of the populations. Most of the lek complexes (49 of 68; 72.1%) that were active at least 1 year from 1960 - 2001, are now vacant (Figure 4). Just over half (26 leks) of these vacant leks are outside the current range, while the remainder (23) reflect a decline in grouse density within the current range (Schroeder *et al.* 2001). In the 20th century, the range of sage grouse in Washington has declined by approximately 92%.

The two remaining populations in Washington are too small to be considered viable, so the persistence of sage grouse in Washington is likely to depend on recovery efforts. Small populations are affected by loss of genetic variability, inbreeding, and predation pressure, and are at risk to random events such as extreme weather or fires. The effective population size of sage grouse populations are smaller than the number of individuals because a small portion of the adult males do most of the breeding. This means that genetically, and demographically, these populations are more similar to populations of a smaller size. Sage grouse numbers are somewhat cyclic, putting small populations at greater risk. Populations of a few thousand individuals may be needed for long term viability (i.e. 100 years).

The population estimate is based on lek counts. Lek counts have been commonly used as an index of population trends, but their use to derive a population estimate has not been experimentally validated (Connelly *et al.* 2003). Lek count derived estimates have no confidence interval or other measure of precision and may typically underestimate the population. Walsh (2002) reported that an adjusted lek count procedure yielded a population estimate that was >40% lower (1,089 birds vs.1,843 birds) than Bowden's Estimator, an intensive mark-recapture technique. The reliability of the annual lek count-based estimates of breeding population depends on the assumptions that all leks are known and surveyed all males were counted on leks, and an assumed constant sex ratio of 1:1.6. Sex ratios and male attendance may vary somewhat annually, and finding all active leks requires frequent surveys, so these assumptions may be regularly violated to some degree. Lek count protocols are designed to maximize the number of males counted without double counting birds that may move between leks. It is likely that most but not all males are counted on leks. Dunn and Braun (1985) reported 43% (SD= 26, range 3-96%) daily attendance by 52 males, with older males attending more regularly than yearling males. Walsh (2002) reported an average daily attendance rate of 42% (SE=0.225, range 7.1-85.7%) for adult males, and 19.2% (SE=0.140, range 0-38.5%) for yearling males.

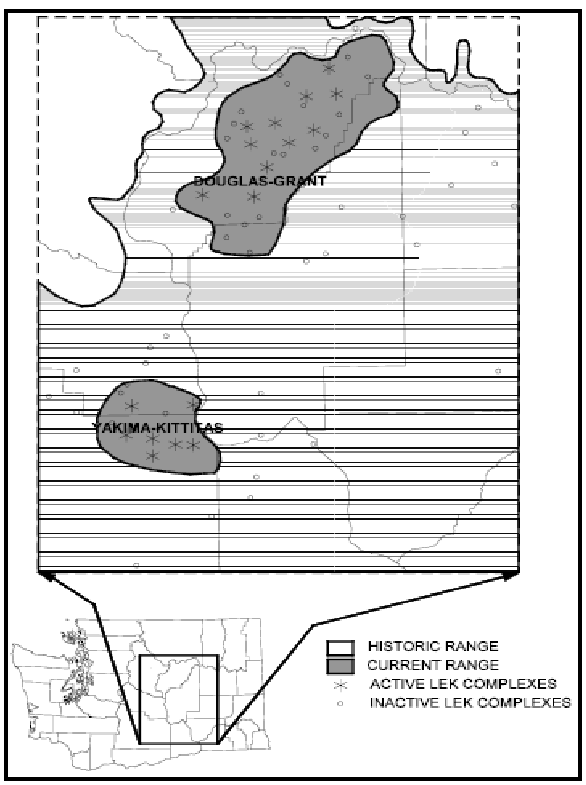

Figure 4. Distribution of active and inactive lek complexes within current and historic sage grouse range in Washington. Inactive leks are those known to be active ≥1 ear since 1960 (Stinson *et al.* 2003).

High lek counts from the peak of attendance are typically used for trend and population estimation, and earlier counts help determine when that annual peak occurs. Emmons and Braun (1984) reported that of 33 radio-marked male birds monitored during 2 years, 90% of juveniles and 94% of adults attended leks during the peak of male attendance, although they used telemetry, and not all males were actually observed on the leks.

The 1 male:1.6 females sex ratio assumption is based on the literature (Girard 1937; Patterson 1952; Rogers 1964; Braun 1984) and sex specific survival data (Schroeder, unpubl. data). The sex ratio may change somewhat year to year, however, if conditions affect mortality of male and female juveniles differently (Swenson 1986). Swenson (1986) reported lower numbers of juvenile males than females killed by hunters, and attributed this to higher male chick mortality during spring and summer resulting from the greater nutritional needs imposed by the males larger size. He did not consider differential vulnerability by sex during harvest, as reported by Connelly *et al.* (2000a).

Although population estimation based on lek counts contains significant uncertainty, other methods would entail the high cost and risks inherent in capturing and marking a significant portion of the population. Additional research is needed to determine if lek counts can be calibrated using markresighting or sightability techniques to derive better population estimates.

5.0 Factors Affecting Sage Grouse Populations and Ecological Processes

Several factors limit sage grouse populations or prevent habitat from being reoccupied. These include the quality of habitat present, the quantity of breeding and wintering habitat, isolation from occupied habitat, and the general health of existing sage grouse populations. The quantity and quality of breeding habitat limits the expansion and recovery of sage grouse in all management units. Some units, including Colockum, Umtanum Ridge, Bridgeport Point, Rattlesnake Hills, Saddle Mountains, Potholes Reservoir and Hanford, may currently have insufficient quality or quantity of breeding habitat and will require restoration to support breeding populations.

Sage grouse are absent from many areas in Washington that contain winter and breeding habitat in adequate condition, but habitat is not present in adequate quantity. Habitat patches are too small and too isolated from other patches to support a population that can persist for very long. There may also be unoccupied areas in Washington that may contain an adequate quantity of breeding and winter habitat but lack sage grouse simply due to isolation from source populations. This may include the Toppenish Ridge unit which is currrently being analyzed for its capability to support a population. The lack of habitat corridors is becoming a more critical problem every year as occupied habitat becomes more fragmented and isolated. Although the lack of winter habitat is not believed to be a significant factor in the declines of sage grouse in currently occupied areas, the lack of sagebrush in some areas may reduce the opportunities for population recovery. Management units lacking, or with a low amount of wintering habitat include Bridgeport Point, Colockum, Crab Creek, Hanford, Potholes Reservoir, Saddle Mountains, and Umtanum Ridge.

5.1 Factors Affecting Continued Existence

The primary threat to remaining sage grouse populations is habitat loss and degradation resulting from large-scale fires; the potential reduction of lands in the Conservation Reserve Program; and conversion of shrubsteppe to agriculture on Department of Natural Resources state-owned lands to produce income for state trust funds. The two remaining sage grouse populations, at the YTC and in Douglas and Grant counties are too small to be considered secure. Fire prevention and management of training activities are critical to maintaining sage grouse at the YTC and continuation of the Conservation Reserve Program and protection of remnant patches of native habitat are critical for sage grouse in Douglas County. Genetic data suggest the two populations are isolated from each other and losing genetic diversity. Both populations have many leks with low numbers of males. Small reductions in habitat quality may have significant effects on the continued use of leks. Without continued and expanded conservation effort to address the remaining threats, the sage grouse population in Washington is likely to continue to decline.

5.1.1 Population Size and Isolation

Population isolation is potentially a significant factor influencing the continued existence of sage grouse in Washington. As grouse populations naturally fluctuate due to environmental conditions, the smaller the population, the greater the risk of extirpation. The potential for compounded effects of habitat change are great when populations have dropped to low levels. For example, dispersal by juvenile sage grouse is typically advantageous in widespread and connected populations. However, it may become detrimental in isolated populations if juveniles that disperse widely are a net loss to the population and there is no compensating immigration. Both the YTC and Douglas County sage grouse subpopulations in Washington have fluctuated to estimated lows of 100-150 females during the 1990s. Many authors indicate that long-term survival (greater than 100 years) of isolated populations may require many more individuals (Lande and Barrowclough 1987; Dawson *et al.* 1987; Grumbine 1990).

Although chance events, such as fires or extreme weather, may be the biggest current threat to the Washington populations, the isolation of small populations may result in a loss of genetic quality (Lacy 1987) that may require the introduction of individuals to counteract loss of fitness. Inbreeding depression of productivity has contributed to declines and extinctions of several species in the wild (Brook *et al.* 2002). Inbreeding has been reported to affect male fitness in black grouse (*Tetroa tetrix*) (Högland *et al.* 2002). Genetic health (represented by adequate genetic heterogeneity) may be an important issue in both populations of sage grouse in Washington, but particularly in the remaining population on the YTC. Benedict *et al.* (2003), after a range-wide analysis of greater sage grouse populations, reported that the two Washington populations exhibited the lowest genetic diversity, probably a reflection of recent population declines. The YTC was represented by only 1 common haplotype and the Douglas/Grant population contained only 2, compared to an average of 6.4 haplotypes for all populations (Benedict *et al.* 2003). Additional work on microsatellites seems to confirm this loss of genetic diversity. The lack of genetic health may reduce the viability of the population and its ability to expand into adjacent management units. Benedict *et al.* (2003) indicated that management strategies should address the probable loss of genetic variation caused by this bottleneck. Bellinger *et al.* (2003) reported the loss of genetic variation in greater prairie chickens (*Tympanuchus cupido pinnatus*) following a population bottleneck in Wisconsin. Westemeier *et al.* (1998) and Bouzat *et al.* (1998) reported the reduced heterogeneity and fertility in a declining, remnant population of greater prairie chickens in Illinois. Fertility, hatching rate, and the population size of the Illinois population increased following augmentation with birds from large healthy populations (Westemeier *et al.* 1998).

5.1.2 Fire

Wyoming big sagebrush, the dominant shrub in most shrubsteppe communities in eastern Washington, is fire intolerant, so the abundance of sagebrush reported by early European explorers in the region suggests that fire was infrequent probably because vegetation was relatively sparse and discontinuous (Tisdale and Hironaka 1981). Big sagebrush only re-colonize burned areas by seed, so assuming a seed source is in the general vicinity, 30 years or more may be required to regain pre-burn densities (Harniss and Murray 1973). Wildfires have converted large tracts of sagebrush in some areas to cheatgrass monocultures that are unsuitable as sage grouse habitat (Drut 1994). Burning may also facilitate invasion by noxious weeds in addition to cheatgrass which may out-compete native grasses and forbs.

Nelle *et al.* (2000) examined vegetation cover, forb abundance, and invertebrate abundance on 20 different-aged burns in mountain big sagebrush on the Upper Snake River Plain in southeastern Idaho. They found no benefits for sage grouse from burning nesting and brood-rearing habitat. They further concluded that burning had long-term negative impacts on nesting habitat because sagebrush required >20 years for canopy cover to become sufficient for nesting. Data from the oldest burns suggested that 36 years may allow sufficient recovery for sage grouse nesting to resume. Pyle and Crawford (1996) reported that prescribed burns of plots with >35% cover of mountain big sagebrush and bitterbrush resulted in increased production of some forbs (*Chichorieae*) that are important food of sage grouse chicks, but noted that further investigation of optimal interspersion with sagebrush cover is needed to determine the utility of burns to enhance brood-rearing habitat. Wambolt *et al.* (2001) also examined different-aged burns on mountain and Wyoming big sagebrush sites in Montana and found that big sagebrush burns up to 32 years old had not recovered to the density of surrounding unburned portions of study sites. They also noted that the decrease in sagebrush from burning did not result in the generally anticipated increase of herbaceous species. Fischer *et al.* (1996b) and Connelly *et al.* (2000c) studied a prescribed burn in Wyoming big sagebrush-three-tip sagebrush nesting and early brood rearing habitat and observed no increase in forbs or use by grouse, and a decrease in ants. That study found a more rapid decline in breeding age grouse in a burned area than in a control, and Connelly *et al.* (2000c) urged managers to refrain from burning in low precipitation (<26 cm) sagebrush areas. They indicated that their study did not support the use of fire to enhance brood rearing habitat. Byrne (2002) investigated burns and habitat use in southeast Oregon and reported that unburned areas were generally selected and burned areas were generally avoided by female sage grouse during the breeding season. When burned areas were used they were typically 20 year old burns. All nests (n=5) in 20 year-old burns failed, but nest success in 20 year-old burns did not differ from success in unburned areas. Byrne (2002) found some use of 20 year-old burns in mountain big sagebrush types which recover more quickly than drier types, but no use of burns 20 years old in other cover types. Burns in Wyoming big sagebrush appeared to have no value to female sage grouse. Wambolt *et al.* (2002) reviewed the impact of fire on big sagebrush ecosystems and noted recovery usually takes several decades. They concluded that there was “no empirical evidence supporting the notion that fire has positive effects on sage grouse over the short or long term.”

The invasion by cheatgrass, which is accelerated with fire, and increases fire frequency, requires that fire prevention receive greater emphasis in management of shrubsteppe. Where a healthy community of native bunchgrasses and forbs are present, they will survive, and only the sagebrush component may need to be restored. Burned areas where cheatgrass is a significant component, however, may need immediate restoration if a community of sagebrush and native perennials is to be maintained on the burned site. The alternative may be an annual grassland of cheatgrass and perhaps eventual succession to medusahead which is unpalatable to livestock as well as having little value to wildlife (Hironaka 1994). Greenstripping has been used by BLM in Idaho to limit the size of fires that occur (Pellant 1990). Greenstripping involves strategic placement of 30-400 ft-wide strips of fire-resistent vegetation on fire-prone landscapes (Pellant 1994). Monsen (1994b) lists several species with desirable attributes for use in green-stripping. Green-strips may need to be clipped or grazed to reduce fuel. Ideally, some green strips could be removed after recovery of the adjacent shrubsteppe (Monsen 1994b).

Large fires could devastate the core habitats of existing or re-established populations of sage grouse and remain a major threat to sage grouse populations. A large fire in June/July 2000, the "Hanford Fire," burned a total of over 160,000 acres, involving multiple jurisdictions. The burn included >75,000 acres on the ALE unit of Hanford Reach National Monutment, managed by the USFWS, 60,000 acres on the Central Hanford managed by the U.S. Dept of Energy, >20,000 acres of private lands, >3,500 acres of WDFW lands, and about 1,000 ac of BLM land. The extirpation of sage grouse from the Hanford Reservation may have been precipitated by large fires in the 1980s. One fire in 1984 burned >200, 000 acres, including most of the ALE Reserve. During August 2000, the Mule Dry fire burned a total of 70,000 acres, including 40,000 acres on the Yakama Reservation.

Fire is a constant threat on the YTC, particularly when training activities occur during the driest months of May - October. Most fires begin in the Artillary Impact Area or on firing ranges. Between 1987 and 2000 fires have burned >75,000 acres, not including the 12,685 acres impact area where prescribed burns and wildfires occur periodically. A wildfire in August 1996 burned over 48,234 acres on the YTC and portions of the Hanford site (YTC-ENRD 2002). Some areas known to be used by sage grouse were burned, but critical cover near leks and nesting habitat managed for sage grouse were spared. The training center has a comprehensive Wildland Fire Management Plan to minimize the risk and to suppress wildfires as quickly as possible, and fire management improvements have contributed to a decline in the ignition and spread of fires since 1996 (YTC-ENRD 2002).

The YTC may be better prepared for fighting fires than other agencies or jurisdictions in Washington and the risk of large fires may be less or no greater than for other areas with extensive shrubsteppe. The ability of agencies and landowners to reduce risk and suppress fires may ultimately determine the success of recovery efforts.

5.1.3 Livestock Grazing

Livestock grazing has been suggested as a potential factor in both historical (Edminster 1954), and recent declines in sage grouse numbers throughout their range (Braun 1998; Connelly and Braun 1997; Pedersen *et al.* 2003). An earlier range-wide decline coincided with the maximum livestock use of range resources between 1900 and 1915 (Patterson 1952). Yocom (1956) believed overgrazing during the era when cattle, sheep, and horses were much more abundant in Washington may have had a depressive effect on sage grouse population levels, although he noted that the plowing and burning of shrubsteppe had a greater effect. The historical decline from 1870-1930 also occurred during the period when hunting regulations were becoming established. Despite the pervasive influence of livestock grazing in sage grouse range, there have been no experimental studies of the impact on sage grouse populations.

Cessation of livestock grazing would not necessarily result in recovery of vegetation and subsequent benefit to sage grouse. Laycock (1994) reviewed studies that showed that once a site has a reduced understory and sagebrush dominates, the site may remain in that condition for a very long time. He indicates that simple relaxation or removal of grazing often is not sufficient to move a site out of that new stable state (Laycock 1991,1994; West 1999). Observations of this type are consistent with the 'state and transition' theoretical model for rangelands that involves multiple successional steady states (Westoby *et al.* 1989; Pieper 1994). This model is an alternative to the Clementsian model of a climax community with a single successional pathway, that would predict recovery of climax vegetation with the removal of stressors, such as grazing. Pieper (1994) concluded that the traditional model fits "some ranges well, others not so well, and still others barely at all." West and Yorks (2002) reviewed data from grazed and ungrazed portions of a 20-year old burn and concluded that neither the

Clementsian model nor the state and transition model described the vegetation responses observed. Miller *et al.* (1994) state that “our understanding of the long-term effects of light to moderate grazing on plant composition and ecosystem processes in the Intermountain Sagebrush Region has progressed little since the turn of the century.”

Livestock grazing is compatible with sage grouse where the habitat characteristics needed for breeding and wintering can be consistently maintained (Connelly *et al.* 2000b; Wambolt *et al.* 2002; Rowland and Wisdom 2002). Whether this is possible on any particular site probably depends on many factors including the grazing history of the site, site condition, livestock involved, the season, intensity, frequency and duration of grazing. Livestock grazing does not occur on the Hanford sage grouse management unit and was discontinued on the YTC in 1995. Elsewhere, many areas in Washington, though currently lightly or moderately grazed, have little perennial grass or forb cover, a legacy of past over-grazing; nesting sage grouse in Douglas County seem to avoid these areas (M. Schroeder in prep.). Hockett (2002) provides useful recommendations for grazing in sage grouse habitats, and suggests developing strategies that will protect sage grouse spring, summer, and fall habitat from the cumulative effects of grazing during droughts.

5.1.4 CRP and Habitat Security on Private Lands

Sage grouse in Douglas County are dependent upon private lands, but agriculture is the major land use and brush control and shrubsteppe conversion continue. The federal candidate status of sage grouse strained relations with some landowners due to fears of regulation, but has benefitted many landowners when applying for enrollment in the Conservation Reserve Program (CRP). The presence of sage and sharp-tailed grouse contributed to the high acceptance rate of CRP applications in Washington. Douglas County now has 33.3% of its cropland enrolled in the CRP program.

CRP has not been used for livestock grazing, and sagebrush is invading many CRP lands and creating better habitat conditions for sage grouse. The CRP benefits sage grouse by providing essential cover for nesting that would otherwise be unavailable. Beneficial CRP lands are those adjacent to remnant shrubsteppe patches. Many of the island patches of shrubsteppe have been maintained by private landowners for the past several decades. The principal difference between lands in Franklin County (where sage grouse were recently extirpated) and Douglas County (where sage grouse still occur) is the presence of remnant shrubsteppe patches in Douglas County. Both areas have significant acreages enrolled in the CRP and have similar CRP habitats. However, reliance on CRP lands involves significant uncertainty. CRP lands were opened to grazing and haying for “emergency” drought relief in 2002 by the US Department of Agriculture. However, this reduces payments to the landowner, and so far, few landowners have opted to use CRP lands for grazing; so there has been little impact on sage grouse in Washington. Of more long-term concern, CRP is funded through the Farm Bill and depends on renewal of the program by Congress in 2008. Should CRP not be renewed, or be replaced with another program that did not maintain the habitat value of enrolled lands, sage grouse would probably decline dramatically and could be extirpated in Douglas County. Additionally, landowners may choose not to re-enroll lands in CRP if there is a dramatic increase in the price of wheat. New programs in the 2002 Farm Bill may offer additional options that in the long run may become important. For example, the Grassland Reserve Program can be used to purchase permanent easements that may provide the desired long-term security for sage grouse populations. In addition to CRP, grant programs authorized in the 2002 Farm Bill include the Grassland Reserve Program, Wildlife Habitat Incentives Program, Environmental Quality Incentives Program, and the Conservation of Private Grazing Lands Program. Information about grants is available on the USDA website (www.usda.gov/programs/farmbill/2002/products).

5.1.5 Predation

Although predation is the most important proximate cause of mortality for sage grouse, the rate of predation is ultimately dependent on the quality of habitat (Schroeder and Baydack 2001). Habitat that provides good shrub and grass cover for nesting and wintering allows grouse to increase despite predation, but losses to predation may be greater where habitat is fragmented (VanderHagen *et al.* 2002) and may be significant for small populations. Grouse have long coexisted with predators and have developed strategies that minimize predation mortalities. The numbers of some predators may be lower today (e.g. badgers) than they were historically, but other predators that benefit from human-associated food may be more abundant in some locations (e.g. ravens and coyotes). Grouse may come under greater pressure when populations of other prey species (e.g. jackrabbits, ground squirrels) are low. Where studies indicate that juvenile survival is a problem, management of habitat to increase juvenile survival may be critical to restoring sage grouse populations. Predator control programs to benefit bird populations have been shown to be locally effective at improving nest success in ducks (Greenwood and Sovada 1996), and is commonly used to benefit grouse in Europe. However, there is no information on the long term impacts of predator control on the behavior, genetics, and abundance of sage grouse (Schroeder and Baydack 2001). Predator control can be relatively expensive, its benefits short-lived, and it can generate strong opposition. In the only experimental study of predator control for the benefit of sage grouse, Batterson and Morse (1948) reported higher nesting success in an area where ravens had been controlled. Cote and Sutherland (1997) analyzed past studies of predator control to protect birds and concluded that though predator control may reduce nest predation and increase the post-breeding population, it does not reliably result in an increase of the breeding population in subsequent seasons. Connelly *et al.* (2000b) concluded that nest-success rates (>40%) in most locations suggest that nest predation is not a widespread problem. They state that though expensive and often ineffective, predator control programs may provide temporary help where habitat is recovering or where seasonal habitats have been greatly reduced. They recommend that predator management should only be implemented if nest success and hen survival data support the action. If corvids are identified as the dominant nest predator and nest success is < 25% (Connelly *et al.* 2000b), an efficient method of control that could be considered is the use of the avicide DRC-1339 applied to hard-boiled eggs in artificial nests. This would only affect the birds actually depredating nests. Any predator control programs that are implemented should be evaluated for benefits to the breeding population.

5.1.6 Harassment and Disturbance

Potential disturbances to sage grouse include off-road recreational vehicles, farming activities, military training, bird dog field trials, birdwatchers or photographers, falconry, and hunting. Disturbance by military training may lead to greater amount of movements by birds on the YTC. The only current recreational use focused on sage grouse directly is viewing. Uncontrolled viewing could disrupt breeding populations and should be monitored and restricted if necessary. During the breeding season, repeated disturbance at a lek has the potential to reduce mating opportunities and cause decreased production. When humans approach the display site, grouse often flush and may or may not return again that day (Call 1979). Viewing at a distance from automobiles does not appear to disrupt courtship activity; but grouse flush when people leave cars to get a closer look. WDFW personnel do not provide lek locations, but lead occasional tours for college classes or other groups, usually to one specific lek. The “tour lek” has not had a lot of traffic. All the Douglas County leks are on private property, but some are visible from county roads. The location of at least one lek is known by the birding community, and disturbance has on occasion been a problem at that site. At the YTC lek tours are given in accordance with strict guidelines; no reduction in lek attendance or disruption of breeding activities has been observed (M. Pounds, pers. comm.).

5.1.7 Insecticides and Herbicides

Insecticides applied to agricultural fields and shrubsteppe communities may be detrimental to sage grouse. Approximately 91,000 km^2 (35,000 mi^2) of western rangelands were sprayed for grasshopper control from 1985 to 1990 (Johnson and Boyce 1990). Areas sprayed were commonly used by nesting sage grouse. Insects such as ants, beetles, and grasshoppers are a key item in the diet of chicks (Rasmussen and Griner 1938, Patterson 1952, Klebenow and Gray 1968, Peterson 1970, Johnson and Boyce 1990), and chicks more than 3 weeks old show reduced growth rates when insects are removed from their diet (Johnson and Boyce 1990). Blus *et al.* (1989) reported mortalities of sage grouse after application of organophosphorus insecticides (dimethoate and methamidophos) on fields in southeastern Idaho. Herbicides are also used to control weeds, such as knapweeds and cheatgrass. The YTC uses herbicides to control knapweeds on 24,000 ha (Livingston 1998). The herbicides do not harm sagebrush, but suppress forbs which may eliminate those areas as brood habitat. There is little information on toxicity of those herbicides (2,4,D and Picloram®) to birds (Livingston 1998).

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Red-eyed Vireo
(*Vireo olivaceus*)

1.0 Introduction

There has been a major focus over the past several years on songbirds and the reasons for their declines. Many species of Neotropical migrant birds are experiencing population declines mainly because of the loss and fragmentation of breeding, wintering, and migratory stopover habitats. These long distance migrants tend to be more vulnerable to habitat loss and fragmentation than birds that are resident or those that migrate only short distances within North America. Tropical deforestation, forest fragmentation on their breeding grounds and increases in brood parasites like the brown-headed cowbird (*Molothrus ater*) have all been blamed in part for these declines. At least 49 species are highly associated breeding species in riparian forest and shrub habitats. Many of these species are generalists that also occur as breeders in other habitat types [e.g., American robin (*Turdus migratorius*), Bewick's wren (*Thryomanes bewickii*), and Swainson’s thrush (*Catharus ustulatus*)]. However, others such as red-eyed vireo, yellow warbler (*Dendroica petechia*), yellow-breasted chat (*Iceteria virens*), warbling vireo (*Vireo gilvus*), and Bullock's oriole (*Icterus galbula*) are obligate or near obligate to riparian habitat.

Most species are primarily insectivores that take advantage of the high insect productivity that occurs in riparian habitats. In general, the greater the structural layering and complexity of the habitat, the greater the insect productivity and the greater the bird species diversity. Many studies have reported higher species richness, abundance, or diversity in riparian zones than adjacent habitats, particularly at lower elevations (Stauffer and Best 1980; Knopf 1985). Other riparian associated bird species are tied to unique features such as nesting cavities provided by snags [e.g., downy woodpecker (*Picoides pubescens*), black-capped chickadee (*Parus atricapillus*), tree swallow (*Tachycineta bicolor*)], nectar of flowering plants in the understory [e.g., rufous hummingbird (*Selasphorus rufus*)], fruit from berry producing plants in the understory and subcanopy [e.g., cedar waxwing (*Bombycilla cedrorum*)], or a dense, diverse shrub layer (e.g., Swainson's thrush). It is sometimes useful to choose an index species to represent a habitat used by many other species. The red-eyed vireo is a focus species for large canopy trees in riparian deciduous woodland.

The red-eyed vireo is a locally common species in riparian growth and strongly associated tall, somewhat extensive, closed canopy forests of cottonwood, maple, or alder in the Puget Lowlands and along the Columbia River in Clark and Skamania Counties.

This vireo has been one of the most abundant birds in North America, although its numbers seem to have declined recently, possibly as a result of the destruction of wintering habitat in the neotropics, fragmentation of northern breeding forests, or other causes. Its principal habitat, broad-leaved forests, often supports one pair per acre. The red-eyed vireo is a fierce fighter around its nest and can intimidate even the large pileated woodpecker (*Dryocopus pileatus*). Its horizontal posture and slow movement through the understory of broad-leaved woods make it an easy bird to study.

2.0 Focal Species Life History and Habitat Requirements

2.1 Life History

2.1.1 Diet

Vireos are primarily insectivorous, with 85% of its diet composed of insects and only 15% of its diet vegetable, mostly fruits and berries eaten in August to October. A third of the total food is composed of caterpillars and moths, mainly the former. Beetles, hymenoptera bugs and flies rank next to lepidoptera in importance as food items for the red-eyed vireo.

2.1.2 Reproduction

Courtship begins in May, with the peak of egg laying in the first half of June.

2.1.3 Nesting

The nest is a thin-walled pendant cup of bark strips and plant fibers, decorated with lichen and attached to a forked twig, usually containing 3 or 4 white eggs, sparsely marked with dark brown. It is usually found 5 to 10 feet above the ground, although nests as low a 2 feet and as high as 60 feet are reported (Bent 1965). Both sexes share in incubation and the young hatch in 12 to 14 days. Occasionally a pair may raise two broods in a season (Bent 1965).

2.1.4 Migration

The red-eyed vireo is known in Central America as a transient, journeying between its breeding range in North America and its winter home in South America. September is the month when these vireos pass southward through the Isthmus of Panama in the greatest numbers, but stragglers have been recorded in Costa Rica as late as October 28 and November 10 (Bent 1965). The northward passage begins in late March and is at its height in April, while an occasional straggler may be seen early in May (Bent 1965). As they pass through Central America they are met singly or in small flocks.

2.1.5 Mortality

The red-eyed vireo typically lays 3 to 4 eggs. However it is commonly parasitized by the brown-headed cowbird. The host bird incubates and cares for these interlopers, commonly to the detriment of its own young. Often the young cowbird will push the young of the host out of the nest causing failure of the host’s nesting. This parasitism may compromise productivity especially in areas where habitat modification creates openings close to the riparian zone.

2.2 Habitat Requirements

Partners in Flight have established biological objectives for this species in the lowlands of western Oregon and western Washington. These include providing habitats that meet the following definition: mean canopy tree height >15 m (50 ft), mean canopy closure >60%, young (recruitment) sapling trees >10% cover in the understory, riparian woodland >50 m (164 ft) wide (Altman 2001). Red-eyed vireos are closely associated with riparian woodlands and black cottonwood stands and may use mixed deciduous stands.

The patchy distribution in Washington for this species correlates with the distribution of large black cottonwood (*Populus tnchocarrpa*) groves, which are usually limited to riparian areas. The Red-eyed vireo is one of the most abundant species in northeastern United States, but is much less common in Washington due to limited habitat.

3.0 Focal Species Population and Distribution

3.1 Population

3.1.1 Historic

Information for this section is unavailable.

3.1.2 Current

Little is known about population size, although the red-eyed vireo is one of the most abundant species in northeastern United States; it is much less common in Washington due to limited habitat.

3.2 Distribution

3.2.1 Historic

Information for this section is unavailable.

3.2.2 Current

The North American breeding range of the red-eyed vireo extends from British Columbia to Nova Scotia, north through parts of the Northwest Territories, and throughout most of the lower United States (Figure 1). They migrate to the tropics for the winter.

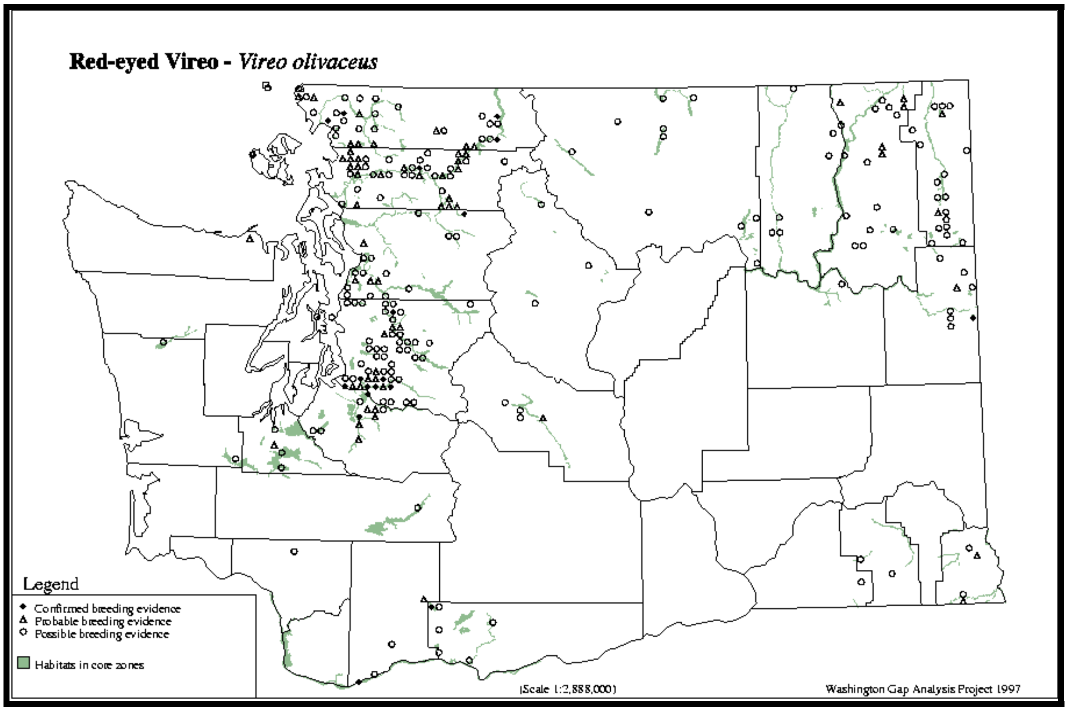

Figure 1. Breeding bird atlas data (1987-1995) and species distribution for red-eyed vireo (Washington GAP Analysis Project 1997).

The patchy distribution in Washington for this species correlates with the distribution of large black cottonwood (*Populus trichocarpa*) groves, which are usually limited to riparian areas. The red-eyed vireo is one of the most abundant species in the northeastern United States, but is much less common in Washington due to limited habitat.

4.0 Focal Species Status and Abundance Trends

4.1 Status

The red-eyed vireo is secure, particularly in the eastern United States. Within the state of Washington, the red-eyed vireo is locally common, more widespread in northeastern and southeastern Washington and not a conservation concern (Altman 1999).

Red-eyed vireos are currently protected throughout their breeding range by the Migratory Bird Treaty Act (1918) in the United States, the Migratory Bird Convention Act (1916) in Canada, and the Convention for the Protection of Migratory Birds and Game Mammals (1936) in Mexico.

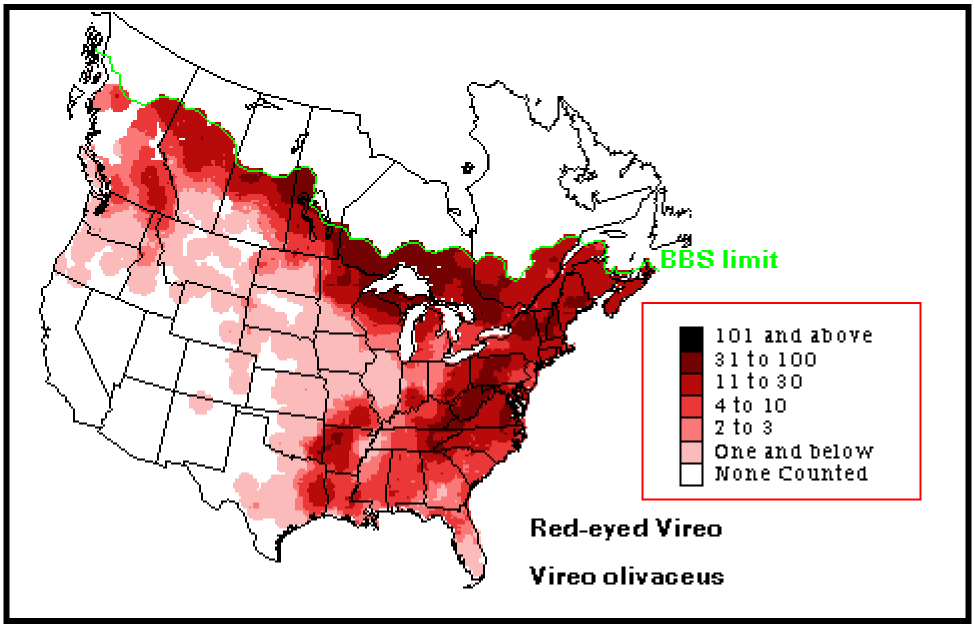

Figure 2. Red-eyed vireo breeding distribution (Sauer *et al.* 2003).

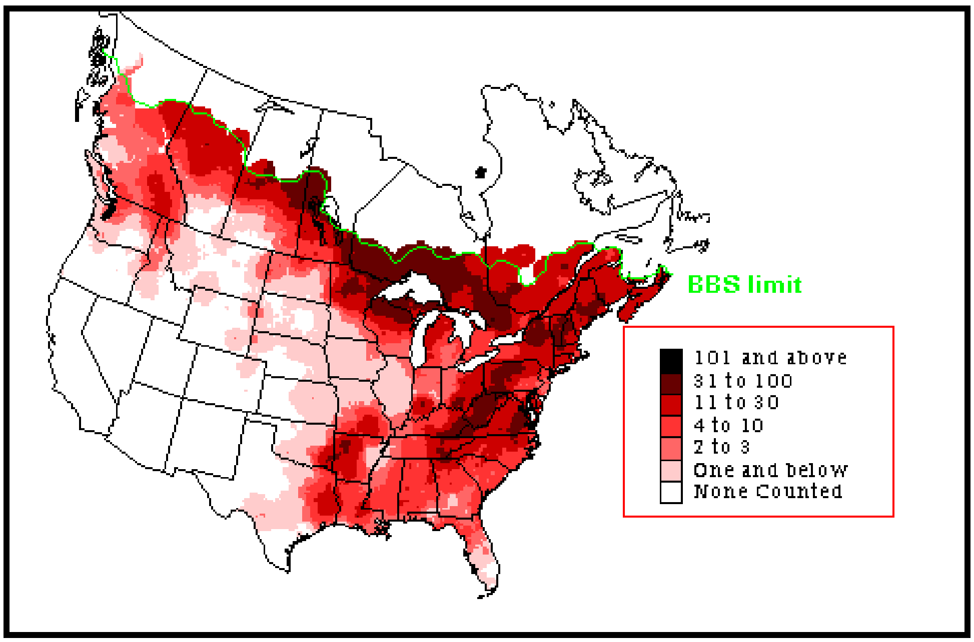

Figure 3. Red-eyed vireo summer distribution (Sauer *et al.* 2003).

4.2 Trends

In Washington, Breeding Bird Survey (BBS) data show a significant population increase of 4.9% per year from 1982 to 1991 (Peterjohn 1991) (Figure 4). However, long-term, this has been a population decline in Washington of 2.6% per year, although the change is not statistically significant largely because of scanty data (Sauer *et al.* 2003). Because the BBS dates back only about 30 years, population declines in Washington resulting from habitat loss dating prior to the survey would not be accounted for by that effort.

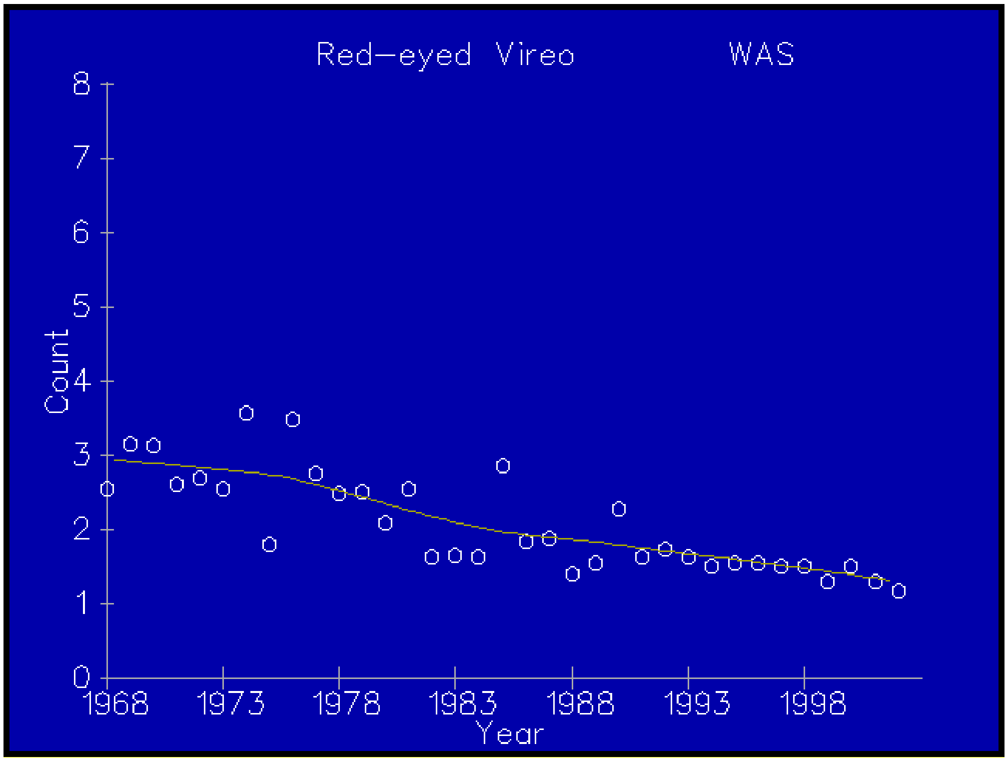

Figure 4. Red-eyed vireo trend results, Washington (Sauer *et al.* 2003).

5.0 Factors Affecting Red-eyed Vireo Populations and Ecological Processes

5.1 Habitat Loss

Habitat loss due to hydrological diversions and control of natural flooding regimes (e.g., dams) has resulted in an overall reduction of riparian habitat for red-eyed vireos through the conversion of riparian habitats and inundation from impoundments.

5.2 Habitat Degradation

Like other neotropical migratory birds, red-eyed vireos suffer from habitat degradation resulting from the loss of vertical stratification in riparian vegetation, lack of recruitment of young cottonwoods, ash (*Fraxinus latifolia*), willows (*Salix spp*.), and other subcanopy species.

Streambank stabilization, which narrows stream channel, reduces the flood zone and extent of riparian vegetation. The invasion of exotic species such as canarygrass (*Phalaris spp*.) and blackberry (*Rubus spp*.) also contributes to a reduction in available habitat for the red-eyed vireo. Habitat loss can also be attributed to overgrazing, which can reduce understory cover. Reductions in riparian corridor widths may decrease suitability of riparian habitat and may increase encroachment of nest predators and nest parasites to the interior of the stand.

5.3 Human Disturbance

Hostile landscapes, particularly those in proximity to agricultural and residential areas, may have high density of nest parasites, such as brown-headed cowbirds and domestic predators (cats), and can be subject to high levels of human disturbance. Recreational disturbances, particularly during nesting season, and particularly in high-use recreation areas may have an impact on red-eyed vireos.

5.4 Pesticides/Herbicides

Increased use of pesticide and herbicides associated with agricultural practices may reduce the insect food base for red-eyed vireos.

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American Beaver
(*Castor Canadensis*)

1.0 Introduction

The American beaver (*Castor canadensis*) is a large, highly specialized aquatic rodent found in the immediate vicinity of aquatic habitats (Hoffman and Pattie 1968). The species occurs in streams, ponds, and the margins of large lakes throughout North America, except for peninsular Florida, the Arctic tundra, and the southwestern deserts (Jenkins and Busher 1979). Beavers construct elaborate lodges and burrows and store food for winter use. The species is active throughout the year and is usually nocturnal in its activities. Adult beavers are nonmigratory.

2.0 American Beaver Life History and Habitat Requirements

2.1 Life History

2.1.1 Diet

Beavers are exclusively vegetarian in diet. A favorite food item is the cambial, or growing, layer of tissue just under the bark of shrubs and trees. Many of the trees that are cut are stripped of bark, or carried to the pond for storage under water as a winter food cache. Buds and roots are also consumed, and when they are needed, a variety of plant species are accepted. The animals may travel some distance from water to secure food. When a rich food source is exploited, canals may be dug from the pond to the pasture to facilitate the transportation of the items to the lodge.

Much of the food ingested by a beaver consists of cellulose, which is normally indigestible by mammals. However, these animals have colonies of microorganisms living in the cecum, a pouch between the large and small intestine, and these symbionts digest up to 30 percent of the cellulose that the beaver takes in. An additional recycling of plant food occurs when certain fecal pellets are eaten and run through the digestive process a second time (Findley 1987). Woody and herbaceous vegetation comprise the diet of the beaver. Herbaceous vegetation is a highly preferred food source throughout the year, if it is available. Woody vegetation may be consumed during any season, although its highest utilization occurs from late fall through early spring. It is assumed that woody vegetation (trees and/or shrubs) is more limiting than herbaceous vegetation in providing an adequate food source.

Denney (1952) summarized the food preferences of beavers throughout North America and reported that, in order of preference, beavers selected aspen (*Populus tremuloides*), willow (*Salix spp.*), cottonwood (*P. balsamifera*), and alder (*Alnus spp*.). Although several tree species have often been reported to be highly preferred foods, beavers can inhabit, and often thrive in, areas where these tree species are uncommon or absent (Jenkins 1975). Aspen and willow are considered preferred beaver foods; however, these are generally riparian tree species that may be more available for beaver foraging but are not necessarily preferred over all other deciduous tree species (Jenkins 1981). Beavers have been reported to subsist in some areas by feeding on coniferous trees, generally considered a poor quality source of food (Brenner 1962; Williams 1965). Major winter foods in North Dakota consisted principally of red-osier dogwood (*Cornus stolonifera*), green ash (*Fraxinus pennsylvanica*), and willow (Hammond 1943). Rhizomes and roots of aquatic vegetation also may be an important source of winter food (Longley and Moyle 1963; Jenkins pers. comm.). The types of food species present may be less important in determining habitat quality for beavers than physiographic and hydrologic factors affecting the site (Jenkins 1981).

Aquatic vegetation, such as duck potato (*Sagittaria spp.),* duckweed (*Lemna spp.),* pondweed (*Potamogeton spp.),* and water weed (Elodea spp.), are preferred foods when available (Collins

1976a). Water lilies (Nymphaea spp.), with thick, fleshy rhizomes, may be used as a food source throughout the year (Jenkins 1981). If present in adequate amounts, water lily rhizomes may provide an adequate winter food source, resulting in little or no tree cutting or food caching of woody materials. Jenkins (1981) compared the rate of tree cutting by beavers adjacent to two Massachusetts ponds that contained stands of water lilies. A pond dominated by yellow water lily (*y. variegatum*) and white water lily (*N. odorata*), which have thick rhizomes, had low and constant tree cutting activity throughout the fall. Conversely, the second pond, dominated by watershield (*Brasenia schreberi*), which lacks thick rhizomes, had increased fall tree cutting activity by beavers.

2.1.2 Reproduction

The basic composition of a beaver colony is the extended family, comprised of a monogamous pair of adults, subadults (young of the previous year), and young of the year (Svendsen 1980). Female beavers are sexually mature at 2.5 years old. Females normally produce litters of three to four young with most kits being born during May and June. Gestation is approximately 107 days (Linzey 1998). Kits are born with all of their fur, their eyes open, and their incisor teeth erupted.

Dispersal of subadults occurs during the late winter or early spring of their second year and coincides with the increased runoff from snowmelt or spring rains. Subadult beavers have been reported to disperse as far as 236 stream km (147 mi) (Hibbard 1958), although average emigration distances range from 8 to 16 stream km (5 to 10 mi) (Hodgdon and Hunt 1953; Townsend 1953; Hibbard 1958; Leege 1968). The daily movement patterns of the beaver centers around the lodge or burrow and pond (Rutherford 1964). The density of colonies in favorable habitat ranges from 0.4 to 0.8/km2 (1 to 2/mi2) (Lawrence 1954; Aleksiuk 1968; Voigt *et al.* 1976; Bergerud and Miller 1977 cited by Jenkins and Busher 1979).

2.1.3 Home Range

The mean distance between beaver colonies in an Alaskan riverine habitat was 1.59 km (1 mi) (Boyce 1981). The closest neighbor was 0.48 km (0.3 mi) away. The size of the colony's feeding range is a function of the interaction between the availability of food and water and the colony size (Brenner 1967). The average feeding range size in Pennsylvania, excluding water, was reported to be 0.56 ha (1.4 acre). The home range of beaver in the Northwest Territory was estimated as a 0.8 km (0.5 mi) radius of the lodge (Aleksiuk 1968). The maximum foraging distance from a food cache in an Alaskan riverine habitat was approximately 800 m (874 yds) upstream, 300 m (323 yds) downstream, and 600 m (656 yds) on oxbows and sloughs (Boyce 1981).

2.1.4 Mortality

Beavers live up to 11 years in the wild, 15 to 21 years in captivity (Merritt 1987, Rue 1967). Beavers have few natural predators. However, in certain areas, beavers may face predation pressure from wolves (*Canis lupus*), coyotes (*Canis latrans*), lynx (*Felis lynx*), fishers (*Martes pennanti*), wolverines (*Gulo gulo*), and occasionally bears (*Ursus spp*.). Alligators, minks (*Mustela vison*), otters (*Lutra canadensis*), hawks, and owls periodically prey on kits (Lowery 1974; Merritt 1987; Rue 1967). Beavers often carry external parasites, one of which, *Platypsylla castoris*, is a beetle found only on beavers.

2.1.5 Harvest

2.1.5.1 Historic

Because of the high commercial value of their pelts, beavers figured importantly in the early exploration and settlement of western North America. Thousands of their pelts were harvested annually, and it was not many years before beavers were either exterminated entirely or reduced to very low populations over a considerable part of their former range. By 1910 their populations were so low everywhere in the United States that strict regulation of the harvest or complete protection became imperative. In the 1930s live trapping and restocking of depleted areas became a widespread practice which, when coupled with adequate protection, has made it possible for the animals to make a spectacular comeback in many sections.

2.1.5.2 Current

Information for this section is unavailable.

2.2 Habitat Requirements

All wetland cover types (e.g., herbaceous wetland and deciduous forested wetland) must have a permanent source of surface water with little or no fluctuation in order to provide suitable beaver habitat (Slough and Sadleir 1977). Water provides cover for the feeding and reproductive activities of the beaver. Lakes and reservoirs that have extreme annual or seasonal fluctuations in the water level will be unsuitable habitat for beaver. Similarly, intermittent streams, or streams that have major fluctuations in discharge (e.g., high spring runoff) or a stream channel gradient of 15% or more, will have little year-round value as beaver habitat. Assuming that there is an adequate food source available, small lakes [< 8 ha (20 acres) in surface area] are assumed to provide suitable habitat. Large lakes and reservoirs [> 8 ha (20 acres) in surface area] must have irregular shorelines (e.g., bays, coves, and inlets) in order to provide optimum habitat for beaver.

Beavers can usually control water depth and stability on small streams, ponds, and lakes; however, larger rivers and lakes where water depth and/or fluctuation cannot be controlled are often partially or wholly unsuitable for the species (Murray 1961; Slough and Sadleir 1977). Rivers or streams that are dry during some parts of the year are assumed to be unsuitable beaver habitat. Beavers are absent from sizable portions of rivers in Wyoming, due to swift water and an absence of suitable dwelling sites during periods of high and low water levels (Collins 1976b).

In riverine habitats, stream gradient is the major determinant of stream morphology and the most significant factor in determining the suitability of habitat for beavers (Slough and Sadleir 1977). Stream channel gradients of 6% or less have optimum value as beaver habitat. Retzer *et al.* (1956) reported that 68% of the beaver colonies recorded in Colorado were in valleys with a stream gradient of less than 6%, 28% were associated with stream gradients from 7 to 12%, and only 4% were located along streams with gradients of 13 to 14%. No beaver colonies were recorded in streams with a gradient of 15% or more. Valleys that were only as wide as the stream channel were unsuitable beaver habitat, while valleys wider than the stream channel were frequently occupied by beavers. Valley widths of 46 m (150 ft) or more were considered the most suitable. Marshes, ponds, and lakes were nearly always occupied by beavers when an adequate supply of food was available.

2.2.1 Foraging

Beavers are generalized herbivores; however, they show strong preferences for particular plant species and size classes (Jenkins 1975; Collins 1975a; Jenkins 1979). The leaves, twigs, and bark of woody plants are eaten, as well as many species of aquatic and terrestrial herbaceous vegetation. Food preferences may vary seasonally, or from year to year, as a result of variation in the nutritional value of food sources (Jenkins 1979).

An adequate and accessible supply of food must be present for the establishment of a beaver colony (Slough and Sadleir 1977). The actual biomass of herbaceous vegetation will probably not limit the potential of an area to support a beaver colony (Boyce 1981). However, total biomass of winter food cache plants (woody plants) may be limiting. Low marshy areas and streams flowing in and out of lakes allow the channelization and damming of water, allowing access to, and transportation of, food materials. Steep topography prevents the establishment of a food transportation system (Williams 1965; Slough and Sadleir 1977). Trees and shrubs closest to the pond or stream periphery are generally utilized first (Brenner 1962; Rue 1964). Jenkins (1980) reported that most of the trees utilized by beaver in his Massachusetts study area were within 30 m (98.4 ft) of the water's edge. However, some foraging did extend up to 100 m (328 ft). Foraging distances of up to 200 m (656 ft) have been reported (Bradt 1938). In a California study, 90% of all cutting of woody material was within 30 m (98.4 ft) of the water's edge (Hall 1970).

Woody stems cut by beavers are usually less than 7.6 to 10.1 cm (3 to 4 inches) dbh (Bradt 1947; Hodgdon and Hunt 1953; Longley and Moyle 1963; Nixon and Ely 1969). Jenkins (1980) reported a decrease in mean stem size cut and greater selectivity for size and species with increasing distance from the water's edge. Trees of all size classes were felled close to the water's edge, while only smaller diameter trees were felled farther from the shore.
Beavers rely largely on herbaceous vegetation, or on the leaves and twigs of woody vegetation, during the summer (Bradt 1938, 1947; Brenner 1962; Longley and Moyle 1963; Brenner 1967; Aleksiuk 1970; Jenkins 1981). Forbs and grasses comprised 30% of the summer diet in Wyoming (Collins 1976a). Beavers appear to prefer herbaceous vegetation over woody vegetation during all seasons of the year, if it is available (Jenkins 1981).

2.2.2 Cover

Lodges or burrows, or both, may be used by beavers for cover (Rue 1964). Lodges may be surrounded by water or constructed against a bank or over the entrance to a bank burrow. Water protects the lodges from predators and provides concealment for the beaver when traveling to and from food gathering areas and caches.

The lodge is the major source of escape, resting, thermal, and reproductive cover (Jenkins and Busher 1979). Mud and debarked tree stems and limbs are the major materials used in lodge construction although lesser amounts of other woody, as well as herbaceous vegetation, may be used (Rue 1964). If an unexploited food source is available, beavers will reoccupy abandoned lodges rather than build new ones (Slough and Sadleir 1977). On lakes and ponds, lodges are frequently situated in areas that provide shelter from wind, wave, and ice action. A convoluted shoreline, which prevents the buildup of large waves or provides refuge from waves, is a habitat requirement for beaver colony sites on large lakes.

3.0 American Beaver Population and Distribution

3.1 Population

3.1.1 Historic

Information for this section is unavailable.

3.1.2 Current

Information for this section is unavailable.

3.2 Captive Breeding Programs, Transplants, Introductions

3.2.1 Historic

Information for this section is unavailable.

3.2.2 Current

Information for this section is unavailable.

3.3 Distribution

3.3.1 Historic

Information for this section is unavailable.

3.3.2 Current

The beaver is found throughout most of North America except in the Arctic tundra, peninsular Florida, and the Southwestern deserts (Figure 1) (Allen 1983; VanGelden 1982; Zeveloff 1988).

Figure 1. Geographic distribution of American beaver (Linzey and Brecht 2002).

4.0 American Beaver Status and Abundance Trends

4.1 Status

Information for this section is unavailable.

4.2 Trends

Information for this section is unavailable.

5.0 Factors Affecting American Beaver Populations and Ecological Processes

Information for this section is unavailable.

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Yellow-breasted Chat
(*Icteria virens*)

1.0 Yellow-breasted Chat Life History and Habitat Requirements

1.1 Life History

1.1.1 Diet

Information for this section is unavailable.

1.1.2 Reproduction

In southern British Columbia, most clutches are initiated from mid-May to late June (mainly early to mid-June) (Cannings *et al.* 1987). Nests with eggs occur primarily in June in Ontario, late May to mid-July in New York (Bull 1974). Some clutches are produced before May 15 in Ohio (Peterjohn and Rice 1991). Clutch size is usually 3-5. Incubation, by the female, lasts 11-15 days. Young are tended by both parents, leave nest at 8-11 days (generally by mid-July in southern British Columbia and Alberta, as early as late June in Ontario and New York, as early as early June in Ohio). Sexually mature in one year. In southern Indiana, nests begun in late June and July were more successful than were nests begun earlier; nearly all nest failures were attributed to predators (Thompson and Nolan 1973).

1.1.3 Nesting

Yellow-breasted chats nest in bushes, brier tangles, vines, and low trees, generally in dense vegetation less than 6.6 feet above ground.

1.1.4 Migration

Information for this section is unavailable.

1.1.5 Mortality

Information for this section is unavailable.

1.2 Habitat Requirements

1.2.1 Breeding

Yellow-breasted chats are found in second growth, shrubby old pastures, thickets, bushy areas, scrub, woodland undergrowth, and fence rows, including low wet places near streams, pond edges, or swamps; thickets with few tall trees; early successional stages of forest regeneration; commonly in sites close to human habitation.

1.2.2 Non-breeding

In winter, establishes territories in young second-growth forest and scrub (Dennis 1958; Thompson and Nolan 1973; Morse 1989).

2.0 Yellow-breasted Chat Population and Distribution

2.1 Population

2.1.1 Historic

Information for this section is unavailable.

2.1.2 Current

See Trends, below.

2.2 Distribution

2.2.1 Historic

Information for this section is unavailable.

2.2.2 Current

2.2.2.1 Breeding

Yellow-breasted chat breeding range includes southern British Columbia across southern Canada and the northern U.S. to southern Ontario and central New York, south to southern Baja California, to Sinaloa on Pacific slope, to Zacatecas in interior over plateau, to southern Tamaulipas on Atlantic slope, and to Gulf Coast and northern Florida (AOU 1998).

2.2.2.2 Non-breeding

Yellow-breasted chat non-breeding range includes southern Baja California, southern Sinaloa, southern Texas, southern Louisiana, and southern Florida south (rarely north to Oregon, Great Lakes, New York, and New England) to western Panama (AOU 1998).

3.0 Yellow-breasted Chat Status and Abundance Trends

3.1 Status

Information for this section is unavailable.

3.2 Trends

North American Breeding Bird Survey (BBS) data indicate a significant population decline in eastern North America, 1966-1988; and a significant increase in western North America, 1978-1988 (Sauer and Droege 1992); in North America overall, from 1966-1989, there was a nonsignificant decline averaging 0.8% per year from 1966-1989 (Droege and Sauer 1990), a nonsignificant 9% decline from 1966 to 1993, and a barely significant increase of 8% from 1984 to 1993 (Price *et al.* 1995). Yellow-breasted chats may have declined in south-central and southeastern New York between the early 1900s and mid-1980s (Eaton, in Andrle and Carroll 1988). Numbers have steadily declined in some areas of Ohio, though the range has not changed much since the 1930s (Peterjohn and Rice 1991). Yellow-breasted chat has declined in Indiana and Illinois since the mid-1960s. Yellow-breasted chat has declined along the lower Colorado River with loss of native habitat (Hunter *et al.* 1988). Canada: thought to be slowly declining due to habitat destruction in British Columbia; populations in Alberta and Saskatchewan apear to be stable; population has declined at Point Pelee National Park in Ontario, which contains a considerable proportion of the province's small population; no longer breeds at Rondeau Provincial Park (Ontario); population on Pelee Island (Ontario) appears to be stable (Cadman and Page 1994). Washington trends are illustrated in Figure 1. Yellow-breasted chat breeding season abundance (from BBS data) is illustrated in Figure 2 and winter season abundance (from CBC data) is illustrated in Figure 3.

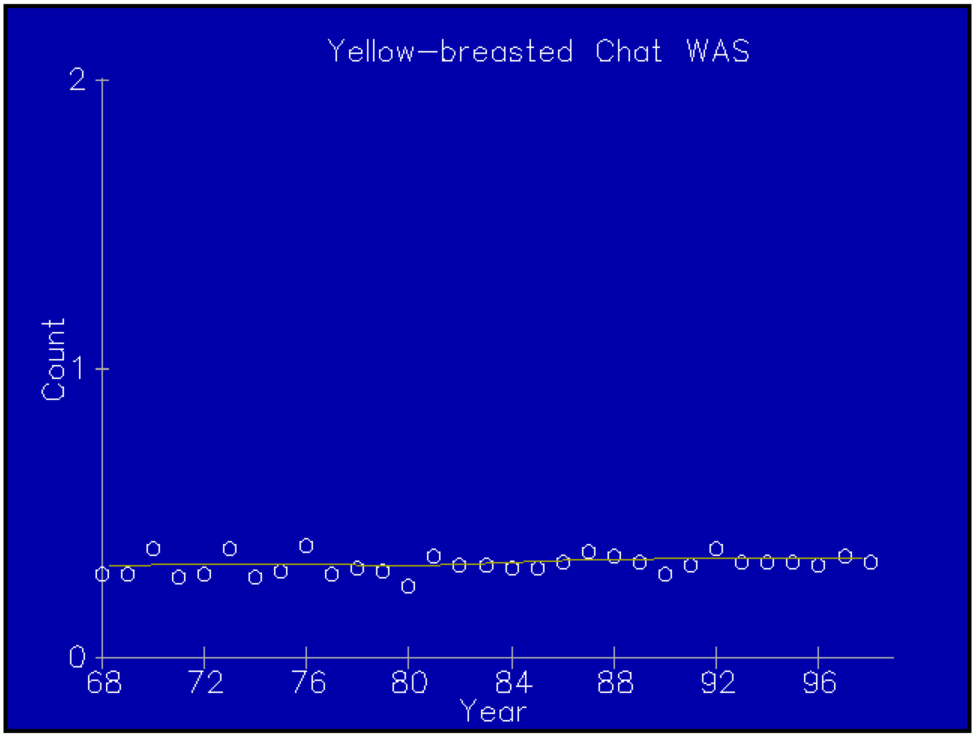

Figure 1. Yellow-breasted chat population trend data (Sauer *et al.* 2003).

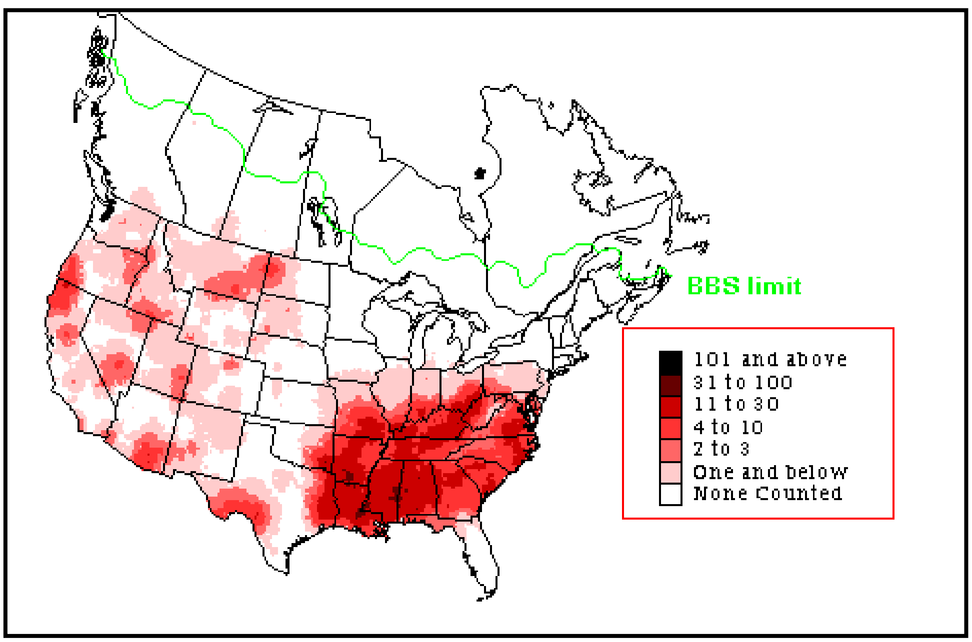

Figure 2. Yellow-breasted chat breeding season abundance (Sauer *et al.* 2003).

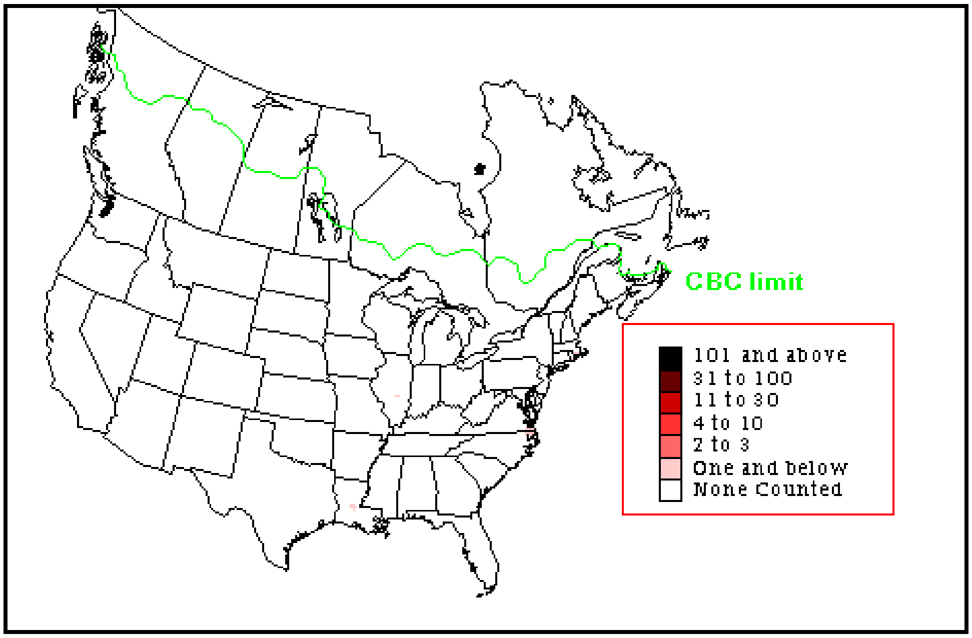

Figure 3. Yellow-breasted chat winter season abundance.

4.0 Factors Affecting Yellow-breasted Chat Populations and Ecological Processes

Threats include habitat loss due to successional changes and clearing of land for agricultural or residential development. Frequently parasitized by the brown-headed cowbird (*Molothrus ater*), but whether this has a significant impact on reproductive success is not well known.

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Lewis' Woodpecker
(*Melanerpes lewis*)

1.0 Introduction

The Lewis' woodpecker (*Melanerpes lewis*) in habits open forest stands and feeds primarily on insects from spring to fall and on mast crops during the winter (Bock 1970). It occurs regularly in western North America "... from eastern Colorado west to the Pacific, and from British Columbia to northernmost Mexico" (Bock 1970:80). The species may be a year-round resident in suitable habitats (Bock *et al.* 1971).

2.0 Lewis' Woodpecker Life History and Habitat Requirements

2.1 Life History

2.1.1 Diet

The most common foraging method during the breeding season is flycatching, which requires open scanning perches such as stumps, trees, or fence posts. Other commonly used foraging methods include foraging on the ground or shrubs, and gleaning. Lewis' woodpeckers also feed heavily on fruits and berries during late summer and fall. The winter diet of the Lewis' woodpecker consists primarily of available acorn mast or corn. Mast is stored in caches and is occasionally used early in the breeding season. It is assumed that potential mast production (and winter food suitability) in the shrub stratum increases with increased canopy cover of mast-producing shrubs.

Lewis' woodpeckers require mast storage sites in the form of trees or utility poles with desiccation cracks. It is assumed in this model that mast sources within 0.5 miles of potential storage sites will be optimally available. Mast sources located more than 1 mile from storage sites are considered unavailable to Lewis' woodpeckers.

2.1.2 Reproduction

Clutches usually include six or seven eggs. Males incubate eggs and brood young at night; both sexes do so during daylight. Multiple Lewis' woodpecker pairs sometimes nest in very close proximity to each other—even in the same tree. In a single case, five adult Lewis' woodpeckers have been observed at a single nest, with most of them feeding young. This case suggests the possibility that the species may engage in cooperative breeding, a behavior well documented among acorn woodpeckers but very rare among birds in general.

2.1.3 Nesting

Information for this section is unavailable.

2.1.4 Migration

The Lewis' woodpecker is highly migratory often flocking in large groups in search of more plentiful sources of food.

2.1.5 Mortality

Information for this section is unavailable.

2.2 Habitat Requirements

2.2.1 Cover

Habitats used by Lewis' woodpeckers are characterized by their openness (Bock 1970). Open forests allow sufficient visibility and movement for the Lewis' woodpecker to flycatch effectively and also allow the development of a shrubby understory that supports terrestrial insects. Vertical interspersion of vegetative strata is important in evergreen forests and in burns in meeting habitat requirements for breeding and, to a lesser degree, for winter habitat. Although logged or burned habitats may provide suitable habitat for 10 to 30 years following the disturbance, the habitat will be unsuitable if it does not contain a shrub stratum (as a result, for example, of overgrazing or intensive forest management). However, the presence of a shrubby understory is apparently of less importance in riparian groves, farmstead fence rows, and oak woodlands. Although the reasons for such a difference in the importance of shrubs is unclear, it may be due to different feeding strategies in coniferous and burned habitats compared to riparian and oak habitats.

2.2.2 Reproduction

The Lewis' woodpecker is restricted, as a breeding species, to areas below the upper montane life zone. Park-like ponderosa pine (*Pinus ponderosa*) stands provide the major breeding habitat of the Lewis; woodpecker throughout its range (Bock 1970). The combination of an open canopy, a brushy understory, and an abundance of insects describes breeding habitat for the Lewis’ woodpecker in ponderosa pine forests. Logged or burned coniferous forests that are structurally similar to park-like pine stands also provide suitable breeding habitat. At lower elevations, breeding habitat is provided by riparian cottonwood groves, fence rows in agricultural areas, and oak woodlands. Suitalbe conditions for breeding in these habitats are provided by the same structural features important in ponderosa pine forests, except that shrub cover is apparently not a critical habitat feature. Areas dominated by agricultural lands may be used by Lewis’ woodpeckers if sufficient nest trees are available in fence rows, along roads, or around buildings (Bock *et al.* 1971). Pinyon-juniper (*Pinus juniperus* spp.) woodlands are infrequently occupied, possible because such woodlands typically occur on dry sites that may not support sufficient insect prey (Bock 1970).

Lewis’ woodpeckers are cavity nesters but are not well suited for excavating their own cavities except in dead or dying trees (Bock 1970). The height of nest cavities summarized by Bock (1970) ranged from 5 to 170 feet, although Thomas *et al.* (1979a) considered the minimum snag height to be 30 feet. Suitable snags have a minimum diameter at breast height (DBH) of 12 inches (Thomas *et al.* 1979a). An average density of one suitable snag per acre is required to support maximum breeding densities of Lewis’ woodpeckers in the Blue Mountains of Washington and Oregon (Thomas *et al.* 1979a). The proportion of the maximum population that can be supported is considered to be positively correlated with snag density; for example, in otherwise equal habitat, an area with an average density of only 0.5 snags/acre will support only 50 percent of the maximum breeding population.

It is assumed that canopy conditions will be optimal if tree canopy closure is less than 30 percent and will be unsuitable if canopy closure exceeds 75 percent. Optimal understory conditions are assumed to exist if shrub crown cover exceeds 50 percent. Both understory and canopy conditions ust be optimal in order to have optimal conditions in ponderosa pine stands. If tree canopy closure exceeds 75 percent or if no shrubs occur in the understory, then it is assumed that the habitat will not be useable by the Lewis’ woodpecker. The same habitat features may be used to describe foraging habitat during the breeding season in deciduous cover types, although a dense shrub stratum is apparently unnecessary. In deciduous cover types, the presence of shrubs is considered to add to the food value, but will not be limiting to food suitability.

Cavity nesters generally face a shortage of nesting sites where trees occur in clumps (Jackman 1975). In areas of high demand for sites, Lewis’ woodpeckers may nest within a short distance of each other. Currier (1928) reported three holes that were occupied by Lewis’ woodpeckers in each of two trees less than 0.25 miles apart. Managed forests generally have fewer available nesting sites than do natural forests, because snags and diseased and damaged trees are usually removed (Jackman 1975). Lewis' woodpeckers exhibit a strong pair bond and high nest fidelity, returning to nest in the same cavity in consecutive years (Bock 1970).

3.0 Lewis' Woodpecker Population and Distribution

3.1 Population

3.1.1 Historic

Information for this section is unavailable.

3.1.2 Current

See trend data, below.

3.2 Distribution

3.2.1 Historic

Information for this section is unavailable.

3.2.2 Current

Lewis' woodpeckers are found throughout the Columbia Basin as far north as Revelstoke and Golden.British Columbia: The Lewis' woodpecker breeds in the southern interior from the Similkameen Valley east to the East Kootenay Trench and north to Revelstoke and near Williams Lake. The core breeding range is in the Okanagan Valley and Thompson Basin. Occasionally, small numbers breed beyond the normal limits of its range. Formerly bred in southeastern Vancouver Island and the lower Fraser Valley (Cannings *et al.* In prep.).

Lewis' woodpecker breeds in North America from interior British Columbia and southwestern Alberta south to Arizona and New Mexico, and from coastal California east to Colorado. Virtually the entire Canadian population occurs in British Columbia. The birds winter from interior British Columbia (casually) south through the western states to northern Mexico, but mainly in the southwestern United States (Cannings *et al.* in prep.).

4.0 Lewis' Woodpecker Status and Abundance Trends

4.1 Status

The Lewis' woodpecker has been included in the Audobon Society's Blue List since 1975 (Tate 1981). The list is intended as an early warning list of species exhibiting noncyclical population declines or range contractions. Competition for nest sites from starlings (*Sturnus vulgaris*) may be a possible cause of the decline. However, evidence also exists that the Lewis' woodpecker has expanded its range into plains habitat in response to maturation of cottonwoods around rural residences and the availability of a mast source in the form of irrigated corn (Hadow 1973). The Lewis' woodpecker is considered a potential sensitive environmental indicator in forest communities dominated by ponderosa pine (Diem and Zeveloff 1980).

4.2 Trends

According to the ICBEMP terrestrial vertebrate habitat analyses, historical source habitats for Lewis' woodpecker occurred in most watersheds of the three ERUs within our planning unit (Wisdom *et al.* in press). Within this core of historical habitat, declines in source habitats has been strongly reduced from historical levels, including 97 percent in the Columbia Plateau and 95 percent in the Owyhee Uplands. Within the entire Interior Columbia Basin, overall decline in source habitats for this species was the greatest among 91 species of vertebrates analyzed (Wisdom *et al.* in press).

Lewis' woodpecker populations tend to be scattered and irregular and are considered rare, uncommon, or irregularly common throughout their range; local abundance may be cyclical or irregular (Tobalske 1997). In the past century, populations have apparently declined in British Columbia by more than 50 percent and decreased in Oregon, California, and Utah (DeSante and George 1994). Based on North American Breeding Bird Survey (BBS) data, numbers may have declined more than 60 percent overall between the 1960s and mid-1990s (Tobalske 1997). BBS data indicate a significant decline in the United States for the period 1966-1996 (-3.3 percent average annual decrease; P = 0.01; N = 62 survey routes) and nonsignificant declining trend between 1980 and 1996 (-1.7 percent; P = 0.22; N = 53). Thirty-year trends were negative but not statistically significant survey-wide and for the Western BBS Region and California; likewise trends were positive but not statistically significant for these analysis areas from 1980 to 1996. Mapped trends for 1966-1996 show steep declines throughout the range. Overall, however, BBS sample sizes are relatively low for robust trend analysis (Sauer *et al.* 1997). Declines have occurred in coastal areas of British Columbia and Washington. Lewis' woodpecker trend data for Washington are illustrated in Figure 1.

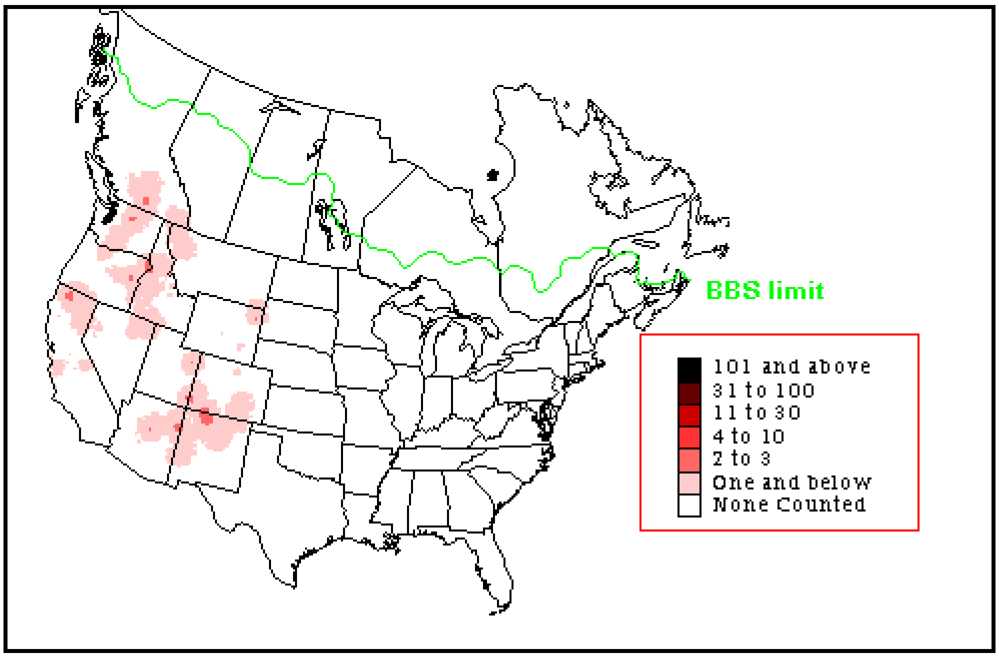

Figure 1. Lewis' woodpecker breeding season abundance (from BBS data) (Sauer *et al.* 1997).

Christmas Bird Count (CBC) data show nonsignificant declining trends survey-wide and in California, Colorado, and Oregon, and a nonsignificant increase in Arizona, for the period form 1959 to 1988 (Figure 2) (Sauer *et al.* 1996). Ehrlich *et al.* (1992) suggest that populations appear to have stabilized recently, but those in riparian habitats in arid regions continue to be vulnerable to drought, overgrazing, and other habitat degradations.

5.0 Factors Affecting Lewis' Woodpecker Populations and Ecological Processes

Although preferred habitat types for breeding and wintering remain structurally similar from year to year, the presence of Lewis' woodpeckers in any given preferred habitat depends heavily on the food supply, either insects or mast (Bock 1970). Because the habitat needs of Lewis' woodpeckers are more specialized in winter than during the breeding season, destruction of winter range represents a greater potential threat to the species than loss of breeding habitat (Bock, pers. comm.)

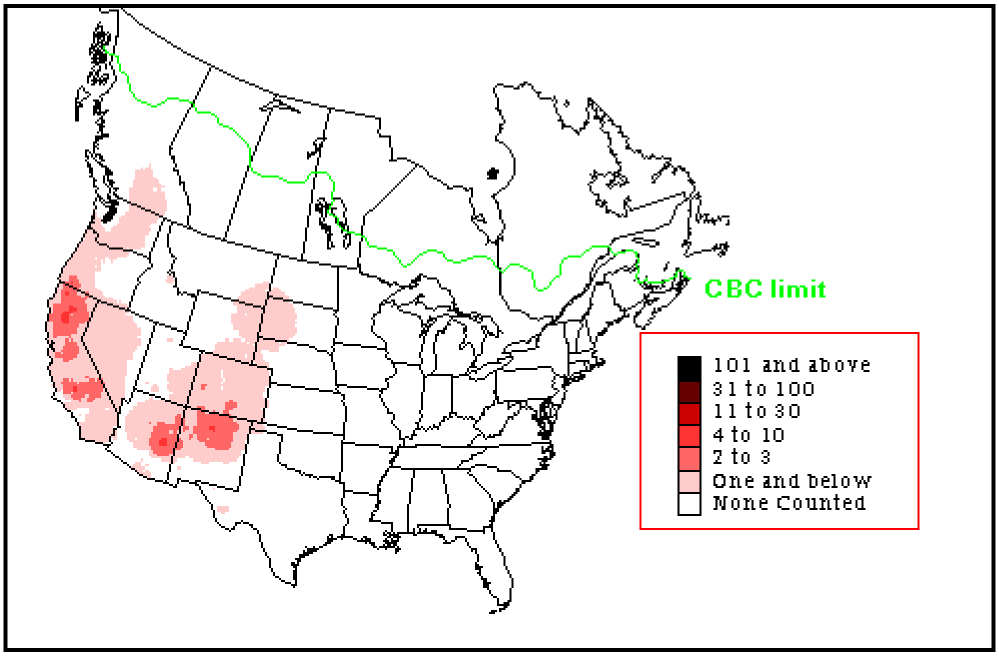

Figure 2. Winter season abundance (Sauer *et al.* 1996).

Lewis' woodpecker habitat may be adversely affected by grazing, it it eliminates brushy undergrowth (Jackman 1975). Forest management practices that provide snags, a brushy understory, and slash provide suitable Lewis' woodpecker habitat.

Lewis' woodpecker is vulnerable to processes that result in loss of large snags (nesting sites) or degradation of foraging habitat. Such habitat alteration evidently is the reason for the declines that have occurred in coastal areas of British Columbia and Washington. Drought and overgrazing pose continued threats to riparian habitats in arid regions (Ehrlich *et al.* 1992). Fire suppression encourages the replacement of ponderosa pine forests by Douglas-fir, and leads to denser, closed-canopy forest stands. Lewis' woodpeckers will decline with fire suppression in ponderosa pine/Douglas fir stands compared to regular fire intervals of 10-30 years (Saab and Dudley 1998). Lewis' woodpeckers may be most sensitive to destruction of specialized winter habitat (Sousa 1983). Sousa (1983) also suggested that European starlings (*Sturnus vulgaris*) may usurp nesting habitat. Lewis' woodpecker does not appear to be sensitive to direct human disturbance (USDA Forest Service 1994).

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Willow Flycatcher
(*Empidonax traillii)*

1.0 Willow Flycatcher Life History and Habitat Requirements

1.1 Life History

1.1.1 Diet

Willow flycatchers feed primarily on insects but occasionally eat fruit. Flycatchers are aerial foragers exhibiting both hawking and hover-gleaning hunting strategies (Sedgewick 2000). Hawking is the capture of a flying insect, hover-gleaning is the capture of an insect sitting on a leaf, branch etc. Foraging flights are nearly horizontal from perches 1-3 m in height primarily in openings away from trees and bushes. Most foraging flights are short, <1-3m from original perch to point of prey capture (Frakes and Johnson 1982).

1.1.2 Reproduction

Willow flycatchers are capable of breeding the first spring after hatch. In Washington, 93% (63 of 68) eggs hatched, and 45% (21 of 47) of hatchlings fledged (King 1955). In southeastern Oregon approximately 65% of pairs (n=875) produce more than one fledgling. Willow flycatchers form monogamous pair bonds soon after arriving on their breeding territory. Adult birds display relatively high fidelity to breeding territories as about half of males and females return to the same general area between years. Additionally, birds often pair with the same partner between years; in southeastern Oregon, 27% of all pairings were with the same mates.

1.1.3 Nesting

Females select the nest site and build the nest, usually low in a shrub or small tree 2.9-4.9 feet (.9-1.5 m.) above the ground. Females typically lay one clutch a season, usually of 4 eggs. Although birds may renest if they lose eggs during incubation only one brood is raised per year (Sedgwick 2000). Nest parasitism by brown-headed cowbirds can be a major factor affecting seasonal productivity in some areas (Sedgwick and Knopf 1988; Sedgwick and Iko 1999; Sedgwick 2000). One study of willow flycatchers (n=882 pairs) in southeastern Oregon concluded that parasitized pairs had lower nest success, fewer eggs survived to hatching, lost more eggs and hatchlings, and reared fewer young than non-parasitized pairs (Sedgwick 2000).

Clutches are incubated for approximately 14 days, incubation and brooding is mostly by the female. Chicks are altricial and dependent on the parents for food and care. Although both parents provide food for the chicks most provisioning is done by the female. Chicks fledge at 14-15 days of age and remain close to the nest while parents continue to provide food. In southeastern Oregon fledglings remain on their natal territory for approximately 14 days before dispersing (Sedgwick 2000).

1.1.4 Mortality

Based on data from Oregon, mean life span (not accounting for dispersal) of males was approximately 1 year, females 0.9 year (Sedgwick 2000). Predation and brood parasitism are the two major factors responsible loss of young. Little information regarding predation levels but nest predators include a wide range of mammalian and avian species (Sedgwick 2000). In southeastern Oregon, parasitism of willow flycatchers nests averaged 23% over 10 years (range 11-41 percent) (Sedgwick and Iko 1999).

2.0 Habitat Requirements

2.1 General

Willow flycatchers are restricted to riparian habitats with dense patches of shrubs interspersed with openings (Altman and Holmes 2000). In southeastern Oregon birds were most abundant in riparian habitats where the willow vegetation measured >5,000 m^3/ha and less abundant in areas where willow was <1,187m^3/ha (Sanders and Edge 1998 in Altman and Holmes 2000). The following habitat features of riparian areas in the Columbia Plateau are recommended: patch size >10m^2 of dense native shrubs interspersed with openings of herbaceous vegetation; 40-80% shrub layer cover; shrub layer height > 1m high; tree cover <30% (Altman and Holmes 2000). Suitable habitat patches should be >8 ha within a matrix of habitat where < 10% is agricultural land that is subject to moderate-heavy grazing as such areas support higher brown-headed cowbird densities

2.2 Breeding

Nests are usually constructed in dense shrubs, out from the main stem and low to the ground (between 0.5 and 1.0 m above ground) (Sedgwick 2000). One study in eastern Washington (near Pullman) found birds nesting in ninebark (*Physocarpus malvaceous*) brush habitat, willow (*Salix sp*.), hawthorn (*Crataegus douglasii*), and chokecherry (*Prunus virginiana*) also were present (Frakes and Johnson 1982). In southeastern Washington nests have been located in rose (*Rosa sp.*), hawthorn, cow parsnip, and chokecherry (Sedgwick 2000).

3.0 Willow Flycatcher Population and Distribution

3.1 Population

3.1.1 Historic

Information for this section is unavailable.

3.1.2 Current

Information for this section is unavailable.

3.2 Distribution

3.2.1 Historic

Information for this section is unavailable.

3.2.2 Current

3.2.2.1 Washington

Willow flycatchers are common on the west side of the state in wetlands, shrubby areas, and clearcuts. In the central Columbia Basin willow flycatchers are rare primarily because of hotter, drier conditions than what is typically found west of the Cascade. Shrubsteppe habitats are generally considered peripheral breeding range but birds may be found in areas of low density development, forest patches, and wetlands (Smith *et al.* 1997). Breeding Bird Survey (BBS) data for Washington show a significant population decrease from 1966-1996 (Sauer *et al.* 2003).

3.2.2.2 Douglas County

Willow flycatchers are rare to uncommon but breeding and migrating birds have been found in suitable willow and riparian habitats. Documented areas where willow flycatchers have been sighted in the county include West Foster Creek, Central Ferry Canyon (both observations in June, M. Schroeder personal communication), McCartney Creek, Douglas Creek, and Alstown.

4.0 Willow Flycatcher Status and Abundance Trends

4.1 Status

The southwestern subspecies, *E. t. extrimus*, was listed in 1995 as endangered by the U.S. Fish and Wildlife Service (USFWS). In Washington the willow flycatcher is listed on the Audubon Society Watchlist. It is not listed by the Washington Department of Fish and Wildlife (WDFW). Breeding Bird Survey data (BBS) indicate a continent wide decline in willow flycatcher numbers between 1966 and1996. Habitat loss, degradation and overgrazing by livestock are cited as the major causes of this decline (Sedgwick 2000).

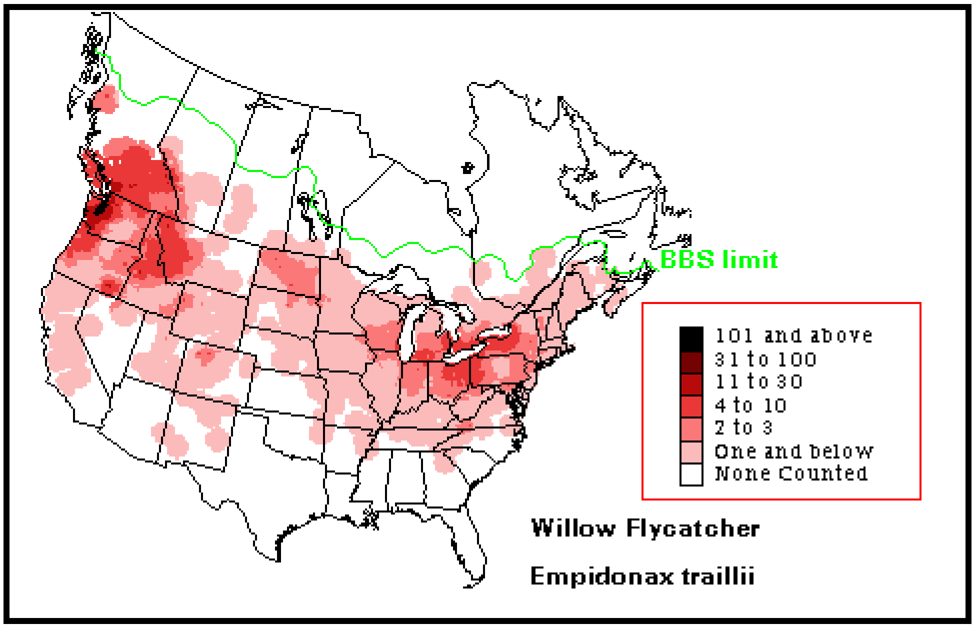

Figure 1. Willow flycatcher breeding distribution (Sauer *et al.* 2003).

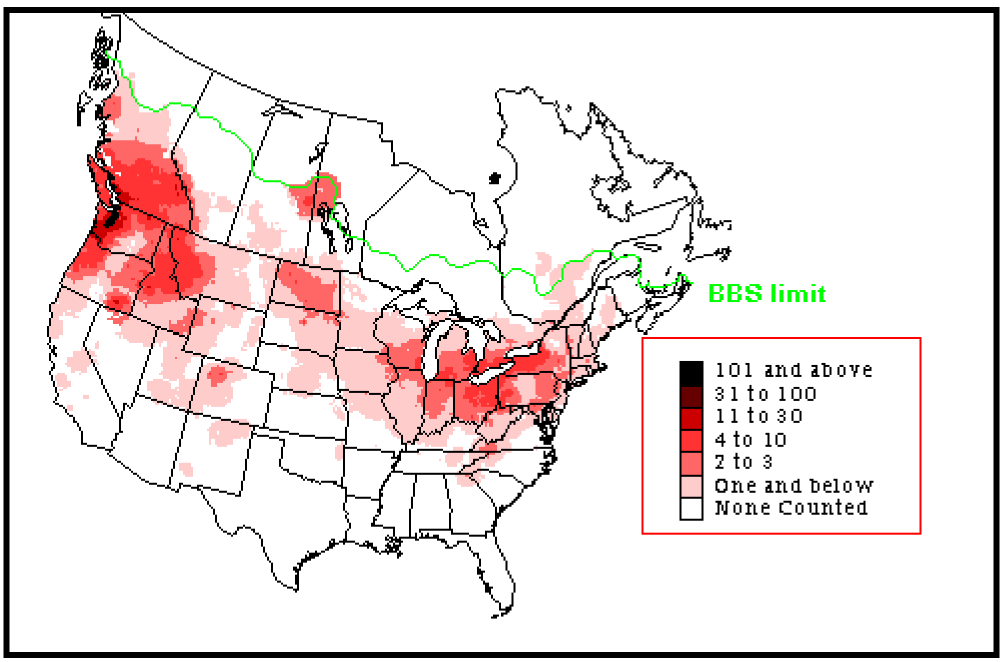

Figure 2. Willow flycatcher summer distribution (Sauer *et al.* 2003).

4.2 Trends

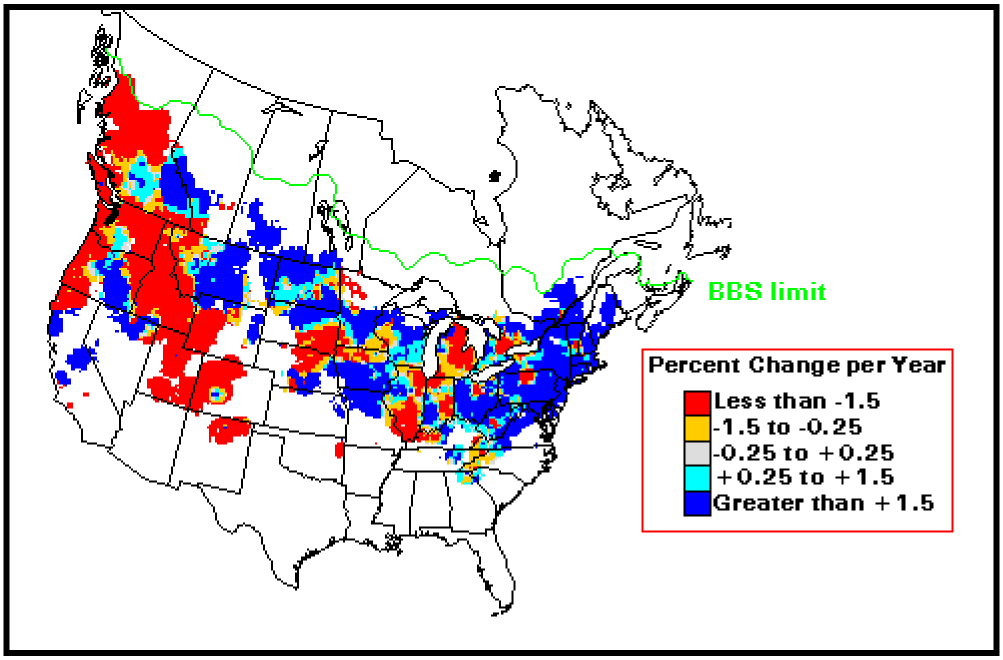

Figure 3. Willow flycatcher Breeding Bird Survey population trend: 1966-1996 (Sauer *et al.* 2003).

5.0 Factors Affecting Willow Flycatcher Populations and Ecological Processes

5.1 Habitat Loss

Flycatchers are vulnerable to a variety of human influences such as damming, dredging, channelization, urbanization, and de-watering of streams as in many cases they will not nest in the absence of flowing water (Sedgwick 2000). Channeling of riparian areas is discouraged as this reduces the riparian floodplain and the associated shrub habitat.

5.2 Grazing

Belsky *et al.* (1999:419) summarized available literature concerning the major effect of livestock grazing on riparian systems in arid rangelands in the western U.S. and concluded, "Livestock grazing was found to negatively affect water quality and seasonal quantity, steam channel morphology, hydrology, riparian zone soils, instream and streambank vegetation, and aquatic and riparian wildlife." For willow flycatchers, excessive or improper livestock grazing can reduce the recruitment of shrub vegetation in riparian areas used by willow flycatchers (Altman and Holmes 2000). Grazing results in negative impacts to willow flycatchers, including soil compaction and gullying (resulting in a drying of wet meadows), grazing of willow vegetation, and changes in vegetation height. In some cases cattle activity may disturb or trample nests constructed low in the vegetation (Sedgwick 2000).

Brood Parasitism

Willow flycatchers are particularly vulnerable to nest parasitism by brown-headed cowbirds resulting in reduced productivity, even in suitable areas. Concentration of livestock in riparian areas attracts cowbirds to these sites potentially impacting willow flycatchers (Altman and Holmes 2000). In Oregon, willow flycatchers were more abundant in rarely grazed/undisturbed willow habitats than grazed habitats. Additionally, dramatic increases in flycatcher densities followed reduction in cattle-grazing and elimination of willow cutting and spraying (Sedgwick 2000).

6.0 References

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Appendix G: Changes in Key Ecological Functions

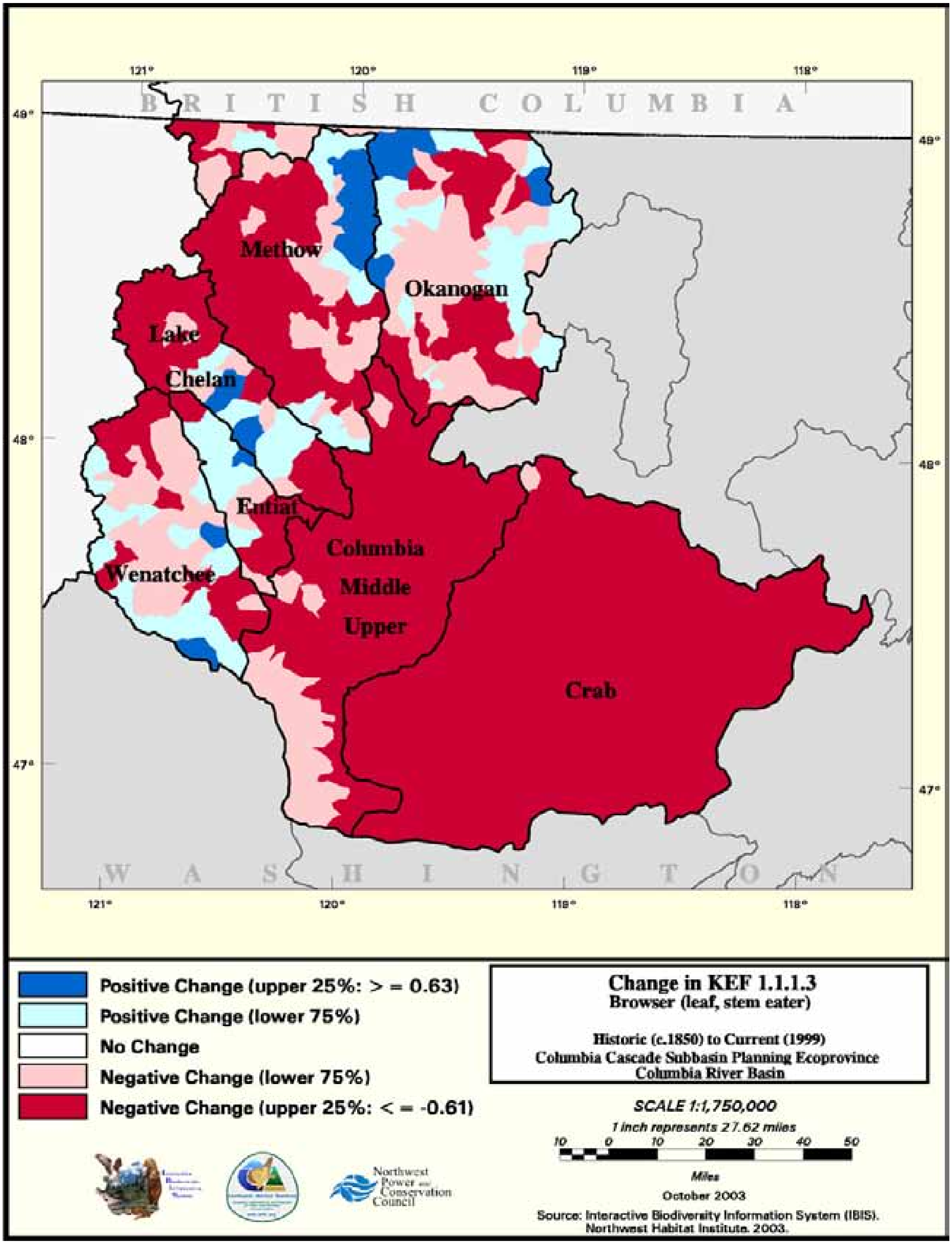

Figure G-1. Change in KEF 1.1.1.3 in the Columbia Cascade Ecoprovince, Washington (NHI 2003).

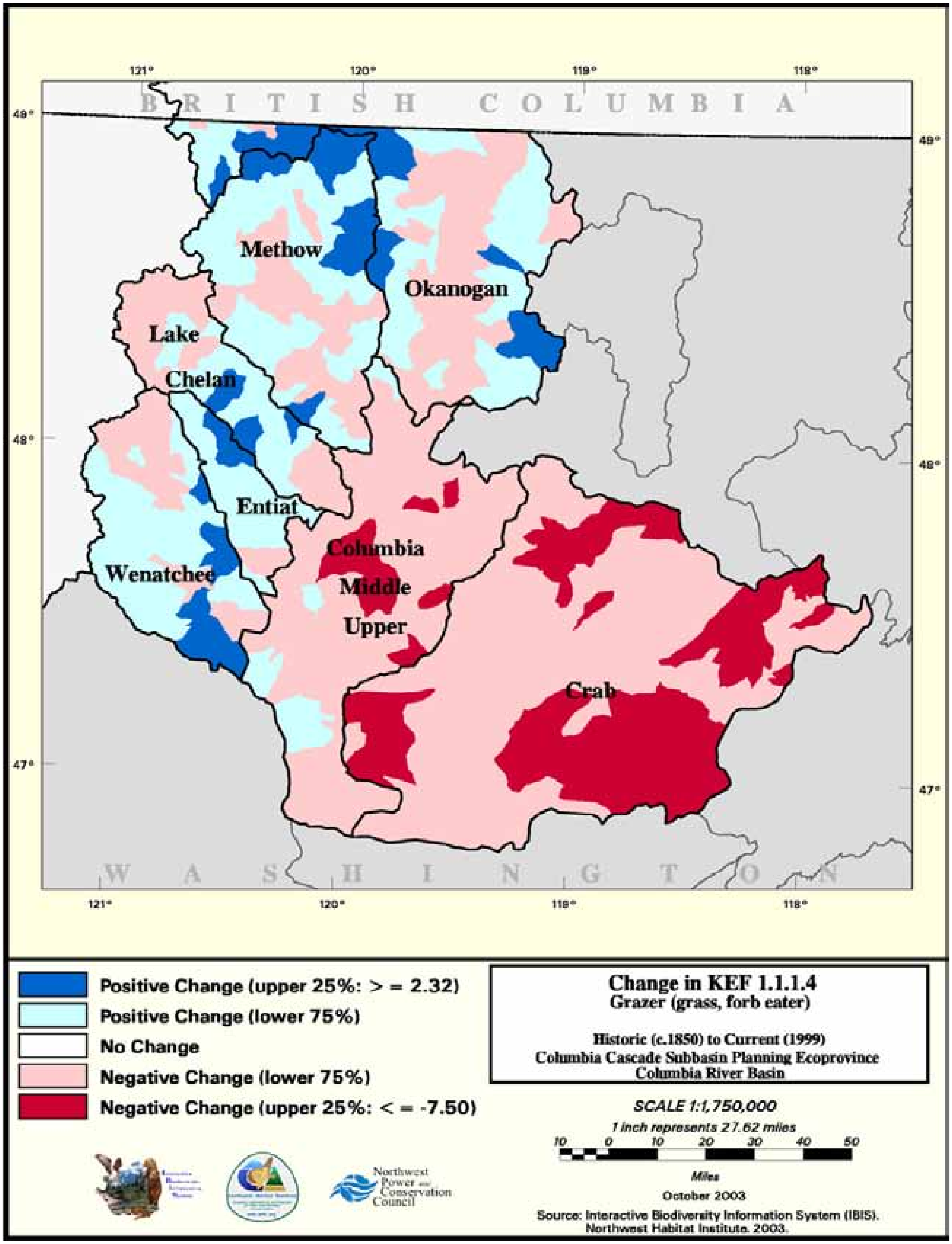

Figure G-2. Change in KEF 1.1.1.4 in the Columbia Cascade Ecoprovince, Washington (NHI 2003).

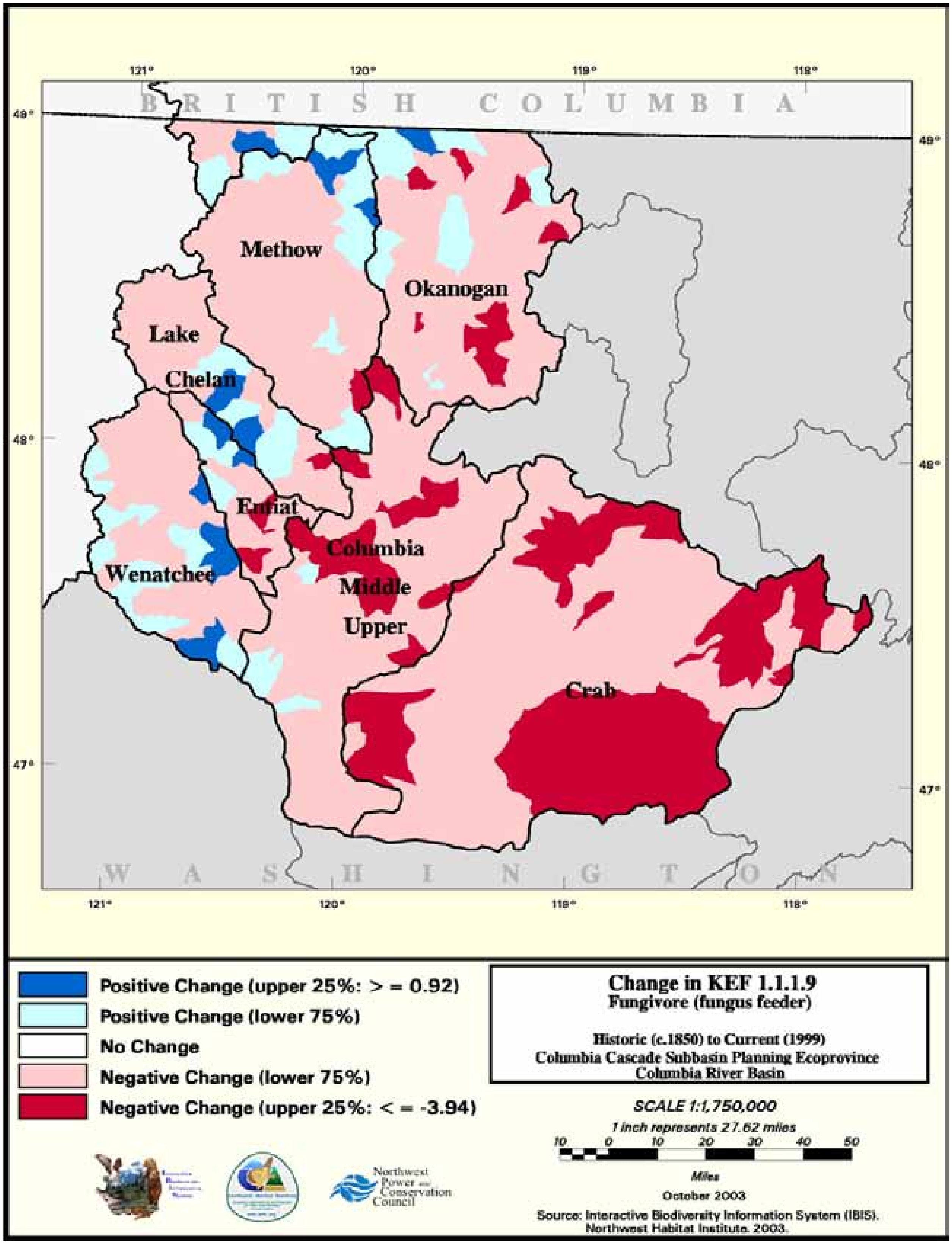

Figure G-3. Change in KEF 1.1.1.9 in the Columbia Cascade Ecoprovince, Washington (NHI 2003).

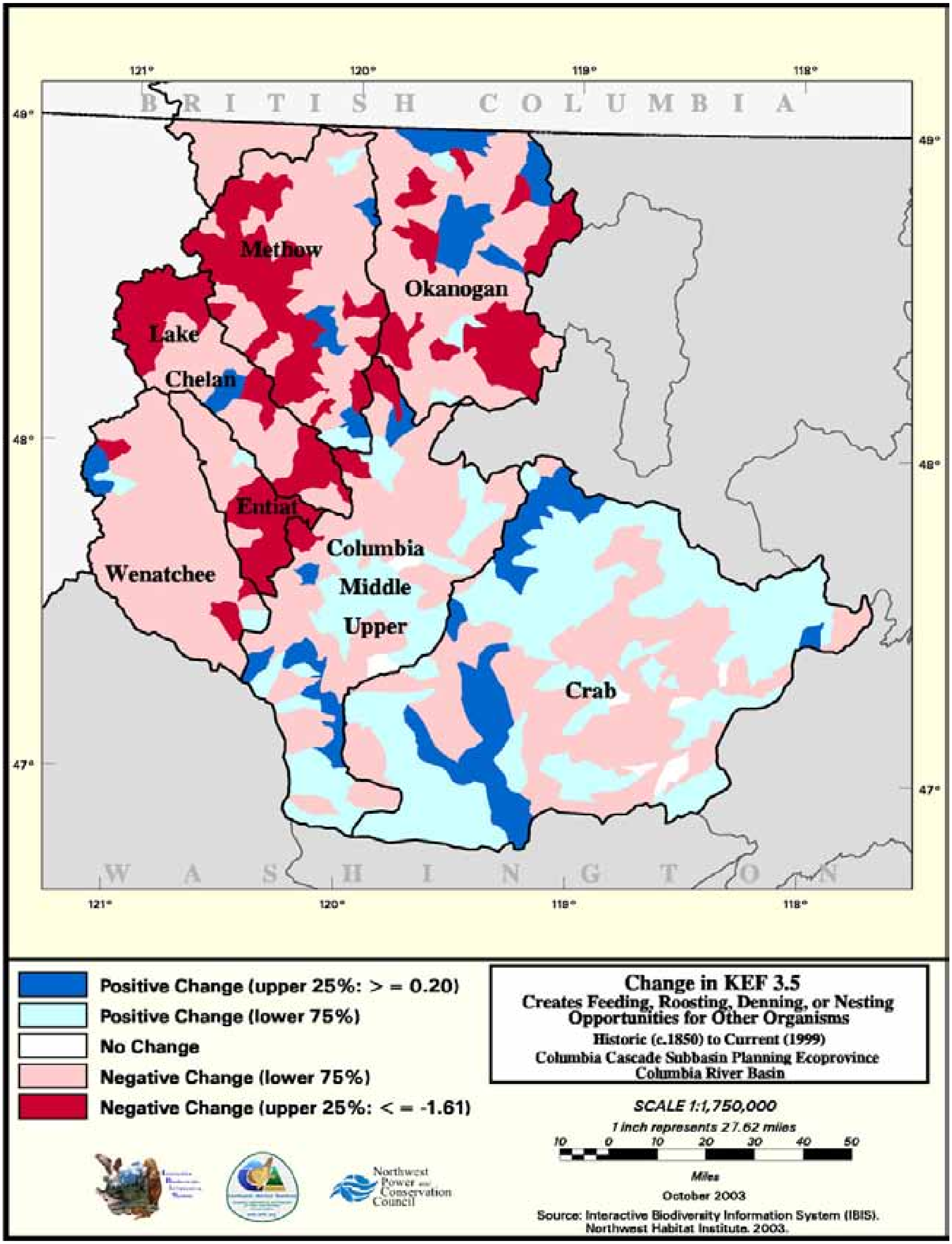

Figure G-4. Change in KEF 3.5 in the Columbia Cascade Ecoprovince, Washington (NHI 2003).

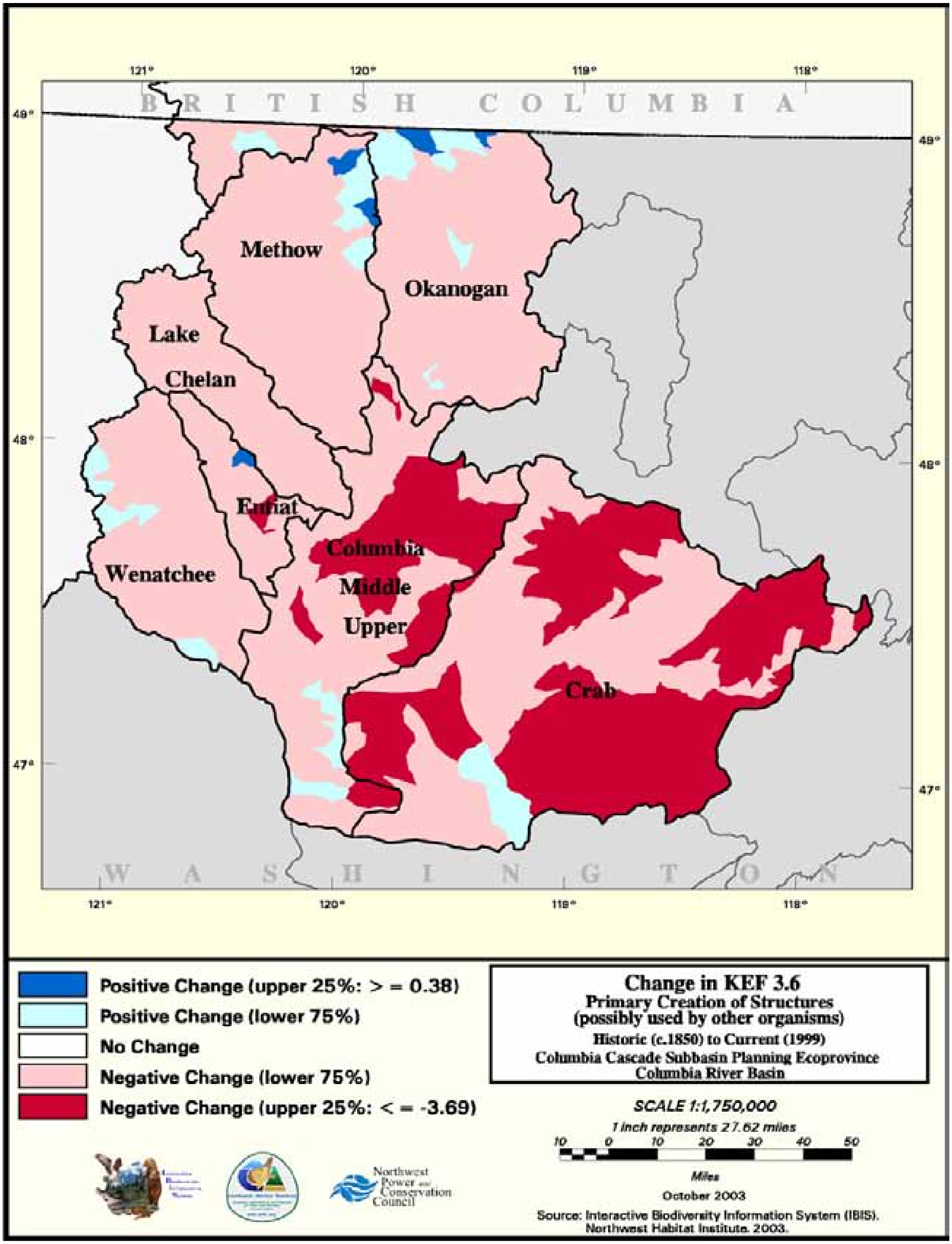

Figure G-5. Change in KEF 3.6 in the Columbia Cascade Ecoprovince, Washington (NHI 2003).

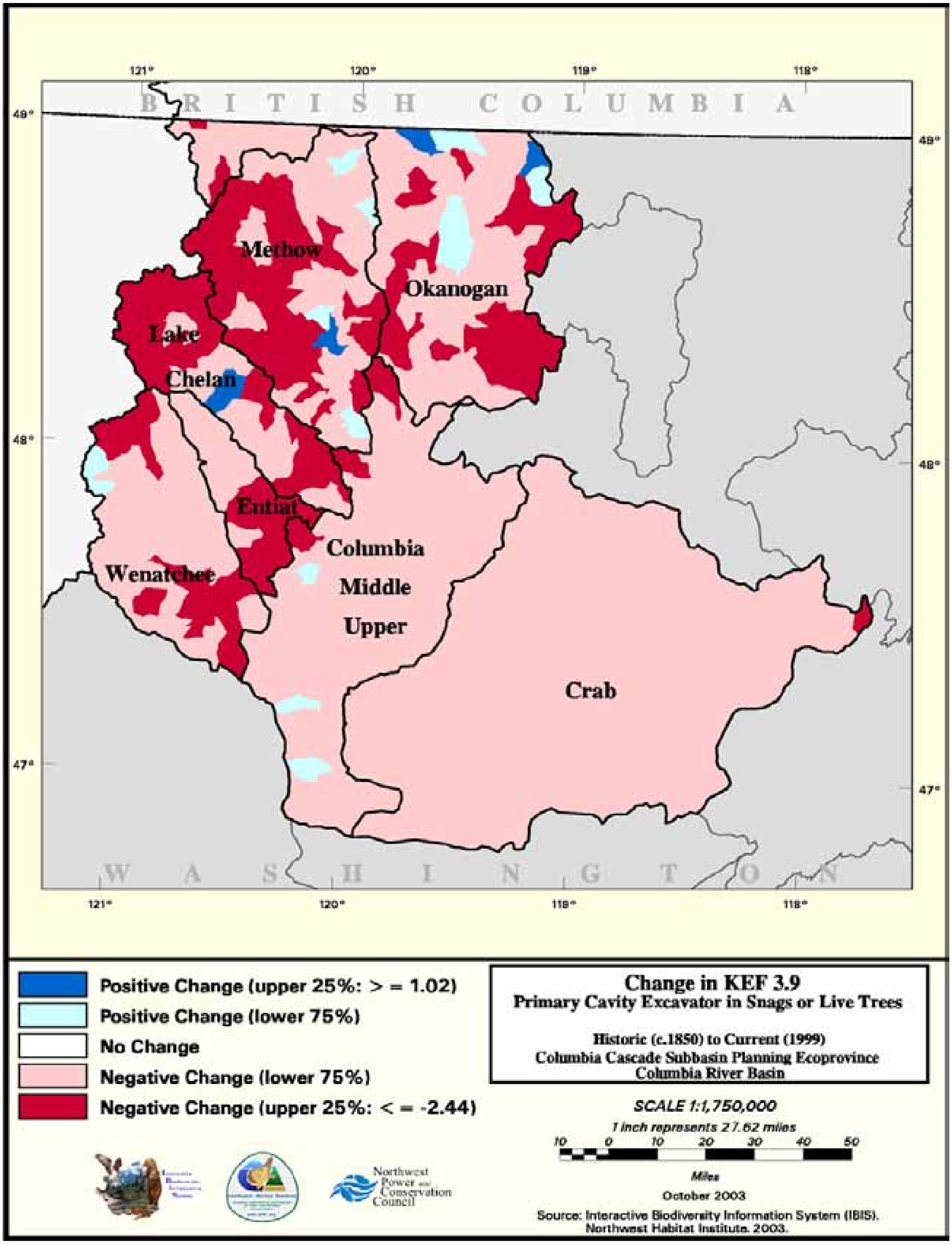

Figure G-6. Change in KEF 3.9 in the Columbia Cascade Ecoprovince, Washington (NHI 2003).

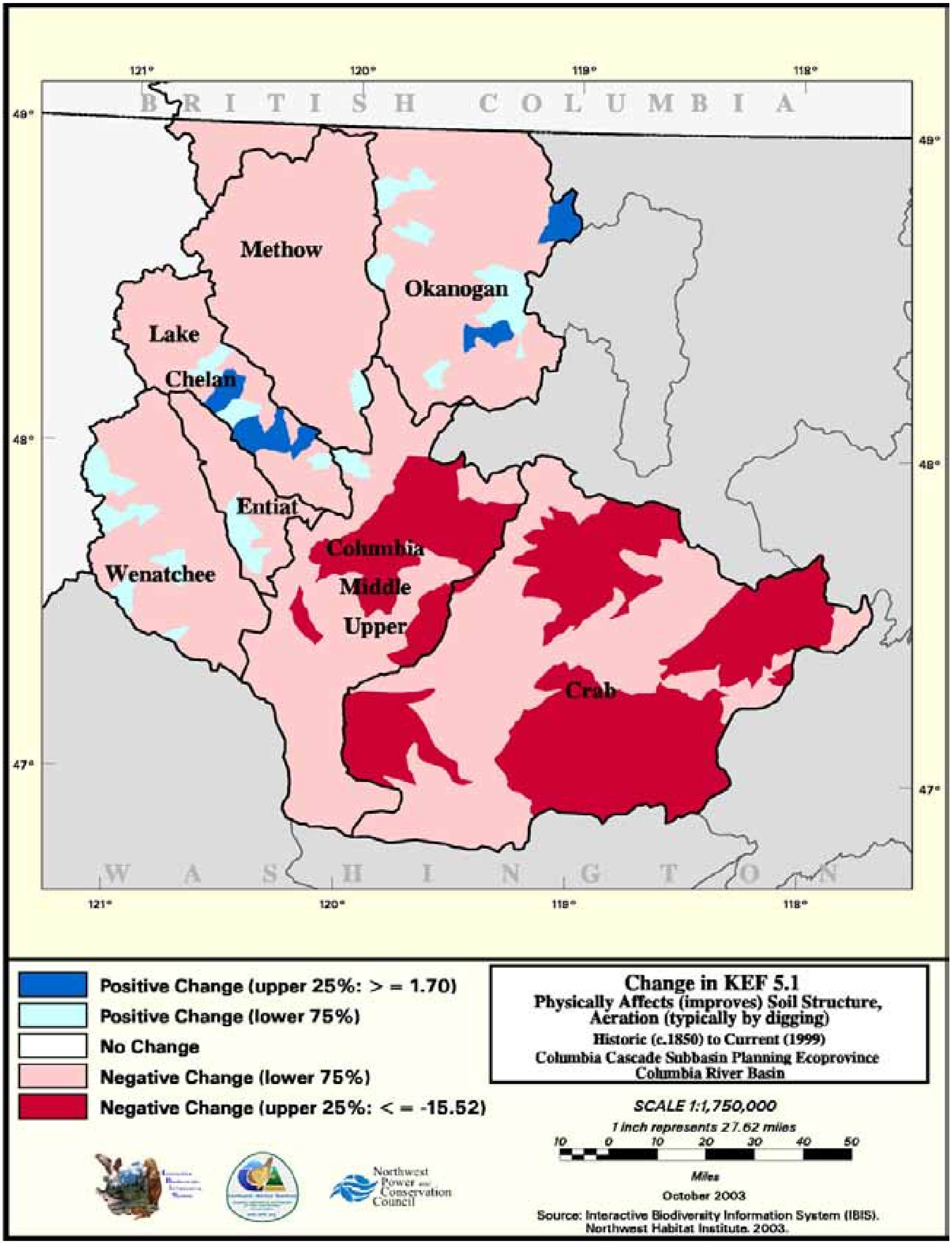

Figure G-7. Change in KEF 5.1 in the Columbia Cascade Ecoprovince, Washington (NHI 2003)