4 Assessment

4.1 Introduction

The subbasin assessment is a technical analysis to determine the biological potential of the subbasin and the opportunities for restoration. It describes the existing and historic resources, conditions and characteristics within the subbasin. The bulk of the assessment work was done by the Yakama Nation and WDFW with support and involvement of Klickitat County. Separate teams of fish and wildlife scientists developed the assessment.

Subbasin planners chose a set of focal fish and wildife species, and habitats, on which to focus their assessment. A focal species has special ecological, cultural, or legal status and is used to evaluate the health of the ecosystem and the effectiveness of management actions. Criteria used in selecting the focal species include a) designation as Federal endangered or threatened species, b) cultural significance, c) local significance and d) ecological significance, or ability to serve as indicators of environmental health for other species.

The focal habitats are montane coniferous wetlands, ponderosa pine/Oregon white oak forests and interior interior riparian wetlands. Focal wildlife species include western gray squirrel, Lewis' woodpecker, Oregon spotted frog, American beaver, yellow warbler and western pond turtle. Focal fish species include fall and spring chinook salmon, coho salmon, steelhead and resident rainbow trout.

4.2 Wildlife Assessment

Introduction

Due to the large number of wildlife species and habitats present in the subbasin biologists could not provide adequate descriptions and status reports for each. Instead, they chose to select focal habitats on which to focus assessment discussions on. For each focal habitat, a small group of focal species was chosen. In this assessment, the rationale behind the selection of the focal habitats and species is discussed, followed by a more thorough discussion of each.

4.2.1 Assessment Methodology

This section briefly describes the framework used to develop subbasin wildlife assessment for the Big White Salmon subbasin plan. Appropriate federal, state, and local wildlife/land management entities have partnered with the Yakama Nation Wildlife Department to complete the subbasin plan. The Yakama Nation Wildlife Department is the lead wildlife agency in the Big White Salmon subbasin compiling wildlife assessment, inventory, and management information for the subbasin, in cooperation with WDFW, Klickitat County and other interested parties.

The wildlife assessment was developed from a variety of “tools” including the Big White Salmon Subbasin Summary (NPPC 2001), the Interactive Biodiversity Information System (IBIS), the WDFW Priority Habitats and Species (PHS) database, the Washington State Gap Analysis Program (GAP) Analysis database, Partners in Flight (PIF) information, and input from local, state, federal, and tribal wildlife managers.

Although IBIS is a useful assessment tool, it should be noted that IBIS-generated historic habitat maps have a minimum polygon size of 1 km2 while current IBIS habitat type maps have a minimum polygon size of 100 ha or 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 microhabitats located in small patches or narrow corridors were not mapped at all. Another limitation of IBIS data is that they do not specifically rate habitat quality nor do they associate key ecological correlates (KEC) with specific areas. As a result, a given habitat type may be accurately depicted on IBIS maps, but may be lacking in functionality and quality. For example, IBIS data do not distinguish between shrub steppe habitat dominated by introduced weed species and pristine shrub steppe habitat.

Washington State GAP data was also used extensively throughout the wildlife assessment. The GAP generated acreage figures may differ from IBIS acreage 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 WDFW has created the PHS list, which is a catalog of species and habitat types that were identified as priorities for management and preservation. For many of these species and habitat types, documents have been created that include, in the case of species, habitat need and use descriptions, basic life history information, population status and trends, and in the case of both species and habitats, provide factors limiting presence and make management recommendations. Available documents were used for species and habitat write-ups as well as for the creation of key findings, limiting factors and working hypotheses to be used in the creation of a management plan.

4.2.2 Wildlife in the Big White Salmon Subbasin

Using IBIS (2003), 349 wildlife species have been identified to currently occur within the Big White Salmon subbasin. For a full list of species and breeding status in our subbasin, see Appendix C, table C.1.

Species richness for the Big White Salmon subbasin is given in table 4. Differences in species richness between subbasins can partially be explained as variation in biological potential and quality of habitats, amount / type and juxtaposition of remaining habitats, and robustness of databases used to establish the species lists.

Table 4 Species richness of the Big White Salmon subbasin, Washington (IBIS 2003).

Class	Number
Amphibians	21
Birds	222
Mammals	85
Reptiles	21
Total	349

Many of the wildlife species found in the subbasin can be listed in several different categories. These categories include: federal and state listed species, game species, Washington State Partners In Flight species, species used in the Habitat Evaluation Procedure (HEP), and species that have documented relationships with salmon. These groups were compiled by IBIS (2003) and are discussed next. These categories were some of the criteria used in choosing focal species later.

Federal and State Listed Species

Of the 349 wildlife species listed above, 45 are either federally (threatened, candidate or concern) or state (endangered, threatened, sensitive or candidate) listed. See Appendix C, table C.2.A for a full list, table C.2.B for definitions of listings.

Game Species

Of the 349 wildlife species identified in the subbasin, 53 species are listed in IBIS (2003) as being game animals. Of these, 1 is an amphibian, 30 are birds and 22 are mammals. For a detailed list of game species in the subbasin, see Appendix C, table C.3.

Washington State Partners in Flight

The goal of Partners in Flight (PIF) 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. Of the 349 wildlife species in the subbasin, there are 222 bird species. Of these, 95 are listed in Partners in Flight for our state. See Appendix C, table C.4 for a full list of species.

Habitat Evaluation Procedure

The wildlife species listed under the Habitat Evaluation Procedure (HEP) are used to assess habitat losses associated with federal hydroelectric facilities on the Lower Snake and Columbia Rivers. Of the 349 wildlife species in the subbasin, 24 are used under HEP, 18 birds and 6 mammals (IBIS 2003). See Appendix C, table C.5 for a full list.

Salmonid Associations

Anadramous salmon provide a rich, seasonal food resource that directly affects the ecology of both aquatic and terrestrial consumers, and indirectly affects the entire food web that knits the water and land together. Wildlife species and salmon have likely had a very long, and co-evolutionary relationship with salmon in the Pacific Northwest. Of the 349 species in the subbasin, 74 are classified as having a routine relationship with salmon (combination of species with Strong and Consistent, Recurrent, Indirect and Rare relationships, see Appendix C, table C.6.B for definitions). See Appendix C, table C.6.A for entire list (IBIS 2003).

Priority Habitat and Species (PHS)

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.

In the subbasin there are 43 wildlife species listed on the PHS list for Washington State. Internet access to the PHS List is available via the World Wide Web at:

http://www.wa.gov/wdfw/hab/phslist.htm.

4.2.3 Wildlife Habitats and Habitat Features in the Big White Salmon Subbasin

Wildlife Habitats

The Big White Salmon subbasin consists of eleven wildlife habitat types as identified by IBIS (2003). These are briefly described in Table 5. Historic and current wildlife habitat distribution is illustrated in figure 2 and figure 3.

Table 5 Wildlife habitat types within the Big White Salmon subbsasin, Washington (IBIS 2003).

Habitat Type	Brief Description
Agriculture, Pastures, and Mixed Environs	Cropland, orchards, vineyards, nurseries, pastures, and grasslands modified by heavy grazing; associated structures.
Alpine Grasslands and Shrublands	Grassland, dwarf-shrubland, or forb dominated, occasionally with patches of dwarfed trees.
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.
Mesic Lowlands Conifer-Hardwood Forest	Dry site coniferous forests and woodlands; Western hemlock and Douglas-fir commonly present, up to 3 other conifer and 2 hardwood species present; understory typically shrub-dominated
Montane Coniferous Wetlands	Forest or woodland dominated by evergreen conifers; deciduous trees may be co-dominant; understory dominated by shrubs, forbs, or graminoids; mid- to upper montane.
Montane Mixed Conifer Forest	Coniferous forest of mid-to upper montane sites with persistent snowpack; several species of conifer; understory typically shrub-dominated
Open Water - Lakes, Rivers, and Streams	Lakes, are typically adjacent to Herbaceous Wetlands, while rivers and streams typically adjoin Eastside Riparian Wetlands and Herbaceous Wetlands
Ponderosa Pine & Interior White Oak Forest and Woodlands	Ponderosa pine dominated woodland or savannah, often with Douglas-fir; shrub, forb, or grass understory; lower elevation forest above steppe, shrubsteppe.
Subalpine Parkland	Whitebark pine (*P. albicaulis*) is found primarily in the eastern Cascade Mountains, Okanogan Highlands, and Blue Mountains.
Westside Riparian-Wetlands	Dominated by Red alder, 3-4 other deciduous broadleaf and 3 conifer trees may also be dominate or co-dominate; understory typically large shrubs and herbs

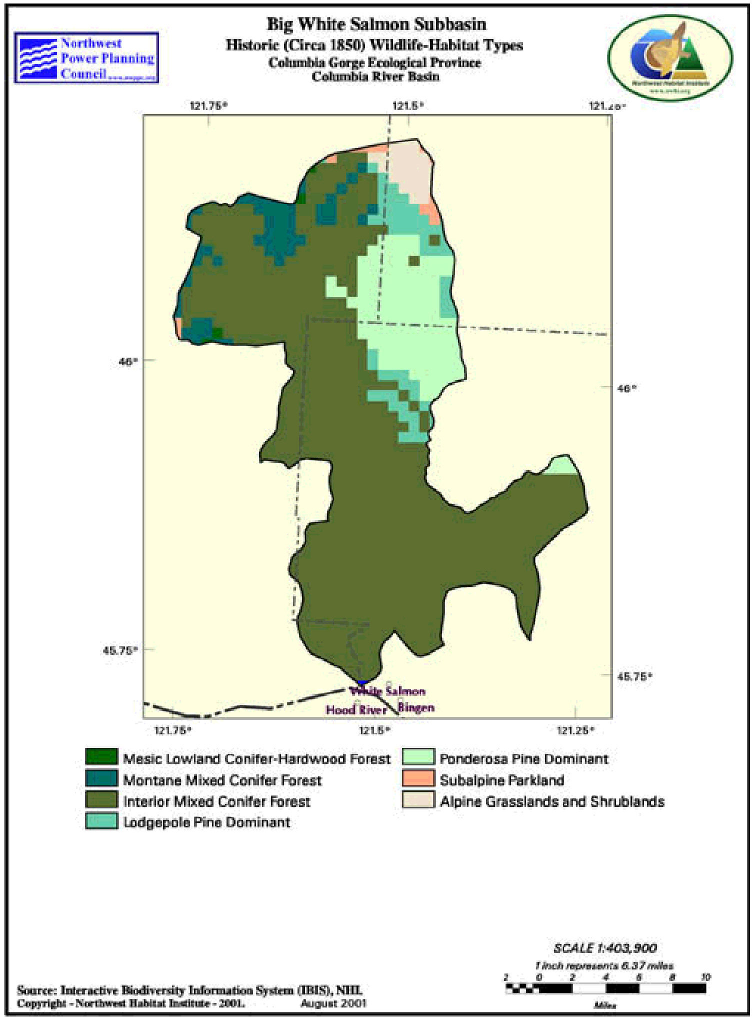

Figure 3 Historic wildlife habitat types of the Big White Salmon subbasin, Washington (IBIS 2003)

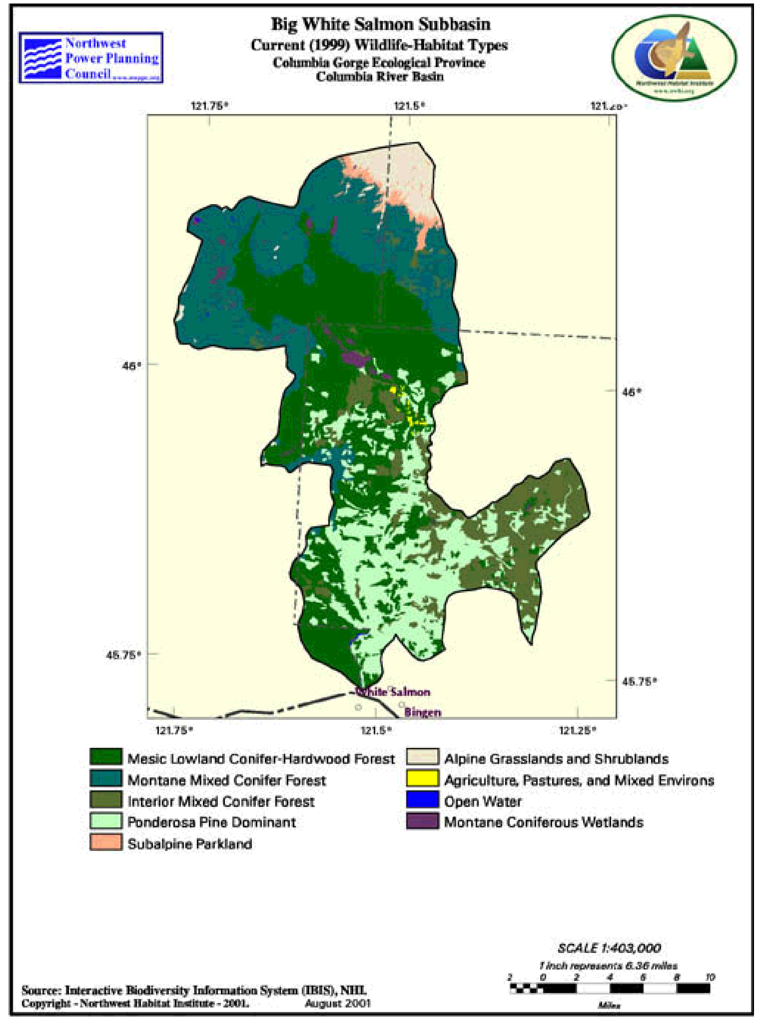

Figure 4 Current wildlife habitat types of the Big White Salmon subbasin, Washington (IBIS 2003)

Rare Plants and Plant Communities

Klickitat and Skamania counties, parts of which are contained within the Big White Salmon subbasin, contain 69 rare plants and 46 rare or high-quality plant communities, identified by the Washington Natural Heritage Program (2003). Complete listings are in Appendix D, tables D.1.A and D.2.

Priority Habitat and Species (PHS)

The PHS List is a catalog of habitats and species considered to be priorities for conservation and management. 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.

In our subbasin there are 17 habitats or habitat elements listed within the PHS list for southwest the (Region 5) (see Appendix D, table D.3). Internet access to the PHS List is available via the World Wide Web at:

http://www.wa.gov/wdfw/hab/phslist.htm.

Plant Species of Importance to the people of the Yakama Nation.

There are many species of native plants that have traditional and modern cultural importance to the Yakama Nation. When looking for focal habitats, habitats that supported culturally important, and often imperiled, plants were considered. For a short list of some of these plant species that have already been published in other literature, refer to Appendix D, table D.5.

Noxious Weeds

To help protect the state’s resources, the Washington State Noxious Weed Control Board adopts a State Noxious Weed List each year (WS NWCB 2004). This list categorizes weeds into three major classes – A, B & C - according to the seriousness of the threat they pose to the state or a region of the state. Klickitat subbasin has 32 classified weed species. Three are Class A, 25 are Class B, and four are Class C.

Noxious weeds have one of the most degrading impacts on our native wetland and terrestrial habitats. They often out compete native plant species and provide a decreased value of wildlife habitat. They can also decrease the recreational and economic value of land. The focal habitats chosen all have noxious weeds that have already degraded or currently threaten what remains of these habitats. See Appendix D, tables D.4.A and D.4.B for a complete list of weeds and Class definitions.

The Big White Salmon subbasin is in the Columbia Plateau province. 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.

4.2.4 Rationale for Focal Wildlife Habitat Selection

Subbasin wildlife planners emphasized an ecosystem approach 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 subbasin scale is more desirable than one that emphasizes individual species.

By combining the “coarse filter” (focal habitats) with the “fine filter” (focal wildlife species assemblage) approach, 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 also will benefit a wider group of species with similar habitat requirements.

To ensure that species dependent on given habitats remain viable, Haufler (2002) advocated comparing the current availability of the habitat against its historic availability (see table 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.

The following rationale was used to guide selection of focal habitats (see table 7) for an illustration of the focal habitat/species selection process):

- Identification of habitats that can be used to evaluate ecosystem health and establish management priorities at the subbasin level (coarse filter)
- Identification of habitats that have experienced a dramatic reduction in acreage or quality within the subbasin (table 6)
- Identification of habitats that are naturally sensitive and have likely undergone reduction in quantity and quality, although historical records may be lacking (riparian habitats)
- Other considerations included cultural, economical, ecological and special factors.

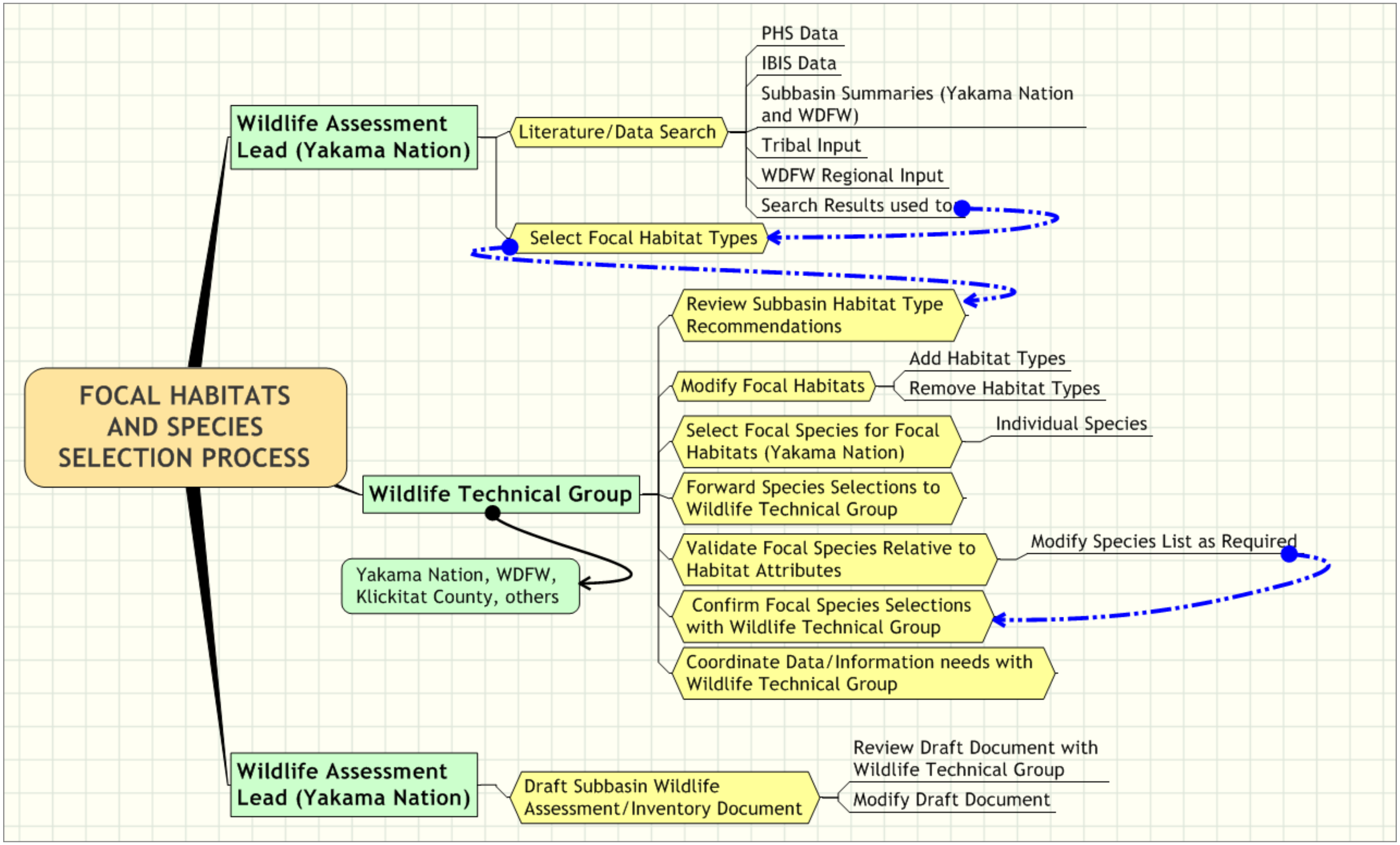

Figure 5 Focal habitat and species selection process summary (prepared by Paul Ashley, 2004)

Table 6 Changes in wildlife habitat types in the Big White Salmon subbasin from circa 1850 (historic) to 1999 (current)

	Status (acres)			
Habitat Type	**Historic**	**Current**	**Change**	**Change (%)**
Mesic Lowlands Conifer-Hardwood Forest	126,244	262,199	135,955	52
Montane Mixed Conifer Forest	43,608	108,108	64,500	60
Eastside (Interior) Mixed Conifer Forest	250,531	34,097	-216,434	-86
Lodgepole Pine Forest and Woodlands	14,195	8487	-5,708	-40
Ponderosa Pine & Interior White Oak Forest and Woodlands	30,167	45,334	15,167	33
Subalpine Parkland	3,383	3313	-70	-2
Alpine Grasslands and Shrublands	6,071	9,558	3,487	35
Agriculture, Pastures	unknown	408	N/A	N/A
Open Water - Lakes, Rivers, and Streams	325	482	157	33
Montane Coniferous Wetlands	unknown	3,765	N/A	N/A
Interior Riparian Wetlands	1,228	unknown	N/A	N/A
Note: Values of 999 indicate a positive change from historically 0 (habitat not believed to be present historically), N/A indicates change is unknown due to lack of historical data.				

IBIS 2003

Subbasin planners selected three focal wildlife habitat types of the 11 that occur within the subbasin. Subbasin focal habitats include Interior Riparian Wetlands, Ponderosa Pine/Oregon White Oak, and Montane Coniferous Wetlands. For a summary of some of the criteria considered during selection, see table 7.

Table 7 Focal habitat selection matrix for the Big White Salmon subbasin.

Habitat Type	Criteria						
	PHS Data	ECA Data	IBIS Data	Considerable loss in quantity	Considerable loss in quality	Listed in subbasin summary	Historically present in macro quantities1
Montane Coniferous Wetlands	No	No	Yes	Likely, not mapped well	Yes	No	No
Ponderosa pine / Oregon White Oak	No	No	Yes	Yes	Yes	Yes	No
Interior Riparian Wetlands	Yes	Yes	Yes	Likely, not mapped well	Yes	Yes	No
Agriculture2	No	No	Yes	-	-	Yes	No

1 Habitat types historically comprising more than 5 percent of the subbasin 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. Focal species were not selected to represent this habitat type.

4.2.5 Changes in Focal Wildlife Habitat Quantity and Distribution

Changes in focal habitat quantity at the subbasin level are depicted in table 8.

Table 8 Changes in focal wildlife habitat types in the Big White Salmon subbasin from circa 1850 (historic) to 1999 (current).

	STATUS			
FOCAL HABITAT TYPE	Historic	Current	Change	Change (%)
Montane Coniferous Wetlands	unknown	3,765	N/A	N/A
Ponderosa Pine / Oregon White Oak	30,167	45,334	15,167	33
Interior Riparian Wetlands	1,228	unknown	N/A	N/A
Agriculture (Habitat of Concern)	0	408	-408	999

Note: Values of 999 indicate a positive change from historically 0 (habitat not present in historic data).

IBIS 2003

The IBIS riparian habitat data are incomplete. Therefore, riparian floodplain habitats are not well represented on IBIS 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.

4.2.6 Rationale for Focal Wildlife Species Selection

The term focal species was defined by Lambeck (1997) 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 (USDA Forest Service 2000).

Subbasin planners refer to these species as “focal species” because they are the focus for describing desired habitat conditions, 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 those factors, which affect habitat quality and integrity within the subbasin, also impact the species, hence, the decision by subbasin wildlife, fisheries and land managers to focus on habitat with focal species in a supporting role.

Subbasin planners consider focal species’ life requirements representative of riparian and wildlife habitat conditions or features that are important within a properly functioning focal habitat type. In some instances, extirpated or nearly extirpated species were included as focal species if subbasin planners believed they could potentially be reestablished and / or are highly indicative of some desirable habitat condition.

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

- primary association with riparian or wildlife habitats for breeding
- specialist species that are obligate or highly associated with key habitat elements / conditions important in functioning ecosystems
- declining population trends or reduction in their historic breeding range (may include extirpated species)
- cultural significance of the species, from a tribal and non-tribal perspective
- special management concern or conservation status such as threatened, endangered, species of concern, management indicator species, etc.
- professional knowledge on species of local interest

Subbasin planners identified a focal species assemblage and combined life requisite habitat attributes for each species assemblage to form a recommended “range of management conditions.” Fisheries and wildlife habitat managers will use the recommended range of riparian and wildlife habitat conditions to identify and prioritize future habitat acquisition, protection, and management strategies and to develop specific habitat management actions/measures for focal habitats.

Focal species can also serve as performance measures to evaluate ecological sustainability and processes, species / ecosystem diversity, and results of management actions (USDA Forest Service 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.

4.2.7 Focal Wildlife in the Big White Salmon Subbasin

A total of two bird species, two mammalian species, one amphibian species and one reptile species were chosen as focal or indicator species to represent three focal habitats in the Big White Salmon subbasin (table 9), also see Appendix C, table C.7 for an entire list of species associated with the focal habitats. Focal species selection rationale and important habitat attributes for each species are described in further detail in table 10.

Table 9 Focal species selection matrix for the Big White Salmon subbasin.

Common Name	Focal Habitat	Priority Habitat Species	Partners In Flight Species	Game Species	Status1	
					Federal	State
Yellow Warbler	Interior Riparian Wetland	No	No	No	-	-
Western Pond Turtle		Yes	No	No	-	SE
Lewis' Woodpecker	Ponderosa Pine / Oregon White Oak	Yes	Yes	No	-	-
Western Gray Squirrel		Yes	No	No	-	ST
Oregon Spotted Frog	Montane Coniferous Wetlands	Yes	No	No	FC	SE
American Beaver		No	No	Yes	-	-
1FC = Federal Candidate; ST = State Threatened; SE = State Endangered						

Table 10 Focal species selection rationale and habitat attributes for the Big White Salmon subbasin.

Focal Species	Focal Habitat	Life / Habitat Requisite	Conservation Focus	Habitat Attribute (Vegetative Structure)	Comments	Habitat Criteria for Selection
Yellow Warbler	Interior Riparian Wetlands	Reproduction	Subcanopy foliage, riparian habitat	> 70% cover in shrub and subcanopy w/ subcanopy > 40% of that, > 70% cover native species	Highly vulnerable to cowbird parasitism; grazing reduces understory structure	Riparian obligate, reproduces in riparian shrub habitat and makes extensive use of adjacent wetlands
Western Pond Turtle		Breeding	Intact and functional montane wetland	Pond complexity, presence of refugia and basking sites, moderate temperature (<35°C), accessibility to overwintering, terrestrial sites	requires continued recovery program to ensure its survival in the state until sources of mortality can be reduced	Riparian obligate, needs permanent wetlands with structural complexity (downed woody debris and veg.).
Lewis' Woodpecker	Ponderosa Pine / Oak Woodlands	Breeding / Winter forage in Oak forests	Large trees / snags of oak and pine	> .8 trees / acre > 21" dbh, canopy closure ≤ 30%, shrub cover ≥50%	Competition from E. starlings detrimental, needs large contiguous blocks	Dependent on insect food supply, mast
Western Gray Squirrel		All life stages, non migratory	Oak and ponderosa pine forests	Acorns and other mast producing plants, important in winter, pine cones and seeds in summer	Eastern gray squirrel just beginning to encroach	Obligate for oak pine woodlands habitat. Mixed stands of oak and ponderosa pine preferred for nesting
Oregon Spotted Frog	Montane Coniferous Wetlands	Breeding	Intact and functional montane wetland	Needs shallow water, 2-12" deep, needs clear, oxygenated water and emergent vegetation, needs warm summer water temps (>68º F)	In Washington state, Bullfrog threatens remaining populations	Dependent on montane wetlands for critical life stages
American Beaver		Food	Canopy closure	40-60% tree/shrub canopy closure trees, < 6" dbh; shrub height 6.6 ft.	Wetland and riparian shrub / forest habitat	Indicator of healthy regenerating cottonwood stands; important habitat manipulator
		Water (cover for food and reproductive requirements)	Permanent water	Stream channel gradient 6% with little to no fluctuation	Keystone species creating pools and standing water used by many species	

Focal Species	Focal Habitat	Life / Habitat Requisite	Conservation Focus	Habitat Attribute (Vegetative Structure)	Comments	Habitat Criteria for Selection
		Food	Shoreline development	Woody vegetation 328 ft. from water		

4.3 Discussion of Focal Habitats and Their Representative Focal Species

4.3.1 Interior Riparian Wetlands

Rationale for Selection

The Interior Riparian Wetlands wildlife habitat type was selected as a focal habitat because its protection may yield the greatest gains for fish and wildlife per unit of area (Knutson and Naef 1997). Riparian habitat represents a relatively small portion of the subbasin's total area, but supports a higher diversity and abundance of fish and wildlife than any other habitat type. Riparian habitat provides important fish and wildlife breeding habitat, seasonal ranges, and movement corridors. Many species that primarily dwell in other habitat types, such as shrub steppe, depend on riparian areas during key portions of their life history.

Riparian habitat has important social values, including water purification, flood control, recreation, and aesthetics. But Interior Riparian Wetlands are also highly vulnerable to alteration. The riparian wetlands have suffered degradation and losses to hydrological function as well as fragmentation of habitat. This phenomenon fragments movement corridors for fish and wildlife.

Description of Habitat

Historic

Since the arrival of settlers in the early 1800s, 50 to 90% of riparian wetland habitat in Washington State has been lost or extensively modified (Buss 1965). 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).

These habitats are strongly influenced by stream dynamics and hydrology. Riparian forests require various flooding regimes and specific substrate conditions for reestablishment. Annual flood cycles occurred in most riparian wetland areas, although flood regimes varied among stream types. Hyporheic hydrology supported riparian wetland conditions considerable distances from perennial creek and river channels. Upwelling and downwelling groundwater dynamics created thermal conditions in wetland and spring brook areas conducive to wildlife use throughout the seasons. Fire typically influenced habitat structure in most areas, but was nearly absent in colder regions or on topographically protected streams. River meander patterns, ice and log jams, sediment dynamics and flood debris deposits provided spatial and temporal changes in habitat condition. Abundant beaver activity cropped younger cottonwoods (Black cottonwood, Populus balsamifera spp. trichocarpa) and willows (Salix spp.), damming side channels. This activity influenced the vegetative, sediment, hyporheic and surface water dynamics creating diverse and complex habitat interactions.

In our subbasin, the density and diversity of wildlife in riparian wetland areas is also high relative to other habitat types. Riparian forest habitats are critical to the structure and function of rivers and to the fish and wildlife populations dependent upon them (Rood and Mahoney 1990). Healthy forested riparian wetland habitat has an abundance of snags and downed logs that are critical to many cavity nesting birds, mammals, reptiles and amphibians. Cottonwood, alder (Alnus spp,) and willow are commonly dominant tree species in riparian wetland areas from the

Cascades down through the valley portion of the subbasin This habitat is often characterized by relatively dense understory and overstory vegetation. Riparian wetland habitats also function as travel corridors between, and provide connectivity to, other essential habitats (e.g., breeding, feeding, seasonal ranges).

Though riparian wetland habitats are often forested, they also contain important sub-components such as marshes and ponds that provide critical habitat for a number of wildlife species. Broad floodplain mosaics consisting of cottonwood gallery forests, shrub lands, marshes, side channels, and upland grass areas contain diverse wildlife assemblages. The importance of riparian wetland habitats is increased when adjacent habitats are of sufficient quality and quantity to provide cover for nesting, roosting, and foraging.

Riparian vegetation was restricted in the arid Intermountain West, but was nonetheless diverse. It was characterized by a mosaic of plant communities occurring at irregular intervals along streams and dominated singularly or in some combination by marshes, side channels, grass-forb associations, shrub thickets, and mature forests with tall deciduous trees. Common shrubs and trees in riparian zones included several species of willows, red-osier dogwood (*Cornus stolonifera)*, alder, Wood's rose (*Rosa woodsii*), snowberry (*Symphoricarpos* spp.), currant (*Ribes* spp.), black cottonwood, water birch (*Betula occidentalis*), trembling aspen (Populus tremuloides), and peach-leaf willow (*Salix amygdaloides*). Herbaceous understories were very diverse, but typically included several species of sedges (*Carex* spp.) along with many dicot species. Marsh habitats contained tule (*Scirpus* spp.), common cattail (*Typha latifolia*), narrow-leaved bur-reed (*Sparganium angustifolium*), wapato (*Sagittaria latifolia*), water-plantain (*Alisma plantago-aquatica*), many species of submersed macrophytes (including sago pondweed (*Potamogeton pectinatus*), common hornwort (Ceratophyllum demersum), and greater bladderwort (Utricularia vulgaris)), yellow waterlily (Nuphar polysepalum), and common watercress (Nasturtium officinale). Lower elevation wet meadows contained much of the vegetation found in their montane counterparts; including sedges, smartweeds (*Polygonum* spp.), spike rushes (*Scirpus* sp.), common camas (*Camassia quamash*), and wild onion (*Allium* spp.). Floodplain grasslands were dominated by great basin wild rye (*Leymus cinereus*), greasewood (*Sarcobatus vermiculatus*), and dogbane (*Apocnum* spp.).

Riparian areas have been extensively impacted within the Columbia Basin such that undisturbed riparian systems are rare (Knutson and Naef 1997). 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. 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 that have affected insect fauna have reduced or altered potential foods for birds as well.

Historic wetland acreage in our subbasin is difficult to measure. The IBIS riparian habitat data are incomplete; therefore riparian floodplain habitats are not well represented on IBIS maps. Evidence of historic riparian wetland location and extent in the subbasin can be found by examining hydric soil acreages, which could not be achieved in the planning timeframe.

Landscape information such as that contained in floodplain maps can also be consulted, again not achieved due to planning timeframe.

Current

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 shrub land 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 ft. in elevation pre-1900; now nearly 80 percent is found above that elevation.

Riparian and wetland conditions in our subbasin range from severely degraded to high quality depending on the level of impact by activities such as hydrologic alteration, land use conversion, agricultural practices, and grazing. Riparian habitats are degraded in some places because of levee development, channelization and inappropriate livestock grazing. Irrigation canals, drains, and rights-of-way act as conduits delivering noxious weeds such as purple loosestrife (*Lysimachia salicaria*) to riparian wetland habitats.

Within the past 100 years, a large amount of our subbasin riparian wetland habitat has been altered, degraded, or destroyed. As in other areas of the Columbia Basin, impacts have been greatest at low elevations and in valleys where hydroelectric development, agricultural conversion, levee and road development, and altered stream channel morphology have played significant roles in changing the character of streams and associated riparian areas.

Stresses

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 wetland 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).

Factors affecting riparian wetlands in our subbasin are summarized in the paragraphs below, as well as in table 11, at end of chapter. Riparian wetland habitat conditions throughout the subbasin have been influenced by one or all of these factors in different ways depending on their location. Restoration plans for these habitats must take in to consideration the location of the habitats, the historic conditions under which they operated, the alterations that have occurred to impact their function, and the possibilities that currently exist to adequately address the stresses in a cost-effective manner.

Alteration of the Hydrograph

The development of irrigated agriculture in the subbasin has altered the river's hydrograph. Irrigation diversions have rsulted in some reduction of the flows in the lower portion of the subbasin. Agricultural drains have altered the hyporheic flows in some tributaries.

Exclusion of the River from its Floodplain

Transportation ways and levee development has restricted the floodplain in some areas. Land conversion from riparian wetland habitat to agricultural, residential, or recreational uses has also occurred behind the levees and roads. Riparian wetland restoration must take in to consideration the effects of restoration on lands that have been converted away from flooded habitats. Landscapes behind levees that have been physically altered by leveling or residential development may be much more difficult to restore than landscapes that have not been altered. Restoration priority should be given to protecting those areas that have not experienced floodplain exclusion and to areas within which floodplain reconnection is economically and culturally possible.

Alteration of Sediment Dynamics

Riparian wetland habitats are spatially and temporally dynamic. Floodplain processes creating and altering these habitats are largely dependent on cut and fill alluviation. The activities creating the altered hydrograph, the floodplain restrictions, the dams across waterways, the agricultural drainage of sediment-laden water into the waterways, the loss of green vegetation, and the reduction in woody debris have disrupted the sediment processes necessary for healthy riparian wetland conditions in some areas. Certain watersheds are experiencing increased sedimentation. Other areas, such as those below irrigation dams, are experiencing a reduction in sediment, causing channel incision. Management actions often can correct alterations in sediment dynamics in localized areas. Priority should be given to projects that include the restoration of sediment processes.

Loss or Alteration of Riparian Wetland Vegetation

Vegetation loss and alteration is caused by multiple factors. All of the impacts listed above result in loss and alteration of riparian wetland vegetation communities. In areas unaffected or receiving little alteration by the factors listed above, vegetation alteration can also occur through heavy grazing or clearing. In areas that have experienced little hydrologic and landscape alteration, vegetation restoration may be as simple as reducing inappropriate grazing or vegetation removal practices. In situations where the hydrology or landscape has been altered in a significant manner, these impacts must be addressed if vegetation restoration is to be successful. Many riparian wetland vegetation reintroduction projects fail because the hydrologic impacts have not adequately been addressed. Priority should be given to projects that adequately address the reasons for vegetation loss or alteration.

Reduction in Large Woody Debris

Healthy riparian wetland habitats create large amounts of dead woody materials. Cottonwood gallery forests are famous for their ability to provide standing and downed snags. The processes mentioned above interact with this dead woody material to supply nesting and feeding opportunities for many fish and wildlife species. This material is responsible, as well, for influencing the floodplain dynamics, especially cut and fill alluviation, necessary for riparian wetland and cottonwood forest health. As cottonwood stands age, the large dead material produced will collect sediment, block side channels, and force the establishment of new channels. The new channels will create exposed gravel and sediment conditions upon which new cottonwood trees will become established. The result is a diverse mosaic of cottonwood stands of different ages within a floodplain area. Restoration of large woody debris, then, is dependent on the restoration of healthy cottonwood stands. This activity requires floodplain areas large enough to provide space for cottonwood stands of various ages. Restoration areas too small may experience declines in the health of the cottonwood forests as they age and are not replaced with new stands. Restoration priority should be given to projects large enough to provide sufficient floodplain conditions conducive to the continued development of healthy cottonwood forests.

Reduction of Beaver Activity

Beaver were central to the maintenance of healthy riparian wetland habitats. Their abundant activity created flooded conditions throughout the subbasin. A testimony to their abundance is reflected in the fact that the Pacific Northwest was revered for its fur trade. Extensive trapping is routinely listed as a major factor in their decline. Healthy beaver populations, however, are returning to many restoration areas in the lower portions of our subbasin. As restoration projects move up the watersheds, there is a possibility that beaver populations will move upstream with them. Beaver damage complaints often will increase in areas adjacent to restoration projects. Restoration managers must be prepared to address these affects if projects are to succeed in the long term. Priority should be given to projects that address the factors necessary to support healthy populations of beavers and to address the unintended impacts to adjacent lands.

Increase in Invasive Non-Native Vegetation

Our subbasin is in no means an isolated area. Global markets and economies cause human interactions unheard of a century ago. Because of this, the introduction of vegetation from exotic locals increases every year. Habitat conversion in the intensively developed irrigated agricultural portions of the subbasin compounds the effects of these introductions. Weed management is becoming an increasingly important component of riparian wetland restoration and management. A list of noxious weed species occurring in our subbasin is included in Appendix D, table D.4.A. To combat these invasive species, techniques must be used that fit the situation within which they are arising. A comprehensive, integrated approach to pest management involves many tools. An important tool is in the restoration of conditions as close as possible to those that existed historically. The re-creation of native conditions conducive to the needs of the native plants which evolved in these conditions will often allow the best defense against infestation by exotic vegetation. Intensive weed control, however, may be necessary to reestablish these native communities in the first place. Many times, the removal of grazing on a heavily disturbed area will result in large weed infestations. Weed issues are much more important in the lower portions of the subbasin, but are increasing in the upper basin as well. Restoration projects must include plans to address weed infestations. Priority should be given to projects that include credible, integrated plans to address exotic vegetation issues.

Human Disturbance

As our subbasin becomes increasingly populated, human disturbance issues will also increase. Fish and wildlife populations need habitats relatively free of human activity. The best habitat will not provide the needs of wildlife if the level of human disturbance is high. Restoration areas must balance the needs of the fish and wildlife with the needs of the local communities. Restoration projects away from large population centers will require less effort to minimize human disturbance than projects near or adjacent to urban areas. Priority should be given to projects adequately addressing human disturbance issues.

Reduction in Anadromous Fish Populations

Many native wildlife species and habitats in our subbasin were dependent on the constant energy sources brought up from the ocean by the large anadromous fish runs. The loss of these fish runs caused a large reduction in energy entering the system, altering wildlife population dynamics. This resulted in less vegetation, lower invertebrate numbers, and thus reduced numbers of wildlife dependent on eating salmon. Priority should be given to riparian wetland restoration activities that emphasize anadromous fish as well as wildlife benefits that promote an increase in the inter-specific interactions.

Table 11 Summary of potential effects of various land uses on riparian wetland habitat elements needed by fish and wildlife.

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 (e.g., width and depth)	X	X	X	X	X	X	X
Stream channelization (straightening)	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

Knutson and Naef 1997

4.3.2 Yellow Warbler (Dendroica petechia)

Rationale for Selection

The yellow warbler is a common native species strongly associated with riparian and wet deciduous habitats. The yellow warbler is a good indicator of functional subcanopy/shrub habitats in riparian areas. It is a locally common breeder along rivers and creeks in the Columbia Basin, where it is declining in some areas. For these reasons, they were chosen as a focal species for the Interior Riparian Wetlands focal habitat.

Key Life History Strategies: Relationship to Habitat

Summary

Partners in Flight (PIF) established the following biological objectives for this species in the lowlands of eastern Oregon and eastern Washington (Altman 2001):

- >70 percent cover in total cover {shrub (<3 m) and subcanopy (>3m) layers}
- Subcanopy layer contributing >40 percent of the total cover
- Shrub layer cover 30-60 percent of total cover (includes shrubs and small saplings), height > 2m
- >70% cover should be native species
- Edge and small patch size (heterogeneity)

General

The yellow warbler is a riparian obligate species most strongly associated with wetland habitats and deciduous tree cover and is a good indicator of functional subcanopy / shrub habitats in riparian areas.

Yellow warbler abundance is positively associated with deciduous tree basal area, and bare ground; abundance is negatively associated with mean canopy cover of Douglas-fir (*Pseudotsuga menziesii*), Oregon grape (*Berberis nervosa*), swordfern (*Polystuchum munitum*), blackberry (*Rubus discolor*), hazel (*Corylus cornuta*), and oceanspray (*Holodiscus discolor*) (Rolph 1998). Altman (2001) reported that, at the landscape level, yellow warbler habitat should include a high degree of deciduous riparian heterogeneity within or among wetland, shrub, and woodland patches and a low percentage of agricultural land use.

At the landscape level, the biological objectives for habitat included high degree of deciduous riparian heterogeneity within or among wetland, shrub, and woodland patches; and a low percentage of agricultural land use (Altman 2001). Their habitat suitability index strongly associates them with a dense deciduous shrub layer 1.5-4 m. (5-13.3 feet), with edge, and small patch size (heterogeneity). Other suitability index associations include % of deciduous shrub canopy comprised of hydrophytic shrubs (wetlands dominated by shrubs had the highest average of breeding densities of 2males/ha) and deciduous tree basal area (abundance is positively associated).

Negative associations are closed canopy and cottonwood proximity. Some nests have been found in cottonwood, but more often in shrubs with an average nest height of 0.9-2.4 m., maximum being 9-12 m. (Schroeder 1982).

Nesting

They are a common breeder in hardwood trees throughout Washington State at lower elevations. Breeding yellow warblers are closely associated with riparian trees, specifically willows, alders, or cottonwoods. In Klickitat County, they are mostly confined to relatively dense riparian vegetation (Manuwal 1989). Optimal nesting habitat for the yellow warbler is provided in wet areas with dense, moderately tall stand of hydrophytic deciduous shrubs (Schroeder 1982).

Population Status and Trend

Core zones of distribution in Washington are the forested zones below the subalpine fir (Abies lasiocarpa) and mountain hemlock (*Tsuga mertensiana*) zones, plus steppe zones other than the central arid steppe and canyon grassland zones, which are peripheral (figure 6).

Within the Washington State, yellow warblers are apparently secure and are not of conservation concern (Altman 1999). Information from Breeding Bird Surveys indicates that the population is stable in most areas. However, yellow warblers have shown population declines in various regions during well-defined time periods. Because the Breeding Bird Survey dates back only about 30 years, population declines in Washington resulting from habitat loss prior to the survey would not be accounted for by that effort.

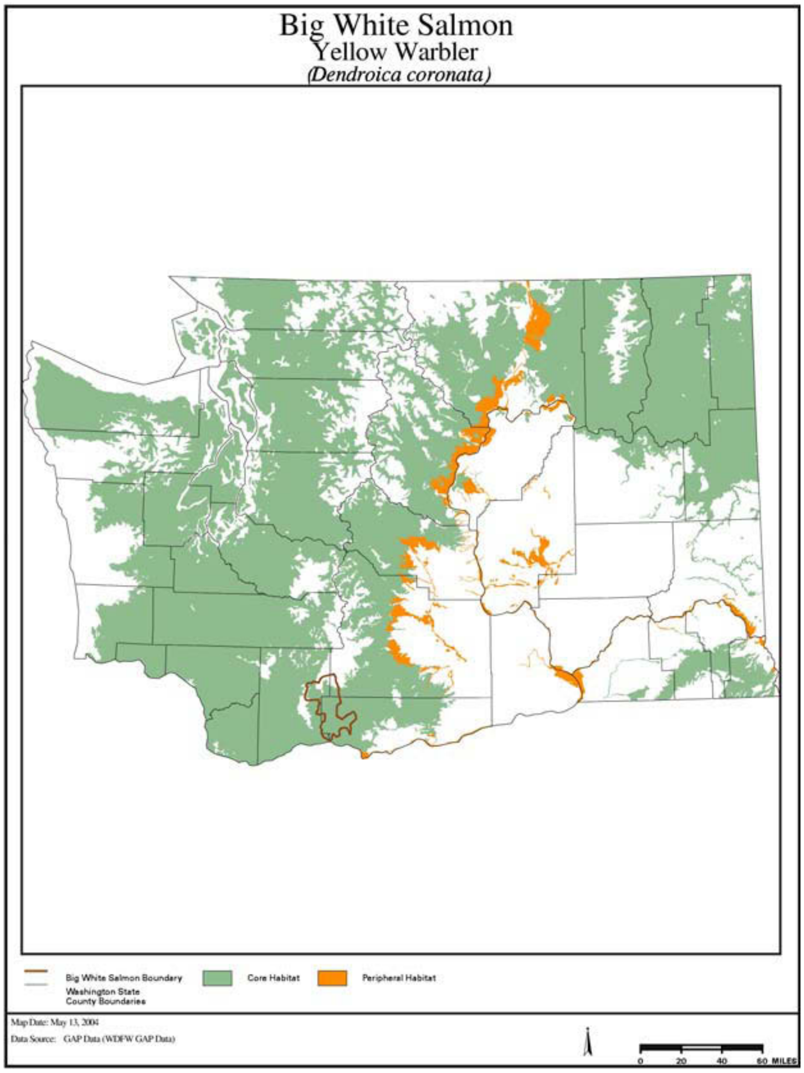

Figure 6 Potential habitat for yellow warbler in the Big White Salmon subbasin (Smith et al. 1997)

They are most abundant in riparian areas in the lowlands of eastern Washington. Numbers decline in the center of the Columbia Basin, but this species can be found commonly along most rivers and creeks at the margins of the Basin.

Management Issues

No specific management issues were identified in our subbasin.

Out-of-Subbasin Effects and Assumptions

The peak of spring migration in Washington and the Columbia Basin is in late May (Gilligan et al. 1994). Southward migration begins in late July, and peaks in late August to early September; very few migrants remain in the region in October (Lowther et al. 1999).

Fall migration is somewhat inconspicuous for the yellow warbler. It most probably begins to leave Washington by the first of August and has generally left the state by the end of September. The yellow warbler winters from the Bahamas and northern Mexico south to Peru, Bolivia and Brazil.

The yellow warbler is a long-distance Neotropical migrant. Spring migrants begin to arrive in the Columbia River Basin in April; dates of 2 April and 10 April have been reported from Oregon and British Columbia, respectively (Gilligan et al. 1994, Campbell et al. in press).

In Yakima County, earliest arrival dates are in late April with most breeders present by mid- to late-May; by late July/early August numbers begin to decline and by early September most yellow warblers have migrated out of the county (Stepniewski 1998).

Relationship with Riparian/Fisheries Issues

Healthy riparian vegetation is important to yellow warbler, and to other terrestrial and aquatic species as well. Riparian vegetation helps stabilize stream banks, reducing sedimentation input in the stream. Riparian vegetation also shades the stream keeping stream temperatures stable. The trees that yellow warbler need for nesting provide large woody debris when they die, increasing refugia for fish and other aquatic vertebrates and invertebrates. Riparian restoration that improves habitat for yellow warblers will also improve riparian aquatic and terrestrial habitat for other species including fish.

Factors Affecting Population

Habitat Loss

Hydrological diversions and control of natural flooding regimes (e.g., dams), inundation from impoundments, cutting and spraying riparian woody vegetation for water access, gravel mining, and urban development have negatively affected yellow warblers in the subbasin.

Vegetation and Habitat Degradation

Degradation of riparian habitat includes: loss of vertical stratification of riparian vegetation, lack of recruitment of young cottonwoods, ash (*Sorbus* spp.), willows, and other subcanopy species; stream bank stabilization which narrows stream channels, reduces the flood zone, and reduces extent of riparian vegetation; invasion of exotic species such as reed canary grass (*Phalaris arundinacea*) and Himalayan blackberry (*Rubus discolor*); overgrazing which can reduce understory cover; reductions in riparian corridor widths which may decrease suitability of the habitat and may increase encroachment of nest predators and nest parasites.

Presence of Development

Hostile landscapes, particularly those in proximity to agricultural and residential areas, may have high density of nest parasites (brown-headed cowbird, *Molothrus ater*) and domestic predators (cats), and be subject to high levels of human disturbance.

Recreational Disturbance

Recreational disturbances during nesting season, particularly in high-use recreation areas, may contribute towards nest abandonment.

Pesticide and Herbicide Use

Increased use of pesticides and herbicides associated with agricultural practices may reduce the warbler's insect food base.

4.3.3 Western Pond Turtle (*Clemmys marmorata*)

Rationale for Selection

The western pond turtle is declining throughout most of its range and is highly vulnerable to extirpation in Washington State. The species requires a continued recovery program to ensure its survival in the state until sources of excessive mortality can be reduced or eliminated. The western pond turtle is associated with a variety of aquatic habitats, both permanent and intermittent. The western pond turtle is listed as an endangered species in Washington State and is a federal species of concern. For the above reasons, this species is a focal species for the Interior Riparian Wetland wildlife habitat.

Key Life History Strategies: Relationship to Habitat

Summary

For aquatic areas (streams, rivers, ponds, lakes) turtles appear to prefer:

1. Pond complexity, creating

- Presence of refugia (large woody debris, underwater vegetation, rocks of various sizes) (Holland and Bury 1998, Hays et al. 1999)
- Presences of basking sites (emergent vegetation, large woody debris, beaches) (Hays et al. 1999)

2. Moderate temperatures, turtles avoid prolonged exposure to water above 35°C (95°F) (Holland 1991c, Holland 1994)

Also, accessibility to upland sites for overwintering and nesting:

3. Overwintering sites, the most use occurs (from Hayes et al., K. Slavens, pers. comm.)

- On slopes of 5-15°
- On east or west aspect
- In 80-90% shrub and tree canopy coverage

Beneath or near Oregon white oak (*Quercus garryana*)

Nest sites in dry, well-drained soils with significant clay/silt content (Holland 1994, Reese and Welsh 1997)

General

In Washington and many areas of Oregon, western pond turtles are generally found in ponds and small lakes, even though in other parts of their range they are more often associated with streams and rivers. They are usually rare or absent in human created water sources such as reservoirs, impoundments, and canals (Hays et al. 1999).

The highest densities of these turtles appear to occur in areas where there are warm, shallow lakes and sloughs and have similar habitat conditions (Holland 1991b, Hays et al. 1999). Western pond turtles are usually restricted to areas near the banks or in adjacent backwater habitats. The conditions that are important about these areas is that the current is relatively slow and abundant emergent basking sites and refugia exist. They generally avoid heavily shaded areas (Holland 1991b).

In general, turtles avoid prolonged exposure to water above 35°C (95°F) (Holland 1991c, Holland 1994). Visibility through water in areas inhabited by turtles may range from less than 15 cm (6 in) to more than 10 m (33 ft) (Hays et al. 1999).

Substrate and Vegetation

The substrate occurring in habitats used by western pond turtles vary and often include solid rock, boulders, cobbles, gravel, sand, mud, decaying vegetation, and combinations of these (Hays et al. 1999).

The vegetative characteristics of habitat used can also vary. There are many areas used by turtles with a rocky substrate and little or no emergent vegetation (Hays et al. 1999). In other areas they are found to occur in slow-moving streams or backwaters with abundant emergent vegetation such as cattails or bulrush (*Scirpus* spp.) (Holland 1991c). In the northern parts of the range, pond lilies (*Nuphar* spp.) or arrow weed (*Sagittaria* spp.) are often the dominant aquatic macrophytes. In disturbed habitats large mats of filamentous algae may be the only aquatic vegetation present. Dense growths of woody vegetation along the edges of a watercourse may shade potential emergent basking sites, and make habitats unsuitable for pond turtles (Hays 1999).

Basking and Refugia

Basking site availability is an important feature of western pond turtle habitat. Habitats that have basking sites have more abundant populations of turtles (Holland and Bury 1998). A variety of habitat structures may be used as emergent basking sites such as rocks, sand, mud, downed logs, submerged branches of near-shore vegetation, and emergent or submerged aquatic vegetation (Hays et al. 1999).

Available refugia is also an important feature of turtle habitat. Underwater refugia is especially important for predator avoidance. These refugia may consist of rocks of various sizes, submerged logs or branches, submerged vegetation, or holes or undercut areas along the bank (Hays et al. 1999). Western pond turtles are rarely found more than a few meters from a refuge of some sort (Holland and Bury 1998).

Overwintering and Breeding

Overwintering and breeding sites adjacent to wetlands are important for overall habitat suitability. Uplands such as oak-pine savanna, prairie, or pastures have been used in Washington State. In Klickitat County, 15 overwintering sites found all had 80-90% shrub and tree canopy coverage and virtually all were beneath or near Oregon white oak (from Hayes et al. 1999, K. Slavens, pers. comm.), showing an important connection between these two habitat types.

Higher fire regimes and human-caused fires may have been beneficial to turtles historically by maintaining open areas used by turtles for nesting. Fire suppression has resulted in an increase in the distribution and cover of coniferous trees such as Douglas-fir (Crawford and Hall 1997). An altered fire regime, that has led to successional changes in grassland and oak woodland habitat, may have played a major role in the decline of western pond turtles (Hays et al. 1999).

Population Status and Trend

Status

The western pond turtle has been extirpated from most of its range in Washington State. Currently, two populations remain in the Columbia River Gorge. A third population is currently being reintroduced in the Columbia River Gorge, Skamania County (D. Anderson, pers. comm.). The historic distribution along the Columbia River can only be approximated, (pre 1850), ? = records that may have resulted from human transport (taken from Hays et al. 1999), (figure 7). Due to the change of water flow caused by dam constructions, western pond turtle habitat has been lost along the Columbia River. Suitable habitat and additional populations of turtles have possibly been lost in recent decades (Hays et al. 1999).

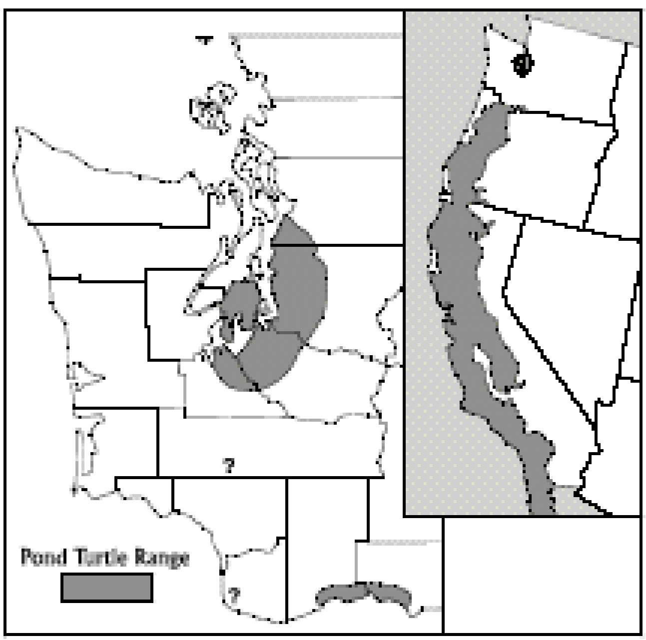

Figure 7 The approximate historical range of the western pond turtle in Washington State and in the United States

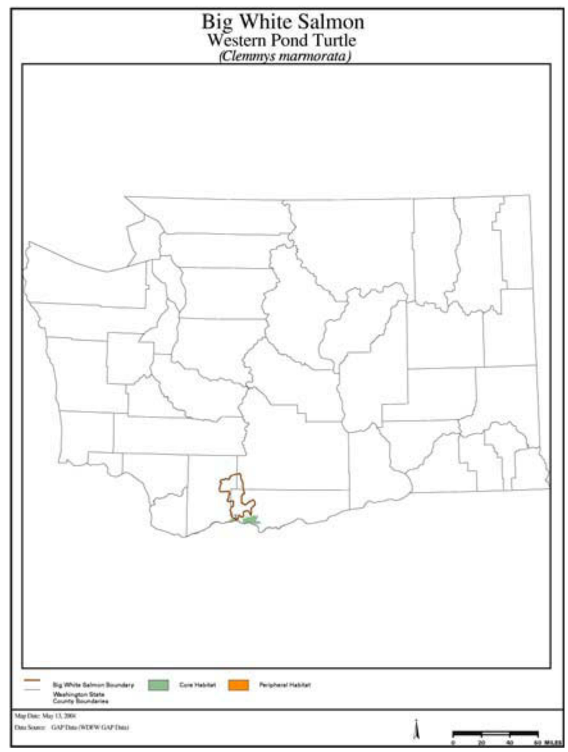

Figure 8 Potential habitat for western pond turtle in the Big White Salmon subbasin (Dvornich 1997)

The total number of western pond turtles, in known Washington populations, is estimated at approximately 500 individuals (D. Anderson, pers. comm.). Approximately half are young turtles from the head start and captive rearing program. Additional turtles may still occur in wetlands in western Washington and the Columbia Gorge, although most suitable habitats have been surveyed.

Trends

The Klickitat population was estimated to total about 108 turtles in 1986 (Zimmerman 1986). At the beginning of 1990, the number was estimated at between 60 and 80 animals (Holland 1991a), although subsequent data indicate the 1990 population was >96 turtles. Measurements of carapace lengths indicated the population was moderately adultbiased, with about 78% of the animals >120 mm (Holland 1991a), compared to 55-70% under normal circumstances (Holland and Bury 1998). This indicated that recruitment may be low and the population may be in decline (Holland 1991a).

In the early 1990s, the Klickitat County population was severely impacted by an unknown pathogen, and at least 36 animals died. Additional diseased animals were treated and released back into the Klickitat population. During this time period the “head start” program was initiated to improve survivorship of juvenile turtles in the wild.

The Klickitat population was estimated at 70 in 1992 and in 1994, at 117 turtles (Slavens, pers. comm., in Scott 1995a).

The Skamania County population was surveyed repeatedly between 1990 and 1994 (Scott 1995b). During 1992 surveys, 26 turtles were detected at 12 sites, and during 1994, 39 turtles were found at over 14 different sites. The 1994 estimate for Skamania and Klickitat counties combined was 156 turtles (39 in Skamania County, 117 in Klickitat County) (Hays 1999 et al.).

Since the mid 1990s the western pond turtle population in the Columbia River Gorge has increased significantly due to the success of the head start program. This continued effort has provided the basis for the reintroduction of a third population.

Management Issues

Currently, WDFW is working on western pond turtle recovery in the Columbia River Gorge and in western Washington. Recovery efforts in the Gorge are centered in habitats of Klickitat and Skamania counties. The goal of the recovery program is to re-establish self-sustaining populations of western pond turtles in the Columbia Gorge region. The recovery objectives in the Columbia River Gorge are to establish at least 4 populations of >200 pond turtles, composed of no more than 70% adults, which occupy habitat that is secure from development or major disturbance. Statewide the goal is to establish 7 populations for delisting, of which 4 would be in the Gorge Province. It is also necessary that the populations show evidence of being sustained by natural recruitment of juveniles. The core pond turtle sites should be wetland complexes that may be less susceptible to catastrophes than sites of a single water body. The recovery objectives need to be met before the western pond turtle would be considered for downlisting to threatened status. Objectives for downlisting to sensitive are similar, except 7 populations of >200 pond turtles will be needed.

Relationship with Riparian/Fisheries Issues

Western pond turtles need healthy, properly functioning wetlands for breeding and foraging. Many wetlands, though, have been declining steadily in size and quality. An improperly functioning wetland can negatively affect the connected riparian systems and fish that live in them. Protecting and repairing degraded wetlands can increase available habitat for western pond turtles and enhance the connected habitat that fish and other vertebrates and invertebrates depend on. Along the Columbia River, riparian habitats that were historically important to western pond turtles are equally critical for healthy fish populations.

Out-of-Subbasin Effects and Assumptions

Movements of western pond turtles typically or of short distance and do not likely occur between subbasins, although they are capable of moving significant distances and occasionally travel several hundred meters in just a few days (Bury 1979).

Factors Affecting the Population

Habitat Loss and Degradation

Human population increases and concomitant development will continue to alter or eliminate habitat for nesting, increase the rate of predation on nesting females, nests, or hatchlings, and/or expose hatchlings to hazardous post-hatching conditions. Though depredated nests have not (either with or without predator exclosures) been found in the Columbia Gorge study areas, predation on nests of other turtle species is higher near ecological edges (Temple 1987), such as those created by human activities.

Alteration of aquatic habitats, by water diversion projects or similar situations, may impose considerable hazard and hardship on moving turtles and result in higher than normal levels of mortality. Roads can fragment habitat and create barriers to movement. Overland movements by western pond turtles increase their vulnerability to vehicle mortality as well as increase their exposure to predation.

Diversion of water for irrigation and other purposes has also eliminated or altered turtle habitat. The construction of dams and creation of reservoirs has been detrimental to western pond turtles by altering water flow in drainages, inundating habitat behind dams and reservoirs, and creating habitat suitable for the spread of non-native species (bullfrogs, warmwater fishes) that are harmful to western pond turtles. Additionally, dams and their associated reservoirs may have fragmented populations by creating barriers to dispersal (Holland 1991b).

Non-native Species

Introduced species have changed the ecological environment in the region for pond turtles. As significant predators on hatchling and small juvenile western pond turtles, non-native species such as bullfrogs and warm water fish seem to reduce survivorship and alter recruitment patterns (Lampman 1946, Holland 1985b). Non-native fish can also alter aquatic habitat when feeding on submerged and emergent vegetation.

Introduced turtles, such as sliders and snapping turtles (*Chelydra serpentina*) may compete with pond turtles and expose them to diseases for which pond turtles have no resistance. The potential for disease is greatly increased when sick pet turtles are released (Hays et al. 1999)

Inappropriate Grazing

Cattle trample and eat aquatic emergent vegetation that serves as habitat for hatchlings and they may crush nests (Hayes et al. 1999).

Disturbance

The western pond turtle appears to be relatively sensitive to disturbance. Disturbance may affect the frequency and duration of basking or foraging behavior, which may be particularly important for gravid females. Interruption of basking may lead to a delay in the maturation and deposition of eggs, leading to a decrease in hatching success or overwinter survival (Holland 1991c). Boat traffic and fishing may influence western pond turtle behavior or cause direct mortality.

Chemicals and Contaminants

The effect of biocontaminants on western pond turtles is largely unstudied. Rotenone, a biodegradable substance extracted from a tropical plant, is commonly used in fishery management to eradicate fish species. Rotenone has been documented to kill amphibian adults and tadpoles, as well as turtles (Fontenot et al. 1994, McCoid and Bettoli 1996). Application of rotenone should be avoided in areas where western pond turtles likely occur.

4.3.4 Interior Riparian Wetlands Key Findings, Limiting Factors, and Working Hypothesis

Table 12 Interior Riparian Wetlands Key Findings, Limiting Factors, and Working Hypothesis

Interior Wetlands		
Key Findings	**Limiting Factors**	**Working Hypotheses**
Habitat has suffered degradation and loss of hydrological function.	Overall Loss of Riparian Vegetation	Properly managed grazing in riparian areas will help reduce the damage to riparian understory vegetation, which will in turn avoid the narrowing of stream channels and reverse increases in water temperature.
	Reduction in Floodplain Acreage	In riparian habitat, avoiding road-building activities, restoring habitat on abandoned roads or railroads and relocating problematic roads would decrease stream bank erosion, decrease sediment, and decrease disturbance to nesting species.
	Displacement of Native Riparian Vegetation with Non-native Vegetation	Reduction of the number of acres dominated by invasive non-native plant species will assist in improving riparian habitat condition for focal species and overall riparian habitat viability. (Weeds replace native trees and shrub)
	Incised Stream Reaches	Increasing floodplain area in selected reaches will allow for hydrologic reconnection into wetland habitats.
	Loss of Hydrological Function	Increasing beaver presence to historic level would help restore hydrological function to floodplains.
	Loss of Stream Complexity and Increased Flows	Appropriate silvicultural practices that maintain and enhance riparian habitat will increase presence of large woody debris in streams. This will increase both fish and wildlife focal species presence and population sizes.
Habitat has suffered habitat loss and fragmentation, removing corridors necessary for wildlife movement.	Hydrological diversions (e.g., irrigation, dams)	Re-establishment of natural floodplain habitat conditions and hydrological pathways would benefit wildlife habitat and result in population increases of focal species.
	Loss of Riparian Habitat and Function	Appropriate silvicultural practices that maintain and enhance terrestrial riparian habitat will decrease sediment discharge, maintain bank stabilization, and increase presence of large woody debris in streams. This will increase both fish and wildlife focal species presence and population sizes.
	Fragmentation of Habitat	Restoring and maintaining adequate riparian amounts of riparian habitat will restore and retain corridors used by wildlife as well as available habitat and forage. This will also retain water storage availability of riparian terrestrial habitat for release in drier seasons.
INTERIOR RIPARIAN WETLANDS - FOCAL SPECIES		
Yellow Warbler		

Interior Wetlands		
Key Findings	**Limiting Factors**	**Working Hypotheses**
Habitat loss and degradation has negatively affected yellow warblers in the subbasin.	Reduction in Floodplain Acreage	Identifying critical habitat, inventorying habitat remaining, and monitoring habitat changes, both locally and at a landscape level, will increase the effectiveness future management and protection of yellow warblers and reduce loss of habitat due to limiting factors.
	Overall Habitat Loss	
	Fragmentation of Habitat	
	Land Conversion	
	Reduced Food Base	Decrease misuse of herbicides and pesticides in riparian areas will decrease mortality of prey based need by yellow warblers.
Western Pond Turtle		
Western Pond Turtles have declined in number largely due to the loss and fragmentation of their historical habitat.	Fragmentation of Habitat	Reducing wetland conversion will decrease the amount of suitable turtle habitat that is lost and populations will increase.
		Reducing the development of wetlands will decrease the amount of suitable turtle habitat that is lost and populations will increase.
	Reduction in Floodplain Acreage	In wetlands, avoiding road-building activities and restoring habitat on abandoned roads / railroads and relocating problematic roads would decrease current and future fragmentation of potential and suitable habitat.
Much of the western pond turtle's suitable habitat has become unsuitable due to habitat degradation.	Overall Loss of Riparian Vegetation	Removing grazing from known turtle locations and better management of grazing in potential turtle habitat will reduce damage to aquatic and terrestrial wetland vegetation and increase survival of eggs and hatchlings.
	Loss of Riparian Habitat and Function	
	Displacement of Native Riparian Vegetation with Non-native Vegetation	
	Predation by Non-Native Animal Species	Control of non-native animal species, such bullfrogs and non-native fish, in occupied wetlands would increase turtle survival by reducing competition. It would also increase vegetation quality and structural complexity.
	Increase in Human Disturbance	Decreasing human recreational activities around known wetlands used by turtles would increase reproduction success and increase overall population growth.

4.4 Ponderosa Pine (*Pinus ponderosa*)/Oregon White Oak (*Quercus garryanna*)

Rationale For Selection

Ponderosa Pine

Much of the ponderosa pine forest in Washington State lies at lower elevations under state and private ownership. Most of this land base was heavily harvested in the first part of the last century, leaving very little late seral or old growth ponderosa pine habitat today. Fire suppression and over grazing had additional impacts. Noss et al. (2001) considers ponderosa pine ecosystems to be one of the most imperiled ecosystems of the West. Much of this land is now over stocked with an understory of Douglas-fir and grand fir (*Abies grandis*) or smaller diameter pine. The loss and alteration of historic vegetation communities has impacted landbird habitats and resulted in species range reductions, population declines and some local and regional extirpations (Altman 2000). Interior Columbia Basin studies (Wisdom et al. 2999) found that wildlife species declines were greatest in low-elevation, old-forest habitats. A more detailed discussion of habitat dynamics for this forest type can be found in Johnson and O'Neil (2001).

There is major dependency on ponderosa pine habitats by white-headed woodpecker (*Picoides albolarvatus*), western gray squirrel (*Sciurus griseus*), Lewis' woodpecker (*Melanerpes lewis*) and flammulated owl (*Otus flammeolus*). Other species that are dependent upon or benefit substantially from this habitat include the pygmy nuthatch (*Sitta pygmaea*) and Williamson's sapsucker (*Sphyrapicus thyroideus*). Other birds that seem to prefer mature ponderosa pine stands are western wood-peewee (*Contopus sordidulus*), mountain chickadee (*Poecile gambeli*), red-breasted nuthatch (*Sitta canadensis*), hermit thrush (*Catherus guttatus*), western tanager (Piranga ludoviciana), chipping sparrow (*Spizella passerine*), Cassin's finch (*Cardopacus cassinii*), red crossbill (*Loxia curvirostra*) and evening grosbeak (*Coccothraustes vespertinus*) (Hutto and Young 1999). Clark's nutcracker (*Nucifraga columbiana*) and brown creepers (*Certia americana*) also use ponderosa pine as a food source (R. Dixon pers. comm.).

Due to the alteration of this ponderosa pine habitat and loss of late seral pines, and due to the importance large pines to wildlife, the Ponderosa Pine / Oregon White Oak wildlife habitat type was chosen as a focal wildlife focal habitat.

Oregon White Oak

Oregon white oak woodlands consist of stands of pure oak or oak / conifer associations. In oak / conifer associations, ponderosa pine and Douglas-fir are important conifer components of these habitats. East of the Cascades, important oak habitat stands should generally be ≥ 5 acres in size to be functional habitat for wildlife. In more developed areas, though, single oaks or small stands of oaks that are < 1 acre in size, can also be valuable to wildlife when the oaks are late seral. These oaks have are larger in diameter, contain more cavities for nesting, produce more acorns, and have a large canopy. Late seral oaks are an important component of all oak forests.

Oregon white oak, known by many as Garry oak, is Washington's only native oak species (Miller 1985). It provides a unique plant community that provides forage, nesting and cover habitat to oak obligate species as well as many other more generalist species. There is a diversity of wildlife species found in all of Washington's oak forests, but in the oak forests found along

Klickitat River, there are several bird species present not otherwise found in Washington State (Manuwal 1989). These include acorn woodpecker (*Melanerpes formicivorus*), scrub jays (*Aphelocoma coerulescens*), and dusky flycatchers (*Empidonax oberholseri*).

Over the last two centuries, oak habitats have changed due to land conversion, timber practices and fire suppression. Today's oak stands are denser with smaller trees. Younger, denser stands do not provide as good wildlife habitat as the older, more open stands. Late seral oak stands are important to western gray squirrels, white-headed woodpeckers and Lewis' woodpecker. In upland oak-pine stands, some of the more common birds include the chipping sparrow, Nashville warbler (*Vermivora ruficapilla*), lazuli bunting (*Passerina anoena*), red-breasted nuthatch, western tanager, and ash-throated flycatcher (*Myiarchus cinerascens*). In the oak-pine riparian areas, some of the most common birds are the spotted towhee (*Pipilo erythrophthalmus*), black-headed grosbeak (*Pheucticus melanocephalus*), American robin (*Turdus migratorius*), black-throated gray warbler (*Dendroica nigrescens*), MacGillivray's warbler (Oporornis tolmiei), lazuli bunting and red-breasted nuthatch (Manuwal 1989). Reptiles found in oak habitats include the California Mountain king snake (*Lampropeltis zonata*), sharptail snake (*Contia tenuis*), western rattlesnake (*Crotalus viridis*), southern alligator lizard (*Elgaria multicarinata*), and the western skink (*Eumeces skiltonianus*) (St. John 2002). There are also several species of invertebrates that use oak forests.

Due the importance of oak, oak-pine and oak riparian habitats to wildlife, the Ponderosa Pine / Oregon White Oak wildlife habitat was chosen as a focal habitat.

Ponderosa pine and Oregon white oak are separate plant habitats that often occur in proximity to one another or overlapping in transitional zones. In the lower Columbia, there have been five oak and pine habitats defined: riparian hardwoods (various amounts of hardwood species, including oak, no pine), riparian hardwood-pine (hardwoods, including oak with pine), riparian ponderosa pine (pine only), oak-pine forests (oak and pine uplands), and pure oak forests (no pine, uplands). The beginning of this write-up will focus, in a general way, on oak and pine as separate habitats, and then will discuss the importance of zones where they are found together.

Ponderosa Pine

Description of Habitat

Historic

Prior to 1850, much of the ponderosa pine habitat in the subbasin, and other parts of the inland northwest, was mostly open and park like with relatively few undergrowth trees. Fire scar evidence in the Wenatchee Mountains indicate that ponderosa pine forests burned approximately every 5-30 years prior to fire suppression, preventing contiguous understory development and, thus, maintaining relatively open ponderosa pine stands. Similar fire cycles are likely in the subbasin as well.

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 (i.e. large trees, open stands), but were relatively heterogeneous at the acre scale, with "patchy" tree spacing, and multi-age trees (Hillis et al. 2001).

Ponderosa pine forms climax stands that border grasslands and is 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 grasslike species such as bluebunch wheatgrass (Pseudoroegneria spicata) and Idaho fescue (*Festuca idahoensis*), elk sedge (*Corex geyeri*), and shrubs such as bitterbrush (*Purshia tridentata*), ceanothus [redstem (*Ceanothus sanguineus*), deer brush (*C. integerrimus*), snowbrush (*C. velutinus*), squaw carpet (*C. prostrates*)] 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):

- Ninebark (Physocarpus malvaceus)
- Common snowberry
- Idaho fescue
- Bluebunch wheatgrass

Daubenmire and Daubenmire (1984) recognize two more habitat types within the ponderosa pine series:

- Needlegrass (*Stipa comata*)
- Bitterbrush

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.

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 conditions that are more favorable. On more mesic sites, ponderosa pine encounters greater competition and must establish itself opportunistically, and is usually seral to Douglas-fir and true firs (mainly grand 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).

Current

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, decreased overstory canopy, and decreased native bunchgrasses. One third of the 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.

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, and Douglas-fir are harvested for timber 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 habitats are now denser than in the past and may contain more shrubs than in pre-settlement habitats. In some areas, new woodlands have even been created with tree establishment at the forest-steppe boundary.

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 Oregon white oak 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-fir, and occasionally western larch, lodgepole pine, and grand fir become increasingly significant. In Yakima and Klickitat Counties, Oregon white oak may be present, especially in drainages (extensive Oregon white oak stands are assigned to the Oak zone). In the Blue Mountains, small amounts of western juniper commonly occur. Lodgepole pine is common in the northeast Cascades and northeastern Washington (Daubenmire and Daubenmire 1968).

Stresses

Timber Activities

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 than ponderosa pine (Habeck 1990). 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).

Ponderosa 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 returns succession to earlier seral stages and eliminates climax, or old growth, conditions. Logging also impacts understory species by machine trampling or burial under 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).

Fire Suppression

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 as Douglas-fir, and grand fir 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, reduces fine fuels that carry low intensity fires, and tends to favor shrub and conifer species. Fire suppression combined with grazing creates conditions that support cloning of oak and invasion by young conifers, including shade tolerant species such as grand fir.

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).

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).

Inappropriate Grazing

Excessive grazing of ponderosa pine stands in the mesic shrub habitat type tends to lead to swards of Kentucky bluegrass and Canada bluegrass (*Poa compressa*). Native herbaceous understory species are replaced by introduced annuals, especially cheatgrass (*Bromus tectorum*) and invading shrubs under heavy grazing pressure (Agee 1993). In addition, four exotic knapweed species (*Centaurea* spp.) are spreading rapidly through the ponderosa pine zone and threatening to replace cheatgrass as the dominant increaser after grazing (Roche and Roche 1988). Dense cheatgrass stands eventually change the fire regime of these stands.

Oregon White Oak

Description of Habitat

Historic

Historically, the distribution of Oregon white oaks in Washington was more extensive than today (Detling 1968, Larsen and Morgan 1998).

Oak and oak / conifer habitats are usually confined to drier microsites between conifer and grassland habitats (Stein 1980). Ponderosa pine and Douglas-fir are often important tree species components of oak habitats and can increase their value to wildlife. In the area, understory shrubs are often dominated by bitterbrush and big sagebrush (Artemesia tridentata) (Taylor and Boss 1975). Understory forbs are often dominated by the same species common to adjacent shrub steppe and grassland habitats, such as lupine, balsamroot, Idaho fescue, bluebunch wheatgrass, elk sedge, blue wildrye, and other common grass-like species.

Nest cavities are an important component of oak forests. Many of the cavities found in oak trees are created by the woodpeckers. Woodpeckers, which are primary excavators, cannot create cavities in all trees and snags (Jackman 1975). It is important to have trees of varying ages and diameters to increase the number of woodpecker-created cavities in an oak forest (Conner et al. 1975). In turn, the higher number of cavities present is directly related to the density of cavity-nesting species (Jackman 1975), such as the flammulated owl, a secondary cavity user. Cavities can also be created when decay-causing organisms infect a wound, such as a broken bole or branch, and the tree grows around the wound to contain the decay (Gumtow-Farrior and Gumtow-Farrior 1994). This can create large, deep cavities inside the tree that are used by species such as the western gray squirrel for nesting and rearing young.

Oak have always been an important food source for wildlife. Oaks support insects within its bark that are eaten by woodpeckers (Jackman 1975). The most important food source from oaks, though, are acorns. Oak masts (acorns) make up the significant portion of the diet of many species of birds and mammals (Voeks 1981, Miller 1985, Larsen and Morgan 1998). Consumers of acorns include western gray squirrel, Douglas' squirrel (*Tamiasciurus douglasii*), Lewis' woodpecker, deer, acorn woodpeckers, scrub jays and black bear (*Ursus americanus*). Acorn production fluctuates yearly for unknown reasons (Larsen and Morgan 1998).

Leaves are an important food source for deer and elk, and contain significant amounts of protein (Miller 1985). Deer and elk, in turn, are an important prey item for several carnivores such as cougars (*Puma concolor*), whose population depends on the population of healthy deer (Barrett 1980). Some invertebrates also rely on oak leaves during larval stages (Pyle 1989, Larsen and Morgan 1998). Leaf litter also may help retain soil moisture that aids in oak seedling survival.

Current

In Washington State, the current distribution of Oregon white oak woodlands is limited primarily to along the Columbia Gorge, northward along the east side of the Cascade Range, as well as in the Puget Trough and in the south-central counties (Scheffer 1959, Stein 1980, Miller 1985) (figure 9). Within this limited range, oak woodlands are considered uncommon.

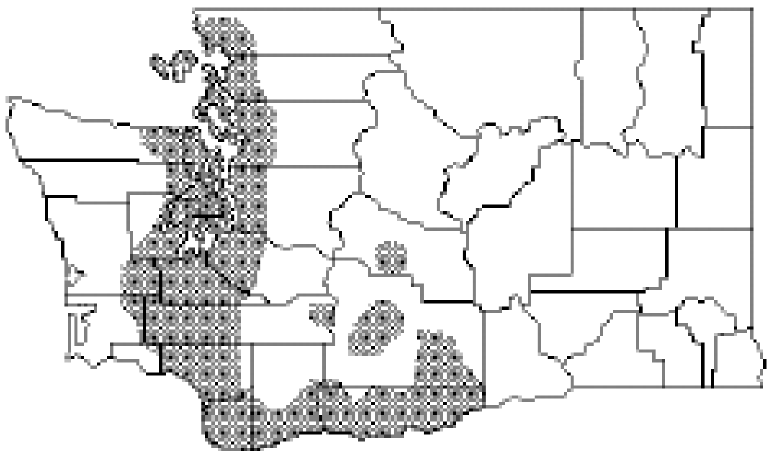

Figure 9 Range of Oregon white oak woodlands in Washington State. Map derived from WDFW data files and the literature (Larsen and Morgan 1998)

Stresses

Fire Suppression

Fire suppression has created denser forests with smaller trees. In oak forests, it has led to denser understories, smaller trees and higher fuel loads. Historically, oak forests, like ponderosa pine, were more open and park-like. Open-canopy stands of oak generally have more complex plant understories than closed-canopy stands and can, therefore, support more wildlife species. Canopy cover of 25-50 % provides ideal habitat for a variety of species as well as needed gaps for sunlight (Barrett 1980).

Although conifer encroachment is an issue in oak forests in many parts of Washington State, it may not be in eastern Washington. Conifer encroachment, predominately by Douglas-fir, occurs primarily west of the Cascade crest and in wetter areas on the east side, such as the White Salmon River drainage of the Columbia Gorge. In drier areas east of the Cascades, conifer competition with oaks is generally negligible. Oregon white oak is usually sub-climax and becomes climax only on dry, rocky, southerly exposures (UFS 1965).

Land Conversion

Most oak woodlands in the state are privately owned, and private parcels collectively comprise the largest contiguous tracts (WDW 1993, Larsen and Morgan 1998). Statewide mapping is underway by WDFW to quantify the extent of Washington State's oak habitat. Klickitat County and adjoining lands harbor the largest stands of Oregon white oak in Washington State. Klickitat County alone, contains approximately 195,000 acres of oak and oak/pine woodlands with >25% canopy coverage. Within this area, there has been conversion of oak stands to agricultural lands, urban development, and losses from fuelwood cutting. These are believed to be the most significant contributors to oak woodland decline (Larsen and Morgan 1998). These land conversions are still taking place. Oregon white oak responds to fire by reestablishment through sprouting. Subsequent to settlement, fire control has resulted in less fire tolerant species competing for habitat with oak, thus replacing it in the community. This is arguably the significant impact to oak on private lands.

Woodcutting

Woodcutting may remove the largest trees from oak forests. Snags and snag recruitment trees may also be removed. Oak snags and dead portions of live trees harbor insect populations and provide nesting cavities and perches for birds and mammals.

Insects and Disease

Some trees succumb to defoliating insects or insects that attack by creating galls between the tree's bark and wood (UFS 1965). Recent insect blights have occurred in Klickitat County where already drought stressed trees have succumbed (B. Weiler, pers. comm.).

Thirty-one species of fungi also affect Oregon white oak. Some inhibit growth, and others kill trees. The major decay fungi are shoestring root rot (*Amillaria mellea*) and trunk rot (*Polyporus dryophilus*) (UFS 1965). Decomposing fungi, coupled with the rotting characteristics of this oak species, simplify the excavation of cavities for woodpeckers by softening wood (Jackman 1975). The process is often facilitated by the loss of limbs that expose heartwood (Gumtow-Farrior 1991).

A recent introduction of Sudden Oak Death syndrome, caused by the fungus Phytophthora ramorum, infects and kills other species of oak in California State. Oregon white oak is currently known to be a host to this fungus, but is not killed by it. Managers must stay aware of this fungus in case it mutates into a form deadly to the oaks.

Timber Activities

Clearcutting reduces oak habitat and the numbers of animals within, encourages conifer encroachment, and creates edges. The extent of this activity in the subbasin is currently low, or not occuring. Edges increase the frequency of predation on interior nesting species (Connel et al. 1973, Conner et al. 1979, Chasko and Gates 1982, Reed and Sugihara 1987).

Appropriate timber practices within oak stands vary according to location and tree species composition. When stands are thinned, Douglas-fir and ponderosa pine are harvested, temporarily leaving pure stands of oak. Selective cutting practices can allow for the retention of different age-class and species composition within stands (Conner et al. 1979), and age diversity within stands contributes to species richness and breeding bird diversity (Connel et al. 1973).

Failure to thin even-aged oak stands and failure to open canopy above overshaded oak sprouts and saplings may result in dense, even-aged oak stands of little diversity. Dense, even-aged oak stands support fewer kinds of wildlife.

Oak / Pine Mixed Zones

The difference between conifer encroachment and those oak/conifer associations valuable to wildlife is often unclear. Consultation with biologists from the WDFW and other oak specialists is strongly recommended whenever uncertainty prevails. Almost without exception, conifers associated with oaks in eastern Washington and along drier sites in the Columbia Gorge do not encroach negatively on oaks. Conifer/oak associations in these areas are limited and very valuable as actual or potential habitat, particularly for western gray squirrels and wild turkeys

(*Meleagris gallopavo*). Conversely, conifer encroachment on oaks in western Washington and along wetter sites in the Columbia Gorge, such as the White Salmon drainage, is prevalent and undesirable.

Oak/conifer associations provide contiguous aerial pathways for squirrels and other animals. Mixed oak/conifer associations are particularly important in potential western gray squirrel habitat and for increasing stand diversity for breeding birds (Rodrick and Milner 1991, WDW 1993).

Failure to provide conifer associations in oak woodlands may limit the number of species of breeding birds present. In addition, roost sites for wild turkeys and other birds, as well as feeding sites for squirrels, will be absent.

4.4.1 Western Gray Squirrel (Sciurus griseus)

Rationale for Selection

Although the western gray squirrel was once abundant and widespread throughout oak-conifer forests, its range in Washington State has contracted to three disjunct populations. In our subbasin, population loss and fragmentation is largely due to disease (i.e., mange) associated with invasion of California ground squirrels and seasonal weather differences, which effect acorn production. Habitat loss and degradation is also a likely long-term factor. In the future, competition from the introduced eastern grey squirrel may also be an issue. The western gray squirrel is heavily associated with both ponderosa pine and Oregon white oak forests. In the Columbia River Gorge, Oregon white oak-ponderosa pine forests prevail. These forests follow stream drainages northward toward Goldendale and into Yakima County (Franklin and Dyrness 1973).

A 1993 unpublished status review by the Washington Department of Wildlife (currently WDFW) found that the species was “in danger of extirpation from most of its range in Washington” (WDW 1993), although in Klickitat County the population appears to be stable. The western gray squirrel is now a state threatened species in Washington State and a federal species of concern. Due to their strong association with late seral oak and pine forests, the western gray squirrel was chosen as a focal species for the Ponderosa Pine / Oregon White Oak wildlife habitat type.

Key Life History Strategies: Relationship to Habitat

Summary

Recommended habitat objectives include the following (Foster 1992):

- Contiguous canopy cover (mean = 60%)
- Nest tree age (69-275 yr, mean = 108 yr)
- Diameter at breast height (21-58 cm, mean = 40 cm; 8.2-22.6 in, mean = 15.7 in)
- Within 180 m (600 ft) of water
- Adequate food sources

- Acorns important in winter and early spring
- Pine cones and seeds in late summer and fall; and
- Adequate habitat within home range: In Klickitat County 95% home ranges from 10-187 ha (mean 73 ha) for males and 3-44 ha (mean 21 ha) for females (Linders 2000).

General

Western gray squirrels need a variety of mast-producing trees for food, cover and nesting sites (WDW 1993). The quality of the habitat is influenced by the number of mast-bearing tree species in and near the nest tree sites, the age and size of the trees, and proximity to permanent water (Cross 1969, Gilman 1986, Foster 1992). The western gray squirrel is usually associated with mature forests, which provide the above-mentioned characteristics (WDW 1993).

Generally, the squirrels require trees of sufficient size to produce an interconnected canopy for arboreal travel (Foster 1992). Barnum (1975) observed no use of a lone pine tree that was full of green cones, conceivably because there was no travel cover available.

Since extinction or extirpation rates are partly area-dependent, the size of reserves, spacing of reserves, and location of dispersal corridors are important. Individual reserves must be large enough to ensure stability of the ecosystem and to provide a buffer from disturbance (Frankel and Soulé 1981).

Oak was more common in Washington 10,000 years ago, before a long-term climatic change (Kertis 1986). The western gray squirrel was probably more widely distributed in prehistoric times and has diminished recently along with the oak woodlands (Rodrick 1987). Presently, both the oak and the squirrel are at the northern extent of their ranges and are subject to increased pressure from a variety of environmental factors.

Nesting

Most squirrels build round stick nests, approximately 60 cm (2 ft) in diameter, in pole to sawtimber-sized conifers, about one third of distance from the top of the tree and next to the trunk. The nests are lined with lichen, moss, and bark shavings (WDW 1993).

Population Status and Trend

Status

In a 2003 Status Review and 12-month finding for a petition to list the Washington population of the western gray squirrel (68 FR 34682), the USFWS concluded that listing was not warranted because the Washington population of western gray squirrels is not a distinct population segment and, therefore, not a listable entity. The Washington populations are discrete from the Oregon and California populations and are declining, they are not “significant to the remainder of the taxon”. The U.S. Forest Service considers the squirrel to be a sensitive species, and uses it as an oak-pine community management indicator species in the Columbia River Gorge National Scenic Area.

Lewis and Clark (Thwaites 1904) described western gray squirrels as locally abundant in the Columbia River Gorge (see figure 10). In a book written on the Klickitat area (Neils 1967), Norris Young, an early settler of the town of Klickitat, wrote in 1890 “About this time our grub was getting low. We had killed almost enough gray squirrels to cover our roof and fringe the eaves with squirrel tails. However, we stayed until our food was all gone and we started to live on meat alone.”

Residents have noticed a decline of western grays in Klickitat County (Rodrick 196). Prior to the invasion of the California ground squirrel, local residents reported more western gray squirrels in the gorge in the 1920s (WDW 1993). Ground squirrel both competed for food and introduced mange to this population, likely contributing to the decline in western gray squirrels (WDW 1993). For example, during a study of western gray squirrels in Klickitat County conducted in 1998 and 1999, an outbreak of mange killed all but 4 of 22 squirrels being monitored by radiotelemetry (Cornish et al. 2001). Although exact reasons for their decline are unknown, changes in the landscape may have played a role.

Isolated populations remain in the southeast slope Cascade region, and the Columbia River Gorge, the latter being the largest in the state (figure 11). Recent records indicate that western gray squirrels are present in five major tributaries of the Columbia Gorge: the Klickitat River, Catherine, Majors, and Rock creeks, and the White Salmon drainage. In Klickitat County, the population seems to have been stable during the past 20 years. Since 1973, D. Morrison (from WDW 1993, pers. comm.) has observed several western grays each year on the Klickitat Wildlife Area. The western gray squirrel appears to be widely distributed across forested habitats of Klickitat County, but populations are localized. The core population of the western gray squirrel is currently found in the lower Klickitat drainage from the southern Yakama Nation boundary to the mouth of the Klickitat River.

Figure 10 Historic distribution of western gray squirrels in Washington (adapted from Booth 1947, Ingles 1965, Source: WDFW 2004)

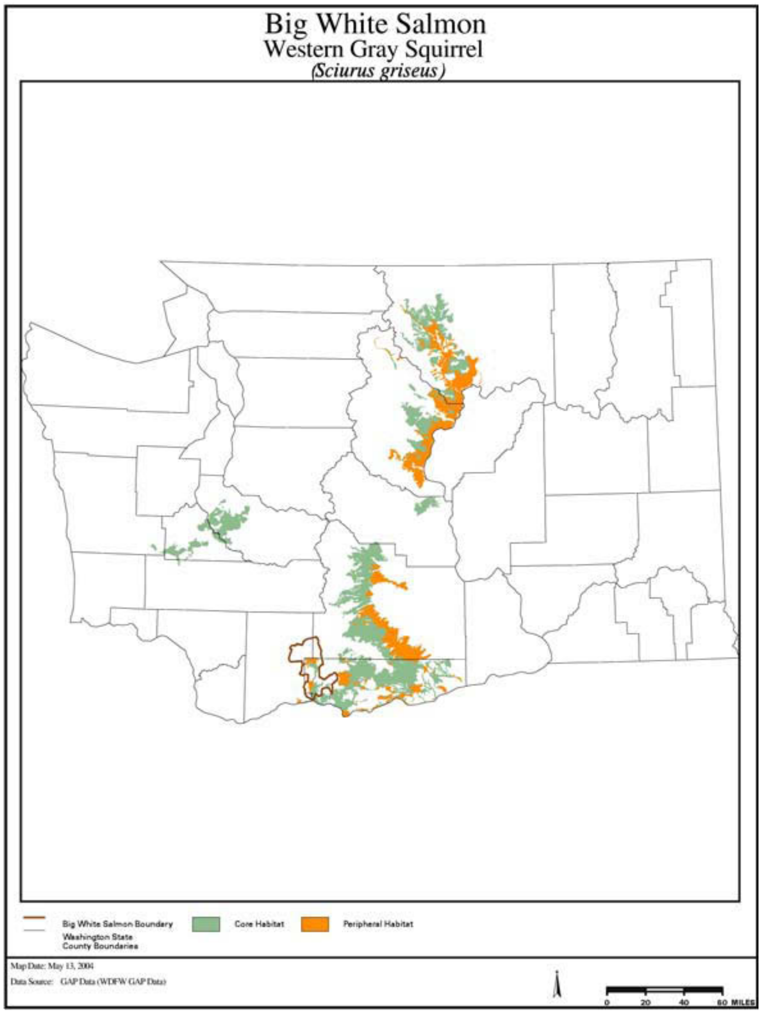

Figure 11 Potential habitat for western gray squirrel in the Big White Salmon subbasin and Washington State (Johnson and Cassidy 1997)

Trend

Long-term trends in the South Cascades population are unclear, although researchers did observe a decline in response to a widespread mange outbreak in 1998-9 and a subsequent rebound in the years following (M. Linders unpubl. data). In Klickitat County, the population seems to have been stable during the past 20 years.

Management Issues

Persistence of this species in the state of Washington will therefore likely depend on state-level protections of oak-conifer habitats and voluntary efforts by landowners federal entities.

The WDFW is in the process of writing a draft recovery plan, which is expected to be due out for public review in the summer of 2004.

Anecdotal evidence suggests there was essentially no acorn crop in the Columbia Gorge in 1991, and an insignificant crop in 1992 (from WDW 1993), indicating that weather cycles associated with mast failures also may cause cyclical declines in squirrel populations.

Out-of-Subbasin Effects and Assumptions

A radiotelemetry study of 25 western gray squirrels in Klickitat County, Wash., found 95% MCP year-round home ranges from 10-187 ha (mean 73 ha) for males and 3-44 ha (mean 21 ha) for females (Linders 2000). Home ranges of males were largest, then breeding females, with nonbreeding females having the smallest ranges (Linders 2000).

Relationship with Riparian / Fisheries Issues

In lower Columbia subbasins, oak habitat is commonly found along the main rivers and their tributaries. Large oak trees can provide shade for streams edges, while roots can provide bank stabilization. Healthy riparian terrestrial habitat provides habitat for wildlife as well as nutrients and woody debris, an important stream component for fish.

Factors Affecting Population

Weather

Annual fluctuations in rain and temperature can effect acorn production, which will result in annual fluctuation in western gray squirrel mortality.

Absence of late seral oak and pine

Older trees produce more acorns and pine seeds, vital food sources, abd produce better nesting sites (cavities in oak, platforms in pine). There is also an increase in crown connectivity:, which is important for arboreal travel.

Presence of exotic squirrel species:

Exotic squirrels, such as the California ground squirrel (*Spermophilus beecheyi*), increases exposure to disease (i.e. mange), and increased competition for food and nesting. The non-native Eastern gray squirrel has also been seen in the Big White Salmon subbasin (D. Anderson and F. Backus, pers. comm.).

4.4.2 Lewis' Woodpecker (*Melanerpes lewis*)

Rationale for Selection

Lewis' woodpecker is considered a potential sensitive environmental indicator in forest communities dominated by ponderosa pine (Diem and Zeveloff 1980). Their populations tend to be scattered and irregular and are considered rare, uncommon, or irregularly common throughout their range (Tobalske 1997). The Lewis' woodpecker is listed as a species of concern in Washington State. Because they can be used as an indicator species of healthy ponderosa pine systems, they are a focal species for the Ponderosa Pine / Oregon White Oak focal habitat.

Key Life History Strategies: Relationship to Habitat

Summary

Recommended habitat objectives for Lewis' woodpecker in ponderosa pine / oak habitat include the following:

- Adequate numbers of snags (1 or more of adequate size);

- Diameter at breast height (dbh) ≥ 30 cm (Thomas et al. 1979a, Galen 1989);
- Optimal height ≥ 9.1 m (Thomas et al. 1979a), range used 1.5-51 m (Bock 1970);
- Tree canopy closure ≤ 30 % (Galen 1989) (closure exceeding 75 % is unsuitable);
- Understory cover ≥ 50 %; and
- Acorn producing oak trees available for winter forage.

General

The tree species often used by Lewis' woodpecker include ponderosa pine, cottonwood, Jeffrey pine (*Pinus jeffreyi*), juniper (*Juniperus* spp.), willow and paper birch (*Betula papyrifera*).

Nesting

Logged or burned coniferous forests that are structurally similar to park-like pine stands also provide suitable breeding habitat. In fact, Lewis' woodpeckers are often characterized as "burn specialists" for their preference for nesting in snags within burned pine forests (Saab and Vierling 2001). Lewis' woodpeckers are considered weak excavators and prefer to excavate nest cavities in soft snags or dead trees instead of live trees (Lewis et al. 2002). The proportion of the maximum population that can be supported is considered to be positively correlated with snag density. Nest trees selected are often taller and larger in diameter than surrounding trees not used for nesting (Vierling 1997).

Diet and Foraging

Habitats used by Lewis' woodpeckers are characterized by their openness (Bock 1970). 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. 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. 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. Both understory and canopy conditions must be optimal in order to have optimal conditions in ponderosa pine stands.

Oak trees are also important to Lewis' woodpecker in this habitat. The winter diet of the Lewis' woodpecker consists primarily of available acorn mast or corn. Habitats that contain mast bearing trees, especially oaks, are important wintering areas for Lewis' woodpeckers. Occupied sites contained more abundant acorn crops than random sites (Vierling 1997). The winter diet of the Lewis' woodpecker consists primarily of available acorn mast or corn. Mast is stored in caches, is aggressively defended, 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. 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.)

Lewis' woodpeckers require mast storage sites in the form of trees or utility poles with desiccation cracks since they do not excavate holes in which to store mast. Modeling has shown 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.

Population Status and Trend

Status

The Lewis' woodpecker has been included in the Audubon 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 European starlings (Sturnus vulgaris) may be a possible cause of the decline.

Along the Klickitat River, a nesting pair was found near mile post 11 on SR 142 just west of the river (Manuwal 1989).

Trends

According to the Interior Columbia Basin Ecosystem Management Project (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 have been strongly reduced from historical levels, including 97 percent in the Columbia Plateau. 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 (figure 12); local abundance may be cyclical or irregular (Tobalske 1997). 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). 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).

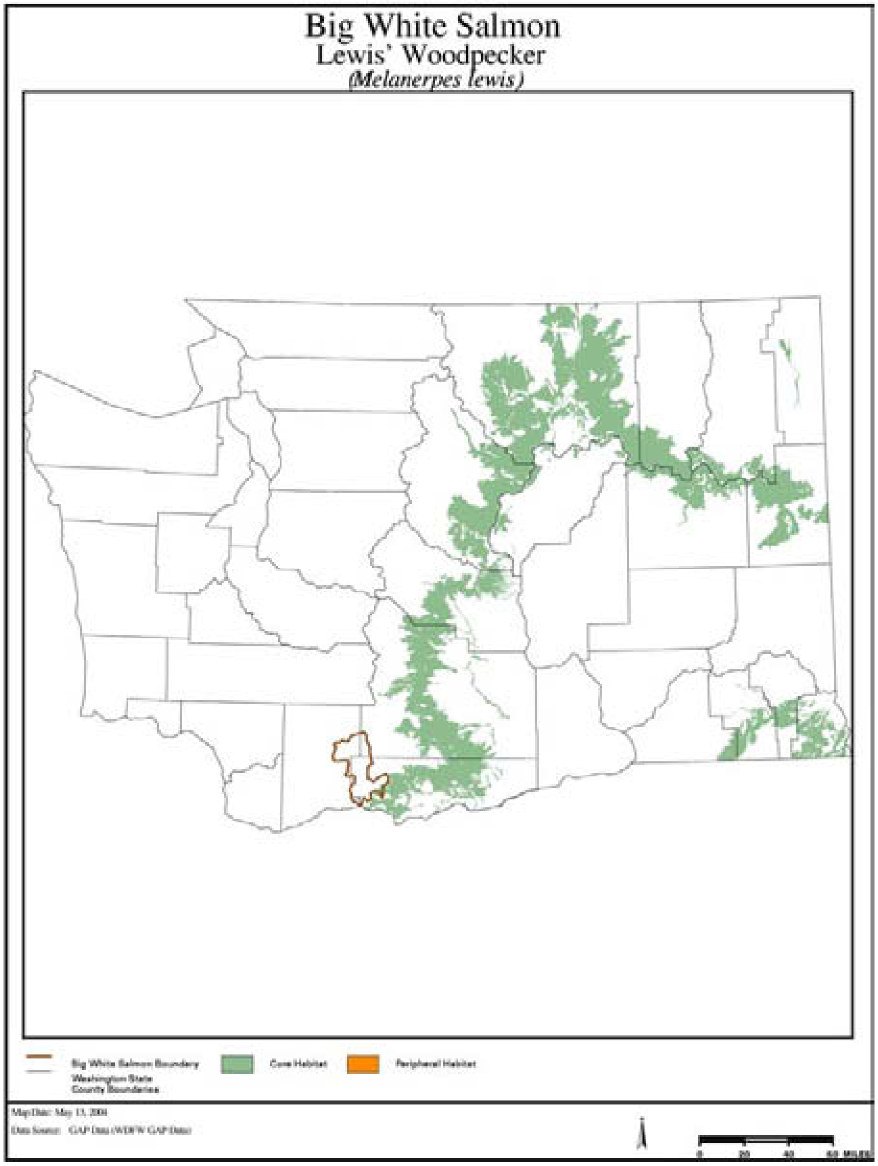

Figure 12 Potential habitat for Lewis' woodpecker in the Big White Salmon subbasin and Washington State (Smith et al. 1997)

Christmas Bird Counts (CBCs) are conducted annually in Klickitat County near Lyle and in the Columbia Hills-Klickitat Valley area. Lewis's woodpeckers appear to be common within the Lyle count circle, where a mean of 61 birds were counted annually from 1997 to 2001. In the Columbia Hills-Klickitat Valley count circle, a mean of 19/year were counted between 1996 and 2001. Although numbers were highly variable in both counts, there were no apparent decreases in populations during the time period that surveys were conducted (Hansen 2002).

Relationship with Riparian / Fisheries Issues

The historic and current heavy harvests of ponderosa pine forests can result in increased runoff into adjacent streams, increasing sediment and raising temperatures for those streams. Maintaining appropriate buffers adjacent to streams capable of supporting white-headed woodpeckers will increase the health of the streams and reduce sedimentation. This will in turn provide better habitat for fish and other stream dependent species.

Out of Subbasin Effects and Assumptions

The Lewis's woodpecker is highly migratory during the non-breeding season; often flocking in large groups in search of more plentiful sources of food.

Factors Limiting Population

Timber Activities

The reliance of Lewis' woodpeckers on mast producing oak trees for their primary winter food supply makes them vulnerable to forestry practices that seek to remove hardwood species in order to propagate more valuable conifers. It is important to continue educating landowners to the importance of Oregon white oak as an extremely valuable wildlife habitat component in order to eliminate this threat.

Fire Suppression

Fire is an important ecological function that serves to maintain the structure and species composition of the pine/oak habitat type. Fire suppression has allowed changes to occur by altering the species composition to favor the encroachment of shade tolerant species such as Douglas-fir. In addition, structure of this habitat type has changed to one that is overstocked and denser, thereby reducing the openness of the habitat so favored by the Lewis' woodpecker for successful aerial foraging for insects during the breeding season. Lack of fire also may limit snag recruitment since fewer oaks and pines are killed overtime; reducing the availability of nest sites.

Invasive Non-Native Species

European Starlings are the primary competitor with Lewis' woodpeckers for nest sites. Continued expansion of human development within the pine/oak zone may increase the abundance of starlings into areas where they are not so common or currently absent, undoubtedly increasing competition for nest sites.

4.4.3 Ponderosa Pine/Oregon White Oak Key Findings, Limiting Factors and Working Hypotheses

Table 13 Ponderosa Pine/Oregon White Oak Key Findings, Limiting Factors and Working Hypotheses

PONDEROSA PINE / OREGON WHITE OAK		
Key Findings	**Limiting Factors**	**Working Hypotheses**
Habitat communities have changed considerably in stand structure and composition compared to historical conditions.	Reduction of Large Diameter Trees and Snags	Appropriate silvicultural practices that retain old overstory trees, increase average diameter of dominant trees, and decrease understory density will recover ponderosa pine late seral composition and structure. These conditions increase habitat and forage available to wildlife.
	Increased Stand Density and Decreased Average Tree Diameter in Ponderosa Pine Stands	Reintroduction of an ecologically-based fire regime (or fire mimicking silvicultural practices when fire cannot be reintroduced) will recover late seral ponderosa pine and Oregon white oak stand dynamics, ecological function and habitat quality for wildlife. (Absence of fire leads to increased stand and stem density and susceptibility to disease and stand replacement fire).
	Displacement of Oregon White Oak by Conifer Encroachment	
	Loss of Native Understory Vegetation and Composition	Properly managed grazing will decrease spread of non-native understory plant species and help reestablish a native plant community. Presence of native grasses and forbs will provide good conditions for both wildlife and livestock.
Habitat communities have suffered habitat loss and fragmentation.	Loss of Large Tracts of Old Growth, or Late Seral, Forests	Silvicultural practices that retain large tracts of intact late seral forests will decrease temporary fragmentation of focal species habitat.
Western Gray Squirrel		
Western gray squirrels have suffered fragmentation between populations due in large part to fragmentation and degradation of late seral oak and pine conditions on which they depend.	Reduction of Large Diameter Trees and Snags	Silvicultural practices that retain large tracts of intact late seral forests will decrease temporary fragmentation of western gray squirrel habitat.
	Increased Stand Density and Decreased Average Tree Diameter	Reintroducing fire into used and potentially used squirrel habitat will increase the quality of the habitat and result in greater numbers of western gray squirrels.
	Loss of Native Understory Vegetation and Composition	Properly managed grazing will decrease spread of non-native understory plant species and help reestablish a native plant community. Presence of native grasses and forbs will provide good conditions for both western gray squirrels and livestock.
	Loss of Individual, Late Seral Trees (From Woodcutting)	Discouraging woodcutting in old growth stands will help retain late seral trees in landscape.

PONDEROSA PINE / OREGON WHITE OAK		
Key Findings	**Limiting Factors**	**Working Hypotheses**
Focal species have suffered declines in their population from competition and introduction of disease due to the presence of exotic squirrel species.	Increased Competition to Western Gray Squirrels	Reduction of California ground squirrels and eastern gray squirrels will increase survival of western gray squirrels locally, increasing numbers present in the subbasin.
Lewis' Woodpecker		
Key Findings	Limiting Factors	Working Hypotheses
Focal species has suffered a decline and degradation of their pine/oak habitat resulting in loss of nesting and foraging habitat.	Reduction of Large Diameter Trees and Snags	Increasing the number of larger, late seral ponderosa pine and Oregon white oak trees within Lewis' woodpecker range, with the use of selective silviculture practices and the reintroduction of a more historical fire regime, will increase available nesting trees and forage, resulting in increase in presence and numbers of Lewis' woodpecker in our subbasin.
	Loss of Large Tracts of Old Growth, or Late Seral Forests	Silvicultural practices and land use that retain large tracts of intact late seral forests will decrease temporary fragmentation of Lewis' woodpecker habitat.

4.5 Montane Coniferous Wetlands

Rationale for Selection

The Montane Coniferous Wetlands wildlife habitat was chosen as a focal habitat due to its ecological and cultural importance. This habitat type is naturally limited in its extent. Categories within this habitat type include wet meadows, streams, ponds, seeps, bogs, swamps, and other forested wetlands. One of the categories of Montane Coniferous Wetlands we are focusing on isupland meadows. Upland meadows have been declining steadily in numbers, size and quality. Meadows are extremely important to the functioning of the surrounding riparian systems as well as for adding habitat diversity within an otherwise forested matrix. They act as a water storage reserve, providing a continuing source of water for many surrounding streams throughout the summer. In many montane wetland types, forest practices and grazing activities have over time compressed the soil, caused stream channel incisement, increased sediment delivery, decreased riparian cover. The functional losses are increases in-channel sedimentation, channel instability and bank erosion, lowered water table, and increased summer stream temperatures. Fire suppression has contributed to forest encroachment on meadow habitats. Loss of wetland function and meadow structure decreases habitat quantity and suitability for native plant and wildlife species, and results in greater runoff peaks and lower baseflows. Meadows are also important culturally, supporting many species of edible and medicinal plants collected by tribal people.

Other montane wetlands also provide unique habitat that is important to vegetation, fish, wildlife and people. This zone has wide ranging impacts on the terrestrial zones surrounding it and beyond. Likewise, terrestrial zones have an impact on riparian habitat.

Many animal species directly depend on streams for all or part of their life cycle (e.g. amphibians, aquatic insects and fish). Aquatic secondary production (e.g. insects, tadpoles and fish) provides food for riparian species such as birds, bats and adult amphibians. Riparian lands and their vegetation also provide important habitat for land-based plants and animals. Not only is there an increased availability of water, there is the presence of often taller and denser vegetation, a more favorable microclimate, more or higher quality shelter and nesting sites and greater concentration of food resources. Riparian lands often have the highest level of plant and animal biodiversity in the forest. Riparian land also provides critical corridors for movement of plants and animals across the landscape. Healthy streams are important to fish, but since all wildlife are connected within a food web, water quality is a fisheries, wildlife and cultural concern.

Healthy riparian zones are also vital to forest health and sustainable land management. Predation upon aquatic organisms (insects, fish or amphibians) could be a major pathway for movement of aquatic nutrients and energy, through riparian food webs, back into terrestrial ecosystems. This movement of nutrients makes healthy riparian habitats an important forest health issue.

Description of Habitat

Montane Coniferous Wetlands are typified as meadows, forested wetlands or floodplains with a persistent winter snow pack.

Montane Coniferous Wetlands and Wildlife

The majority of terrestrial vertebrate species use some kind of riparian habitat for essential life activities making the density of wildlife in riparian areas comparatively high. Forested riparian habitat has an abundance of snags and downed logs that are critical to many cavity birds, mammals, reptiles, and amphibians. Riparian habitat structure tends to be more horizontally and vertically complex and often includes subcomponents such as marshes and ponds provide critical habitat for a number of species. Riparian habitats also function as travel corridors between essential habitats (e.g., breeding, feeding, season ranges). Species that depend on forested riparian habitats include the greater sandhill crane (*Grus canadensis tabida*), Oregon spotted frog (*Rana pretiosa*) and American beaver (*Castor canadensis*).

Historic

The montane coniferous wetland 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.

Historic wetland acreage in our subbasin is difficult to measure. The IBIS riparian habitat data are incomplete; therefore riparian floodplain habitats are not well represented on IBIS maps. Evidence of historic riparian wetland location and extent in the subbasin can be found by examining hydric soil distribution. The aerial photo record begins in the 1940s. In general, more recent photos indicate that historically sinuous meadow streams have become more channelized. Similarly, the distribution and abundance adjacent hydrophytic vegetation has beend reduced.

Snow typically begins accumulating in October and November and persists until March to June with earlier onset and increased duration and abundance directly proportional with elevation. Winter climate varies from moderately cool and wet in rain-on-snow dominated areas to moderately dry and very cold . Summer climates tend to be hot and dry with very little precipitation falling between June and September. 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 of sites the historic hydrology has persisted. Upper soil horizons in meadows where channel incisement has occurred and the water table has dropped, tend to be characterized by relic mottling. 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.

Vegetation

Along with meadow, much of this habitat type occurs as forested streams dominated by evergreen conifer trees (>30 percent tree canopy cover). Deciduous broadleaf trees such as aspen (*Populus tremuloides*) are occasionally co-dominant or occur along the margins of meadows. 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 are often a prominent feature in streams, although it can be lacking on less productive sites. In meadows, areas of herbaceous vegetation may occur, often with conifers encroaching along the edges.

In our subbasin the indicator tree species present for this habitat include: Douglas-fir (*Pseudtsuga menziesii*), ponderosa pine (*Pinus ponderosa*), grand fir (*Abies grandis*), lodgepole pine (*Pinus contorta*), and Western redcedar (*Thuja plicata*) are typical indicator tree species for this habitat. Western hemlock (*T. heterophylla*) and Alaska yellow-cedar (*Chamaecyparis nootkatensis*) are found sporadically in some areas west of the mainstem Klickitat River. Engelmann spruce (*Picea engelmannii*) and subalpine fir (Abies lasiocarpa) is more common at higher elevations. Trembling aspen above 2500', black cottonwood (*Populus trichocarpa*) below 3500', and several alder species (*Alnus spp.*) are also important occasional co-dominants.

Dominant or co-dominant shrubs present in our subbasin include: red-osier dogwood (*Cornus stolonifera*), Douglas' spirea (*Spirea douglasii*), common snowberry (*Symphoircarpus alba*), mountain alder (*Alnus incana*), and a variety of willow species (*Salix* spp.). The dwarf shrub bog blueberry (*Vaccinium uliginosum*) may be an occasional understory dominant in higher elevations. Shrubs more typical of adjacent uplands are sometimes co-dominant, especially big huckleberry (*V. membranaceum*), oval-leaf huckleberry (*V. ovalifolium*), grouse whortleberry (*V. scoparium*), and fools huckleberry (*Menziesia ferruginea*).

In forested wetlands, graminoids present in our subbasins that may dominate a variety of sedge species including smallwing (*Carex microptera*), beaked (*C. rostrata*), and water (*C. aquatilis*) sedges, tufted hairgass (*Deschampsia caespitosa*). Riparian areas with historic overgrazing tend to be characterized by increased abundance of more mesic graminoids such as bluegrasses (*Poa* spp.), false hellebore (*Veratrum* spp.) and possibly trisetum species (*Trisetum* spp.) Other plants that may be present include forbs and ferns such as 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 important species that may be present in montane meadows include common camas (*Camassia quamash*), Indian carrot (*Perideridia gairdneri*), Indian potato (*Claytonia lanceolata*), wild carrot (*Daucus pusillus*), wapato (*Sagittaria latifolia*), and arum-leaved arrowhead (*Sagittaria cuneata*).

http://www.nwhi.org/ibis/Queries/IMAGES/CHP2PHOT/H24_3.JPGThis habitat may extend down into the grand fir zone. It is not well represented by the GAP projects because of its relatively limited acreage and the difficulty of identification from satellite images. The acreage indicated on IBIS generated tables is thus misleading.

Disturbance

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 elevation of the growing surface relative to the stream channel. 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 perhaps the most significant influence in our subbasin.

Fires are typically high in severity and can replace entire stands, as most of 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 (Agee 1993). 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 Cascades and Olympic Mountains. Fungal pathogens and insects also act as important small-scale natural disturbances.

http://www.nwhi.org/ibis/Queries/IMAGES/CHP2PHOT/H24_4.JPGSuccession has not been well studied in this habitat. Following disturbance, tall shrubs may dominate for some time, especially mountain alder, currant, salmonberry, willows, 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. 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.

Current

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 forest practices and grazing, either directly on site or through modifications of stream flows. This type is probably relatively stable in extent and condition, although it may be locally declining in condition because of road building, timber harvest, inappropriate grazing and recreational use. Five of 32 plant associations representing this habitat listed in the National Vegetation Classification are considered imperiled or critically imperiled in Washington State (Anderson et al. 1998).

These habitats in our subbasin are largely on federal, industrial forest, or tribal lands. They fall roughly into two categories: 1. Well protected: High elevation locations on federal Wilderness designations are generally in excellent condition. The lack of roads and vehicular access allows natural processes to continue there; 2. Routinely degraded: Many montane coniferous wetlands are in areas where substantial degradation occurs each year. Many small Montane wetlands adjacent to streams in our subbasin have been severely disrupted by the placement of road fill and associated ditches that completely disrupt hydrologic function. Human disturbance from recreational use probably limits use of these habitats by sensitive wildlife species

Forestry, recreation and grazing activities have been consistently negative in their impacts to these accessible habitats for many years. Changes in grazing patterns, camping sites, vehicle access, road planning and this process offer hope that conditions on the montane wetlands near roads will improve. Without conscious effort, however, trends for these habitats will continue downward.

Stresses

Timber Activities

Logging practices can increase the frequency of landslides and resultant debris flows/torrents, as well as sediment loads in streams (Swanson and Dyrness 1975, Ziemer 1981, Swanson et al. 1987). 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 (Williams et al. 1995). Wind disturbance can be greatly increased by timber harvest in or adjacent to this habitat. Blowdown is common in buffers retained around such habitats.

Grazing

Improper timing, duration, and/or intensity of grazing can result in significant impact to herbaceous plant communities due to the continual presence of livestock. Excessive grazing by livestock can alter vegetation communities, change stream morphology, and increase fecal coliform material in ponds, streams and meadow wetlands.

Road Constuction

Road construction and placement can alter hydrologic regimes of wet meadow systems, directing flows into ditches and culverts and eliminating natural flows. Off road recreational vehicular access can create ruts from “mudding”, thus diverting flows, and compaction in high use areas such as campsites.

Fire Suppression

Fire suppression has had dramatic effects on montane coniferous wetlands particularly wet upland meadows. Fire suppression results in conifer encroachment onto otherwise treeless meadows. These conifers utilize the water resources, decreasing the water table and drying out the meadow. This can change the vegetation composition of the meadow, which is otherwise an important source of plants for native people. A decreased water table also changes the historical hydrological function of these meadows. Meadows act as important water reserves, retaining water that is slowly released into surrounding streams throughout summer. Without these reserves many of these streams will dry out sooner in the year, decreasing water availability to wildlife.

4.5.1 Oregon Spotted Frog (*Rana pretiosa*)

Rationale for Selection

The Oregon spotted frog is nearly always found in or near a perennial water body such as a spring, pond, lake or sluggish stream (Leonard et al. 1993). They are most often associated with non-woody wetland plant communities. Three populations are known extant in Washington today, one in the south Puget Sound lowlands (Dempsey Creek) and two in the Cascade mountain range in south-central Washington State, one at Conboy National Wildlife Refuge in the Klickitat subbasin, and the other at Trout Lake in the Big White Salmon subbasin. They are currently listed as endangered in Washington State and are a federal candidate species. Although they are found at the lower elevations of forested habitat, due to their strong association with wetland riparian habitats, they have been chosen as a focal species for the Montane Coniferous Wetland wildlife focal habitat.

Key Life History Strategies: Relationship to Habitat

Summary

Recommended habitat objectives include the following (McAllister and Leonard 1997):

- Optimal breeding areas, or oviposition sites that include shallow water, often 2–12 in (5–30 cm) deep (also Licht 1974, emergent wetlands, clear, oxygenated water (also M. Hayes, pers; comm.), emergent wetlands within forested landscapes;
- Suitably warm summer water temperatures (>68º F) (also Hayes 1994b);
- Abundance of aquatic and emergent vegetation during the growing season; and
- Large, connected wetlands and riparian habitats (Hayes 1994b).

General

The Oregon spotted frog is typically found in large, perennial wetland complexes, mostly within forested landscapes. Often the perennial water bodies are surrounded by smaller, more shallow ephemeral pools (Licht 1969b) important for breeding. Large marshy wetlands greater than 4 hectares (9 acres) may be necessary to carry sustainable populations of Oregon spotted frogs (Hayes 1994b). Oregon spotted frogs occupy the same wetland complex year round and larger populations may be able to better sustain the higher predation rates (Hayes 1994b).

Temperature

Warm summer water temperatures appear to be an important habitat feature, more often found in a lower elevation, large, shallow wetland. The physiological importance of temperature has not shown for Oregon spotted frogs. Females will often bask in the sun during summer and early fall to obtain higher body temperatures. This has been observed at all three Washington sites (McAllister and Leonard 1997). Males are rarely observed at this time of year (Hayes pers. obs.). At Dempsey Creek, in the Puget Sound lowland, juveniles are numerous in warm, shallow water during late summer (Hayes pers. obs.). In the Oregon Cascades, Oregon spotted frogs were found in water that averaged 83° F (28.6° C). Less than 5% of temperatures taken next to active frogs were <68° F (20° C) (Hayes 1994b).

In early spring, warm temperatures do not appear to be as much an important factor. During this breeding season, Oregon spotted frogs are active at substantially lower water temperatures. Frogs seen at Dempsey Creek were active in water consistently <50° F (10° C) and frogs were found active under ice (including a pair in amplexus) where the water temperature was 31° F. (-0.5° C.) (Leonard et al. 1997a).

Vegetation

Oregon spotted frogs are primarily found in vegetatively productive habitats. During the growing season, these systems support an abundance of aquatic and emergent vegetation. The decomposing vegetation along the bottom of wetlands support a diverse community of invertebrates that, in turn, support many vertebrates such as the Oregon spotted frog.

Vegetative mats are often used for basking (McAllister and Leonard 1997) and for escape from danger (McAllister pers. obs.).

Breeding

Oregon spotted frogs show a preference for shallow water for ovipositioning. Water depth of breeding sites vary from 2–12 inches (5–30 cm) deep (McAllister and Leonard 1997). Shallow, emergent wetlands appear to provide habitat critical to the persistence of this species (Hayes 1994a). Grasses, sedges, and rushes are usually present though eggs are laid where the vegetation is low or sparse (Hayes pers. obs.). Vegetation is characterized by soft rush (Juncus effusus), slough sedge (*Carex obnupta*), and creeping buttercup (*Ranunculus repens*). Mats of aquatic vegetation are used for basking. These habitats often provide a thin layer of unusually warm water that the frogs appear to prefer. Escape from danger is also achieved by a quick dive beneath the cover of the vegetation (Hayes pers. obs.). At Trout Lake during early spring, numerous adults have been found in shallow pools under a canopy of black cottonwood (McAllister and Leonard 1997).

Licht (1974) described improved hatching success for egg masses laid in river margin areas where flowing water improved oxygenation and cleansed the eggs of algae and fungus. Communal oviposition sites found to date are sufficiently removed from run-off channels such that surface water movement is imperceptible, except during periods of high water (Hayes pers. obs.).

Diet and Foraging

Oregon spotted frogs are almost entirely aquatic in habit, making suitable wetland habitat even more important than for other more terrestrial species. Wetlands associated with lakes, ponds, and slow-moving streams can provide suitable habitat; however, these aquatic environments must include a shallow emergent wetland component to be capable of supporting an Oregon spotted frog population (McAllister and Leonard 1997). Historically, this critical element was found in the floodplains of many larger water bodies. Various emergent-wetland and floating aquatic plants are found in abundance in Oregon spotted frog habitat. Adult female and juvenile frogs, in particular, spend summers in relatively warm waters of this shallow emergent wetland environment (McAllister and Leonard 1997).

Population Status and Trend

Three populations are known extant in Washington today, one in the south Puget Sound lowlands and two in the Cascade mountain range in south-central Washington: one near Trout Lake in the Big White Salmon subbasin and the other at Conboy National Wildlife Refuge, in the Klickitat subbasin (figure 13). These two populations inhabit large expanses of marsh. Surveys during 1997 at Trout Lake produced a minimum egg mass count of 572 (Leonard 1997). From this data, researchers are able to calculate an estimated adult population of a minimal 1,144 frogs. Engler (pers. comm.) reported that surveys at Conboy Lake covered an estimated 35-40% of suitable habitat and counted 664 egg masses. From this data, the population was estimated to include a minimum 1,328 adult frogs.

Range wide, Oregon spotted frogs have been found at only 13 of the 59 historical localities where there is verification that they once occurred (figure 14). Based on current status at specific historic sites, loss of populations is estimated to have affected 78% of the species' former range

(Hayes 1997). However, when considering the much broader range suggested by the historical data, it is estimated that the species has been lost from over 90% of its former range (Hayes 1997). The sizes and geographic extent of the three known remaining populations in Washington State are poorly known.

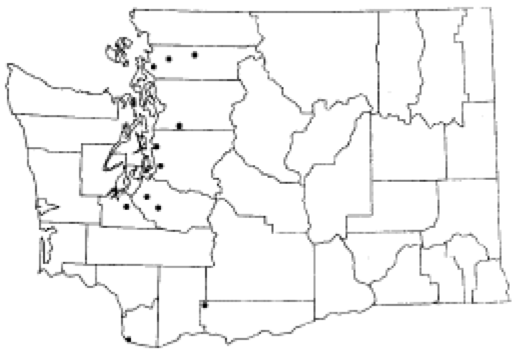

Figure 13 Locations of Oregon spotted frog populations found prior to 1990 (taken from McAllister and Leonard 1997)

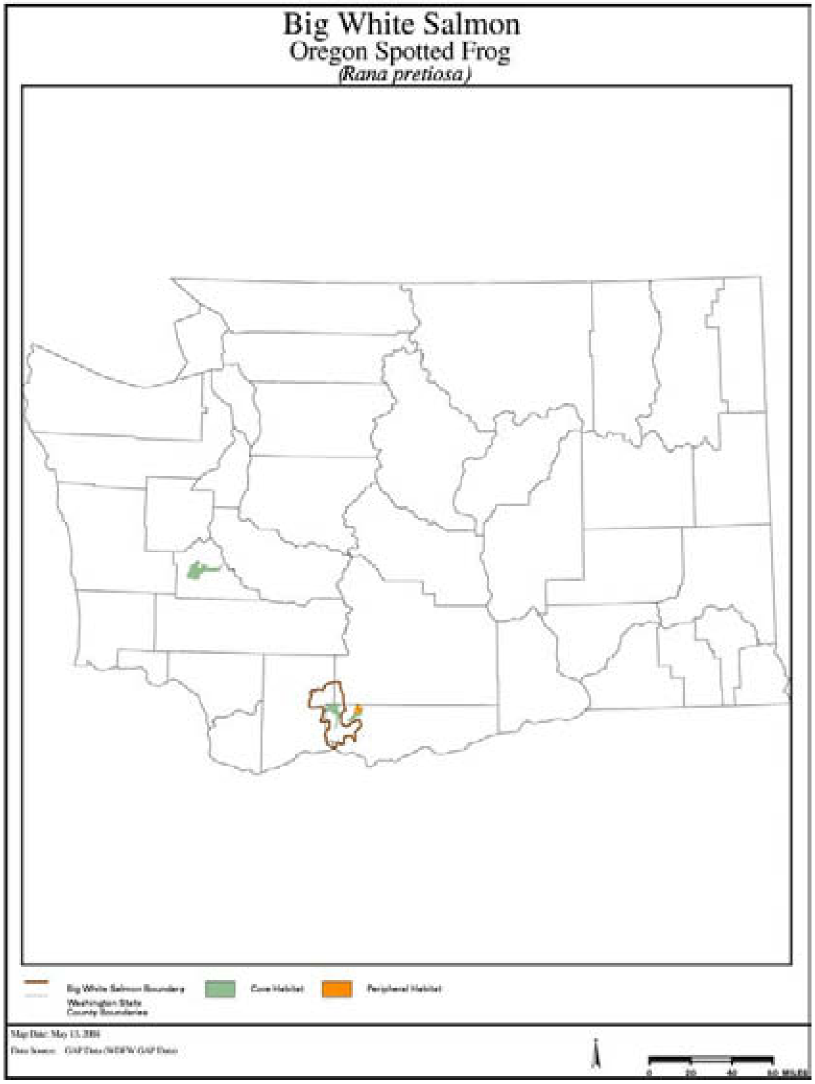

Figure 14 Potential habitat currently available for Oregon spotted frog in the Klickitat subbasin and Washington State

Management Issues

The two southern Washington Cascades populations are undergoing varying levels of research, inventory, and habitat protection. These activities are the combined effort of Federal and state agencies as well as a private landowner

The Trout Lake population is well-distributed over a mixture of state and private land. The site was approved for a new Natural Area Preserve and money has been appropriated to acquire privately-owned lands. Acquisition of this site is ongoing. Meanwhile, Oregon spotted frog surveys are conducted each year to identify key habitats such as overwintering and oviposition sites. Much of this marsh is currently grazed, including the oviposition sites found to date. Once established as a Natural Area Preserve, grazing will likely be discontinued (unless grazing is shown to be important to maintaining habitat conditions which benefit Oregon spotted frogs).

The Conboy Lake population is predominately within a National Wildlife Refuge. It is the only population in Washington known to be surviving in close contact with a population of introduced bullfrogs. Portions of this large marsh and ditch network have been surveyed for Oregon spotted frogs. The U.S. Fish and Wildlife Service have completed an initial evaluation of bullfrog predation on Oregon spotted frogs at this site (Engler and Hayes pers. comm.).

Out-of-Subbasin Effects and Assumptions

There was no literature found documenting long distance migration that would be needed for movement between subbasins. Seasonal movements appear to be within the large wetland complexes Oregon spotted frogs are found in (McAllister and Leonard 1997).

Relationship with Riparian / Fisheries Issues

Oregon spotted frogs need healthy, properly functioning wetlands for breeding, foraging and overwintering. Many wetlands, though, have been declining steadily in size and quality. Wetlands are an integral part of a properly functioning riparian system. Even though Oregon spotted frog depends on fishless wetlands, an improperly functioning wetland can negatively affect the connected riparian systems that do contain fish. Protecting and repairing degraded wetlands can increase available habitat for Oregon spotted frogs and enhance the connected habitat that fish and other vertebrates and invertebrates depend on.

Factors Affecting the Population

Habitat Loss and Degradation

Human population increases and concomitant development will continue to alter or eliminate habitat for breeding. Alteration of aquatic habitats, by water diversion projects or similar situations, may impose considerable hazard and hardship on migrating frogs and result in higher than normal levels of mortality.

Many wetlands have been drained and many more have been filled and developed. State-wide, a tremendous number of former wetlands, as well as uplands, are now covered by impervious surfaces such as roof-tops, asphalt, or compacted soil. These impervious surfaces shed run-off water quickly, putting increased demands on existing wetlands and stream courses to retain or carry the run-off water. As a result of these changes to the landscape, water levels fluctuate more dramatically. Rain or meltwater quickly enters the remaining wetlands and streams and fills them to capacity, often overflowing into non-wetland areas. Many streams have been dredged and straightened to help carry these floodwaters more quickly away from human developments. The floodwaters rise and fall at an increased rate. Oregon spotted frog breeding habitat (the margins of shallow wetlands) can be dramatically affected by these hydrologic changes. Eggs laid during or immediately following late winter rains are often left exposed to freezing and desiccation by rapidly dropping water levels.

Roads can fragment habitat and create barriers to migration. Overland movements by Oregon spotted frogs increase their vulnerability to vehicle mortality as well as increase their exposure to predation.

Diversion of water for irrigation and other purposes has also eliminated or altered frog habitat. The construction of dams and creation of reservoirs has been detrimental to western pond turtles by altering water flow in drainages, inundating habitat behind dams and reservoirs, and creating habitat suitable for the spread of non-native species (bullfrogs, warm water fishes) that are harmful to Oregon spotted frogs. Additionally, dams and their associated reservoirs may have fragmented populations by creating barriers to dispersal (Holland 1991b).

When these changes result in a reduction of size, permanence, and spring water depth, the otherwise suitable habitat can become unsuitable for Oregon spotted frog. This becomes especially critical in breeding habitat.

Non-native species

Introduced species have changed the ecological environment in the region for Oregon spotted frogs. As significant predators on tadpoles and small subbadult frogs, non-native species such as bullfrogs (*Rana catesbeiana*) and warm water fish seem to reduce survivorship and alter recruitment patterns (Lampman 1946, Holland 1985b). Non-native fish can also alter aquatic habitat when feeding on submerged and emergent vegetation. Many ponds where bullfrogs and non-native fish are found today are absent of native amphibian species that were once found there before.

Inappropriate Grazing

Cattle trample and eat aquatic emergent vegetation that serves as habitat for hatchlings and they may crush nests (Hayes et al. 1999).

Disturbance

Human caused disturbance (grazing, logging, roads, urban) can interfere with breeding behavior and alter breeding habitat, making it unsuitable.

Chemicals and Contaminants

The effect of biocontaminants on Oregon spotted frogs is largely unstudied. Rotenone, a biodegradable substance extracted from a tropical plant, is commonly used in fishery management to eradicate fish species. Rotenone has been documented to kill amphibian adults and tadpoles (Fontenot et al. 1994, McCoid and Bettoli 1996). Application of rotenone should be avoided in areas where Oregon spotted frogs likely to occur.

4.5.2 American Beaver (*Castor canadensis*)

Rationale for Selection

American Beavers are an indicator of healthy riparian systems. Beavers are dependent on permanent riparian systems with consistent year round stream flow rates, adequate stream-side an in-stream vegetation and presence of in-stream downed woody debris. Beavers are also an important tool in maintaining and repairing properly functioning riparian systems. Because of their strong relationship with healthy riparian systems, they were chosen as a focal species for the Montane Coniferous Wetland focal habitat.

Key Life History Strategies: Relationship to Habitat

Summary

Recommended habitat objectives include the following:

- Permanent source of water (Slough and Sadleir 1977);
- Ability to build lodges;
- Mild or no annual or seasonal water level fluctuations (Slough and Sadleir 1977) (Murray 1961, Slough and Sadleir 1977);
- Slow water flow (Collins 1976b);
- Low stream channel gradient (Slough and Sadleir 1977, Williams 1965);
- Stream channel gradients of 6 percent or less have optimum value as beaver habitat; streams of 15 percent or more are uninhabitable (Retzer et al. 1956);
- Presence of food source;
- Herbaceous plants include aspen, willow, cottonwood, alder) (Denney 1952) and aquatic vegetation (Collins 1976a); and
- 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).

General

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.

Lodge and Dam Building

Lodges and / or burrows, are built 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). On lakes and ponds, lodges are frequently situated in areas that provide shelter from wind, wave, and ice action.

For beavers to build dams, there must be a low seasonal and annual water level fluctuations, slow water flow and a low stream channel gradient.

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 14 percent or more, will have little year-round value as beaver habitat.

Diet and Foraging

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.

Various factors, including the poor placement, construction and maintenance of road systems in the subbasin, have contributed to changes in stream channel morphology. Stream channels have become incised, secondary channels have been lost, and beaver access to floodplains has been reduced. These factors contribute and relate to a decline in the recruitment of aspen and cottonwood, both food sources for beaver. The loss of wetlands is an additional factor limiting beaver populations.

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).

Population Status and Trend

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 remarkable comeback in many sections (figure 16).

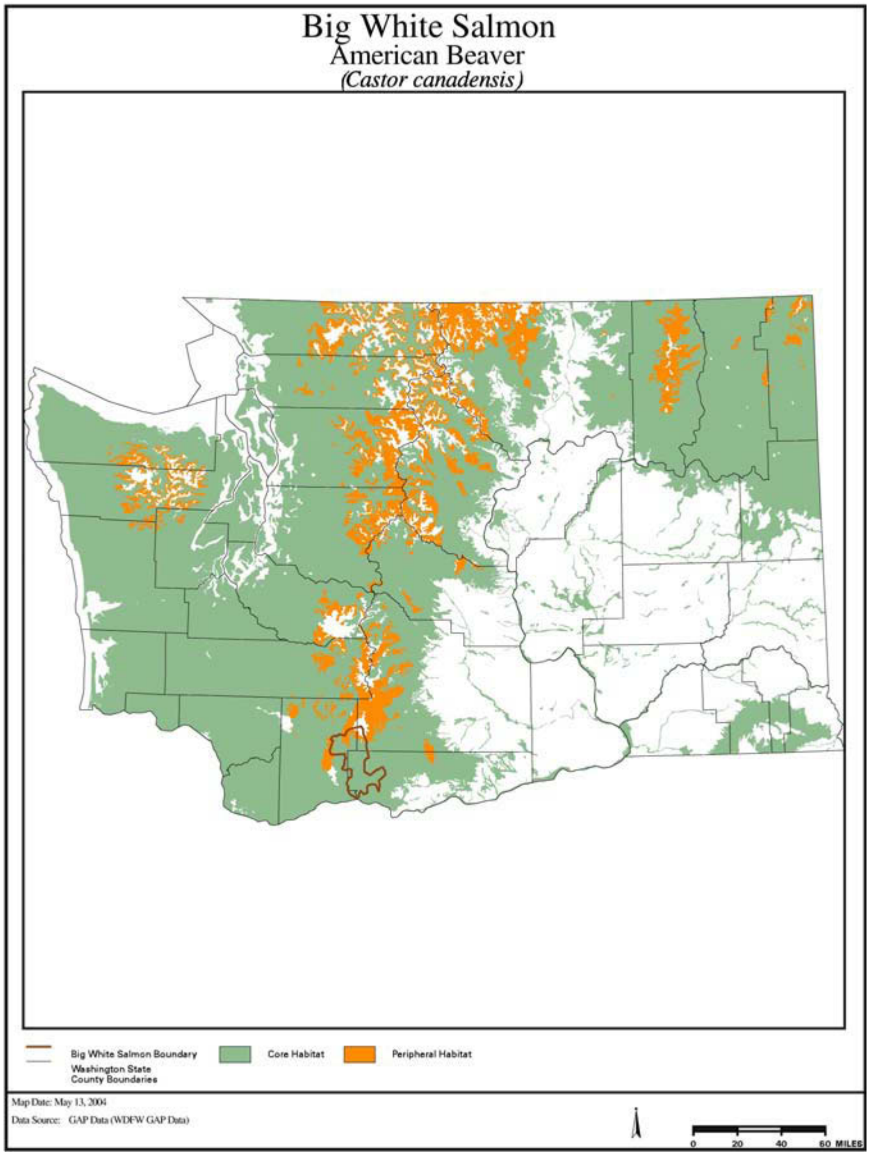

Figure 15 Potential habitat for American Beaver in the Big White Salmon subbasin and Washington State (Johnson and Cassidy 1997)

Management Issues

Trapping removed almost all of the beaver from the subbasin. Once this happened, they were no longer available to provide activities necessary to maintain the early-successional habitats on which they depend. Without beaver, a cycle is broken and important ecosystem and riparian / wetland functions are lost. In upland riparian habitats, beavers are unable to re-colonize the area with restoration and management efforts.

Transplants do occur of "problem" beaver from lower elevation riparian areas to higher elevation riparian areas. Little documentation is available on whether transplanted beaver have been successful in living in their new locations. Research and organization of these transplants would be valuable. Transplanting beaver could also be used to assess the quality of riparian restoration efforts, as well as act as a tool in the restoration efforts themselves.

There are many other human activities that have implications to both beavers and their habitat (Cederholm et al. 2000). Some examples include timber activities, presence of roads and cattle grazing. Timber activities can fragment wildlife habitat. It can also decrease woody debris available to streams and increase sedimentation. High amounts of sediment can increase water temperature, making streams unsuitable for fish, amphibian and aquatic macroinvertebrate species. Roads fragment habitat and creating barriers to migrating species. Roads can also cause sediment increase and edge degradation. Grazing both degrades terrestrial and aquatic vegetation, impacting both wildlife and fish.

Relationship with Riparian / Fisheries Issues

Beavers have long co-existed with salmon (*Oncorhynchus* spp.) in the Pacific Northwest, and have had an important ecological relationship with salmon populations (Cederholm et al. 2000). The beaver created and maintained a series of beneficial aquatic conditions in many headwater streams, wetland, and riparian systems, which serves as juvenile salmon rearing habitat. Beavers have multiple effects on water bodies and riparian ecosystems that include altering hydrology, channel morphology, biochemical pathways, and stream productivity. This function, however, has been severely altered by people. It is difficult to imagine the amount of influence beavers have had on the landscapes, most Pacific Northwest streams had been void of beaver activity for many decades before ecologists had the opportunity to study them.

Beavers are extremely important in contributing to large woody debris, which is a critical structural component in streams. Large woody debris provides important structural complexity as well as vital nutrients to streams. Large woody debris and beaver dams decreases stream velocity and temperature. It also provides refugia to migrating fish.

Beaver dams can obstruct channels and redirect channel flow and the flooding of stream banks and side channels (Cederholm et al. 2000). By ponding water, beaver dams create enhanced rearing and over-wintering habitat that protect juvenile salmon during high flow conditions. Beaver dams are often found associated with riperine ponds called “wall-base channels” along main river flood plains, and these habitats are used heavily by juvenile coho salmon (*Oncorhynchus kisutch*) and cutthroat trout (*Oncorhynchus clarki*) during the winter.

Factors Limiting Populations

Habitat loss and fragmentation

The lack of habitat and the loss of proper ecosystem and riparian fuctioning have hindered the natural re-colonization of beaver in this subbasin. Multiple factors have influenced the loss of habitat and riparian processes. The poor placement, construction and maintenance of road systems in the subbasin, have contributed to changes in stream channel morphology. Stream channels have become incised, secondary channels have been lost, and beaver access to floodplains has been reduced.

Food availability

Availability of food is a limiting factor. Degradation of streams contributes and relates to a decline in the recruitment of aspen and cottonwood. In winter, the amount of available winter food cache plants (woody plants) may be limiting (Boyce 1981). At lower elevations, riparian habitat along many waterways has been removed to plant agricultural crops, which removes important habitat and food sources for beaver.

Dam removal

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

Trapping

Historically, trapping removed beavers from the subbasin, resulting in the alteration of their riparian / wetland habitats.

4.5.3 Montane Coniferous Wetlands Key Findings, Limiting Factors and Working Hypotheses

Table 14 Montane Coniferous Wetlands Key Findings, Limiting Factors and Working Hypotheses

MONTANE CONIFEROUS WETLANDS		
Key Findings	**Limiting Factors**	**Working Hypotheses**
Montane Coniferous Wetlands have been and reduced in size and quality. Wet meadows have been especially reduced in size and number due to fire suppression, roads and other factors.	Tree and Shrub Encroachment into Wet Meadows	Reintroduction of an ecologically-based fire regime will decrease encroachment of conifers into montane wet meadows, increasing the water table and help reestablish proper hydrological function.
	Incised Streams and Loss of Wetland Function	Restoring stream channels in selected reaches will allow for hydrologic reconnection into wetland habitats.
	Displacement of Native Plant Communities by Non-native Plant Species	Removing reed canary grass (decreasing monotypic stands) will increase presence of native species, and increase habitat quality for wildlife.
	Overall Loss of Native Vegetation and Wetland Function	Appropriate management of livestock grazing in wetland areas minimizes damage to native meadow and streamside vegetation, reduces damage to stream banks, and reduces pollution in streams and ponds.
	Hydrological Alteration	Relocating wetland meadow roads, reducing or improving stream crossings, and locating motorized recreation to more appropriate sites improves hydrologic conditions, reduces fragmentation, and decreases disturbance to sensitive wildlife.
	Upland Hydrological Effects	Limiting silvicultural practices above meadows and enforcing a buffer around meadows will decrease sediment release in meadow hydrology and will increase water quality for fish and wildlife needs.
	Loss of Hydrological Function	Increasing beaver presence to historic level would help restore hydrological function to floodplains.
Oregon Spotted Frog		
Oregon spotted frogs have declined in number largely due to the loss and fragmentation of their historical habitat.	Loss of Wetlands	Decreasing the loss of wetlands to development and conversion would stabilize the populaton.

MONTANE CONIFEROUS WETLANDS		
Key Findings	**Limiting Factors**	**Working Hypotheses**
Much of the Oregon spotted frog's suitable habitat has become unsuitable due to habitat degradation.	Tree and Shrub Encroachment into Wet Meadows	Reintroduction of an ecologically-based fire regime will decrease encroachment of conifers into montane wet meadows, increasing the water table and help reestablish proper hydrological function.
	Decrease in Water Quality	Increasing water quality in important breeding ponds would increase survivorship of tadpoles.
	Displacement of Native Plant Communities by Non-Native Plant Species	Removing reed canary grass (decreasing monotypic stands) will increase presence of native species, and increase habitat quality for Oregon spotted frog.
	Competition and Predation by Non-Native Species	Control of non-native animal species, such bullfrogs and non-native fish, in wetlands used by Oregon spotted frogs and western pond turtle would increase survival. It would also increase vegetation quality and structural complexity.
	Reduced Viability	Reduction of chemical runoff into key breeding ponds would decrease mortality of frogs.
American Beaver		
American Beavers are unable to reestablish in historical locations due to habitat fragmentation, loss and degradation.	Fragmentation of Habitat	Reestablishing corridors of movement would help enable beaver to reestablish themselves in historical locations.
	Overall Loss of Riparian Vegetation	Restoration of riparian vegetation would increase food availability and quality for beaver, increasing survivorship and establishment efforts.

4.5.4 Agriculture

Description

Agriculture has replaced much of the native habitats historically existing in the subbasin, especially interior grasslands and shrub steppe. Due to the extensive presence of agriculture, it is considered a habitat type today. Some native species still exist in this habitat type, but the diversity of wildlife and plant species is decreased compared to historical habitat that have been replaced by agriculture. Also, agriculture has resulted in introduced plants and animals in the subbasin, many spreading beyond the borders of the agricultural habitat, reducing the quality of native habitats still existing today. Due to the quantity, and likely permanence of this habitat, it must be considered in management of wildlife in the subbasin. It is not considered a focal habitat, but is a habitat of concern that must be addressed in this subbasin plan. Although there are no focal species chosen for this habitat type, some of the wildlife species that are found in these habitats are: Great blue herons (*Ardea herodias*), Canada geese (*Branta canadensis*), mallards (*Anas platyrhynchos*), gopher snakes (*Pituophis catenifer*), and deer, among others.

Key Findings

Agricultural lands are an important economic and habitat component in the subbasin. Agricultural lands are found in areas that were historically shrub steppe, or interior grasslands. Athough not a historic land use, agriculture does provide many benefits to wildlife. A significant portion of what has been traditionally cropped is now in CRP (Conservation Reserve Program). This program provides Permanent native grass with scattered native shrubs that create excellent habitat for wildlife. The remaining agricultural land is predominantly alfalfa, wheat, or pasture. Agriculture like most other industries is becoming more environmentally friendly. No till or Direct Seeding is now being used wherever it is feasible, reducing emissions, erosion, and conserving natural resources. This subbasin, along with the majority of eastern Washington depends on agriculture as its leading economy.

4.6 Fish Assessment

4.6.1 Rationale for Focal Fish Species Selection

Focal species for the White Salmon River were chosen based on societal importance, data availability, and analysis tools. NOAA-Fisheries has listed chinook salmon, chum salmon, and steelhead populations in this basin as threatened under the ESA (NMFS 2002). Coho salmon, while not currently listed, are considered a candidate species for protection under ESA (NMFS 2002). Since NPPC, BPA, and NOAA have designed subbasin planning to provide a technical foundation for recovery plans, these species have been designated as focal species (NPPC 2001).

In addition to ESA, salmon and steelhead have cultural and economic importance to YN, the State of Washington, and the United States by providing harvest and non-consumptive benefits. These focal species are valuable indicator or diagnostic species to assess ecosystem performance because: 1) they depend on streams which are good indicators of watershed conditions, 2) they are sensitive to environmental conditions, 3) they use extensive portions of the watershed, and 4) they exhibit diverse life history patterns that are dependent on different high quality habitat types to be sustainable (Lestelle et al. 1996). Focal Species are listed in table 15.

Table 15 Focal fish species and their distribution within the White Salmon subbasin

Focal Fish Species	Habitat Represented
Spring Chinook	Below RM 16
Fall Chinook	Below RM 16
Steelhead	Below RM 16
Coho Salmon	Below RM 16
Rainbow Trout	Above RM 16

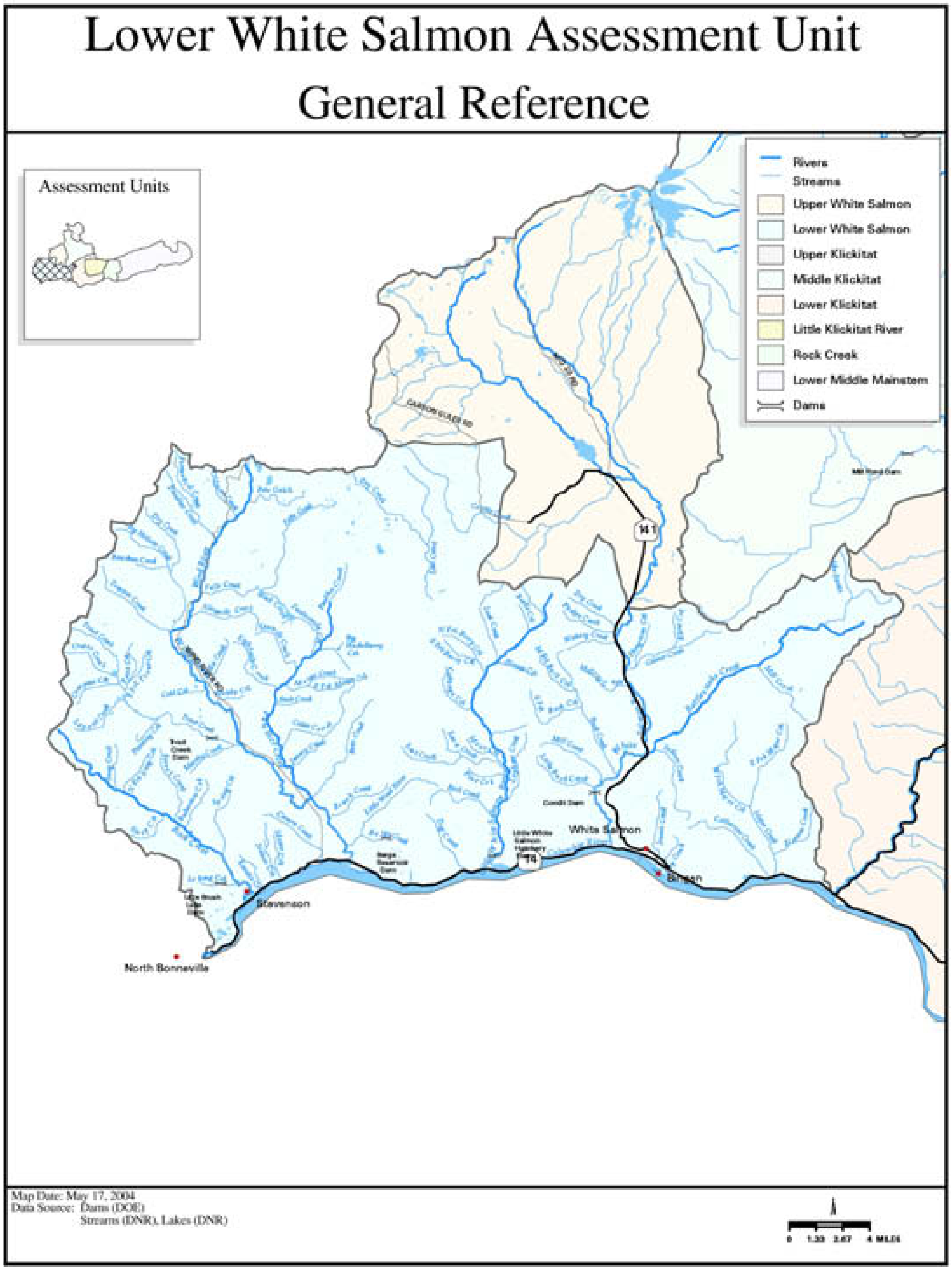

Figure 16 Lower White Salmon River Assessment Unit

4.7 White Salmon River Mouth to River Mile 16 Assessment Unit

4.8 Fish Focal Species: Chinook

Species characterization and status

Characterization

Chinook salmon are native to the White Salmon River (WDF et al. 1993) and their historical distribution extended from the mouth up to above Husum Falls (RM 12) in the mainstem, and Rattlesnake Creek. However, it was unclear if the chinook salmon observed at Husum Falls were spring or fall chinook salmon. Since Condit Dam inundated a gorge in the White Salmon River it is unclear if barrier waterfalls existed to maintain a separation between spring and fall chinook salmon. For the purposes of EDT modeling, the mouth of Little Buck Creek was chosen to separate the two chinook races and the historical distribution is found in figure 18. Current spawning distribution for both races is limited to the area below Condit Dam. The habitat below Condit Dam is more important for fall chinook and the areas above Condit Dam are more important for spring chinook. There is probably a transition zone in between these sites where the habitat is important for both races. The current distribution for fall chinook salmon is limited to the area below Condit Dam (RM 3.4). Spring chinook salmon were extirpated from the subbasin and recent hatchery releases return to spawn below Condit Dam. However, their reproductive success is unknown.

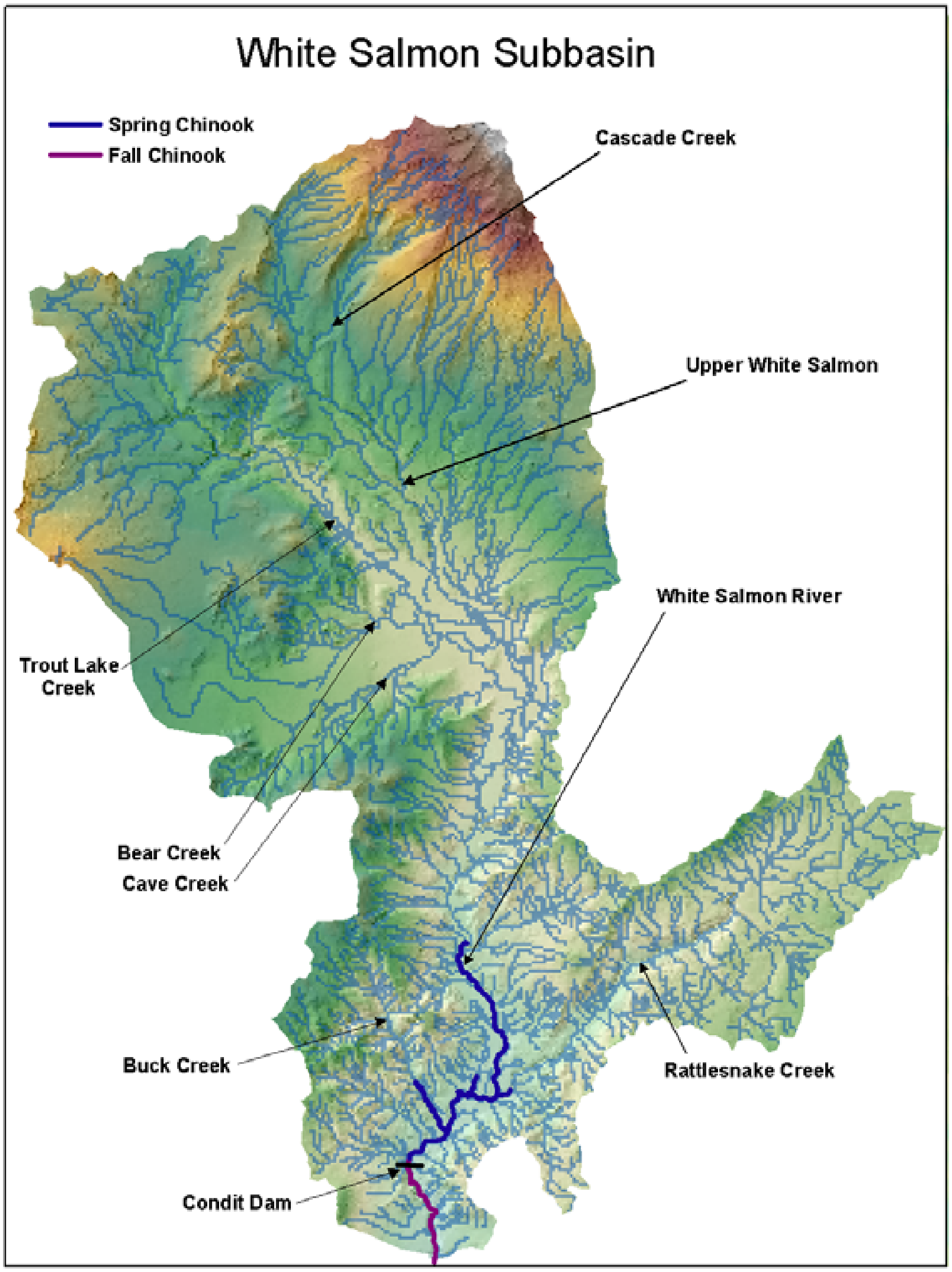

Figure 17 Historic spawning distribution of spring and fall chinook salmon in the White Salmon River.

Washington's Columbia River chinook salmon have been split into two split Major Ancestral Lineage (MAL): 1) Upper Columbia and Snake spring chinook and 2) Upper Columbia summer chinook and Columbia River fall chinook (Marshall et al 1994). Native fall chinook from the White Salmon River are part of the Mid-Columbia "tule" fall chinook GDU, and the native spring chinook salmon are part of the Lower and Mid-Columbia genetic diversity unit (GDU).

The recently established fall chinook "bright" population in the lower White Salmon is part of the Upper Columbia fall GDU, and the Carson stock hatchery spring chinook salmon released into this subbasin are part of Upper Columbia River GDU. NMFS included has included White Salmon "tule" fall chinook salmon and spring chinook salmon in the Lower Columbia River (LCR) EDU (Myers et al. 1997). Both races are isolated to the lower 3.4 miles of river below Condit Dam. Subpopulation structure of chinook salmon in the subbasin is unknown.

Figure 18 depicts the relationship of fall chinook salmon in the White Salmon with other Columbia River stocks. The SPRING CR H FA are tule fall chinook sampled from Spring Creek Hatchery. Since this stock was founded from White Salmon River tules, this collection best represents the current White Salmon River tules. It is a unique tule stock that clusters with other Lower Columbia River tule stocks. The introduced bright stock is best represented by the BELOW BONN. 96&97 or LT WHT SALMON H FA collections. Both of these populations cluster with the Upper Columbia River fall chinook. This is not surprising, since the PRIEST RAPIDS and HANFORD REACH are the original broodstock for these programs.

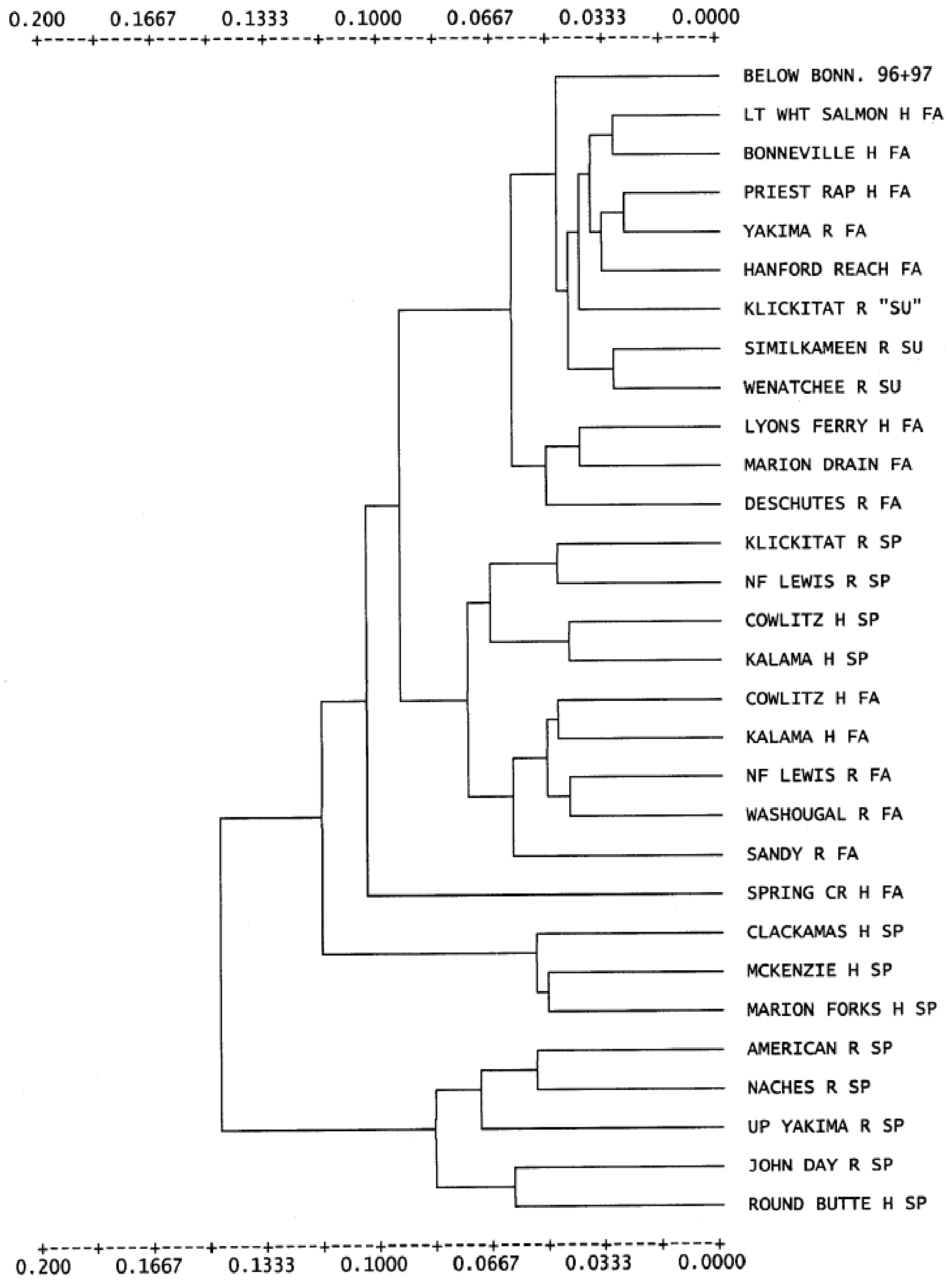

Figure 18 Cluster analysis of genetic distances among 30 Columbia Basin chinook populations. (Cavalli-Sforza and Edwards (1967)

BELOW BONN. = fall "upriver bright" natural spawners in the Columbia River below BonnevilleD.; H=Hatchery; R=River; FA=Fall Run; SU=Summer Run; SP=Spring Run.

Status

The status of native "tule" fall chinook salmon in the White Salmon River is listed as depressed and the status of "bright" fall chinook salmon is listed as unknown (WDF et al. 1993). Both "tule" and "bright" fall chinook populations are monitored in the White Salmon River. Escapements are estimated using the peak count expansion method (Norman 1982). Historically, spawning ground surveys were conducted from the base of the dam to the mouth; currently surveys are conducted from the powerhouse to the mouth. The accuracy and precision of the estimates is unknown, due to assumptions about temporal spawning distribution and observer efficiency. Bright fall chinook salmon were likely present after bright production was initiated in nearby hatcheries but escapement estimates were first made in 1988.

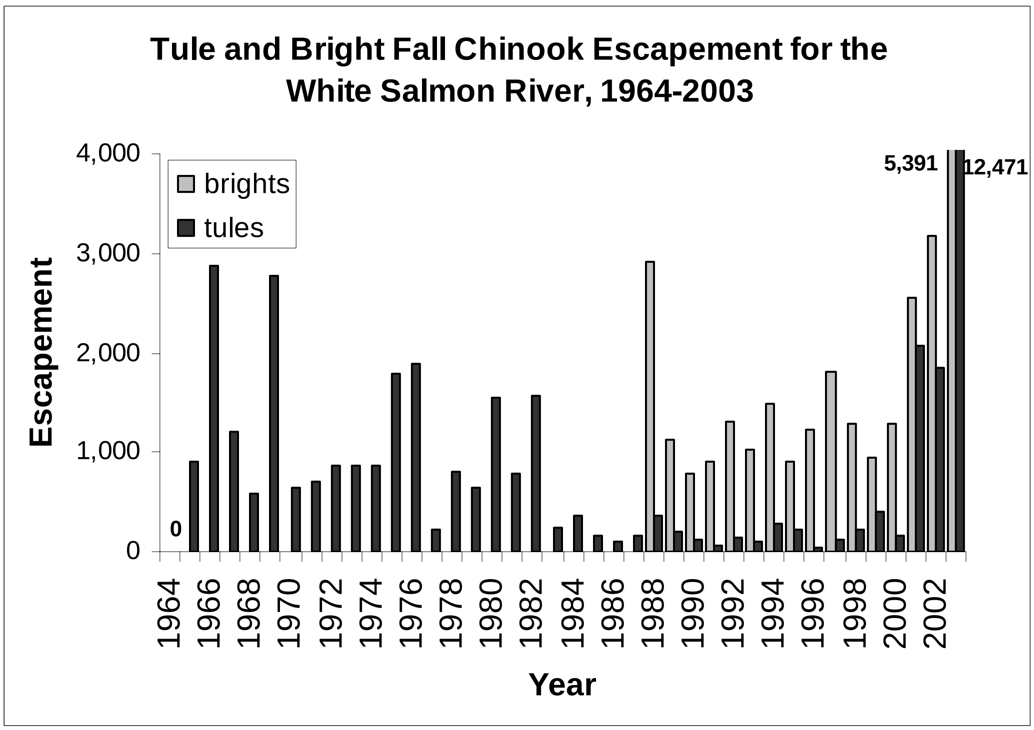

Figure 19 Fall chinook salmon population estimates for Tule and Bright stock in the White Salmon

The amount of wild tule production is unknown. However, Pacific States Marine Fisheries Commission (PSMFC) estimates the number of hatchery tules by expanding the coded wire tags (CWT) recovered during carcass surveys by the Spring Creek Hatchery brood year tag rate (Kelly Harlan, PSMFC). The wild component is estimated by subtracting the estimated hatchery production from the total tule escapement. Estimates of wild spawners are available from 1992 to the present. The estimated wild escapement averaged 319 and has ranged from 32 to 1,696 (figure 21).

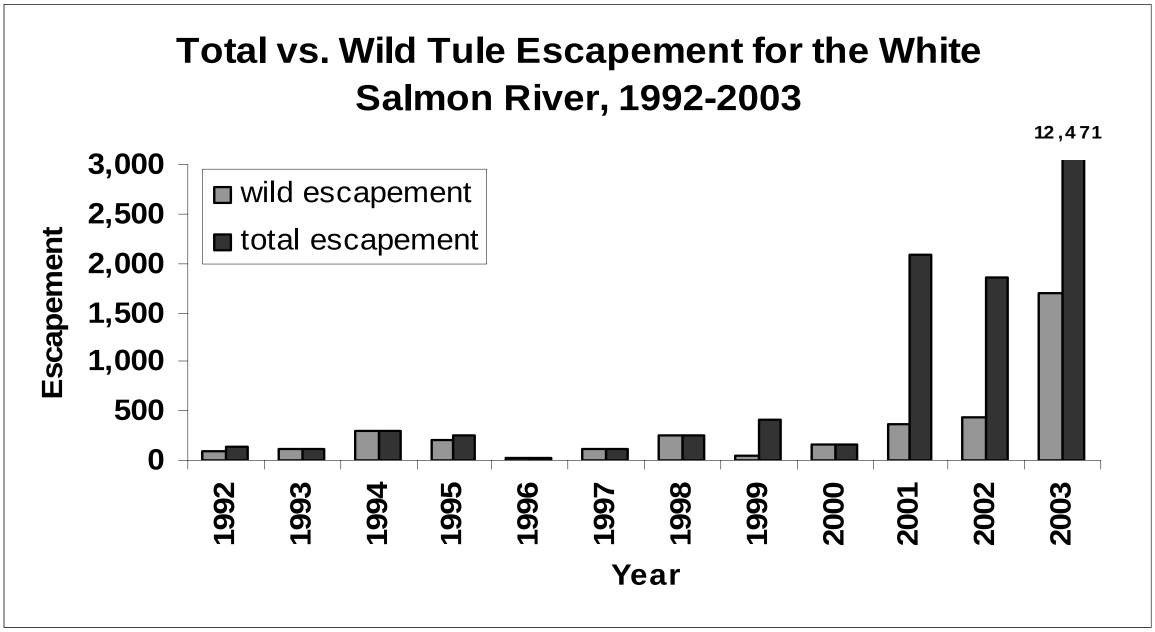

Figure 20 Wild and total tule fall chinook escapement from 1992 to 2003.

Spring chinook salmon were extirpated from the White Salmon basin, likely because of the lack of fish passage at Condit Dam. The facility, built in 1913 at river mile 3.4, blocks access to habitat upstream. Carson stock has been periodically released in the basin since the 1980s. Spring chinook spawning escapement is estimated from redd surveys. Escapement averaged slightly more than 100 fish (figure 22). Most spawners are presumed to be of hatchery origin.

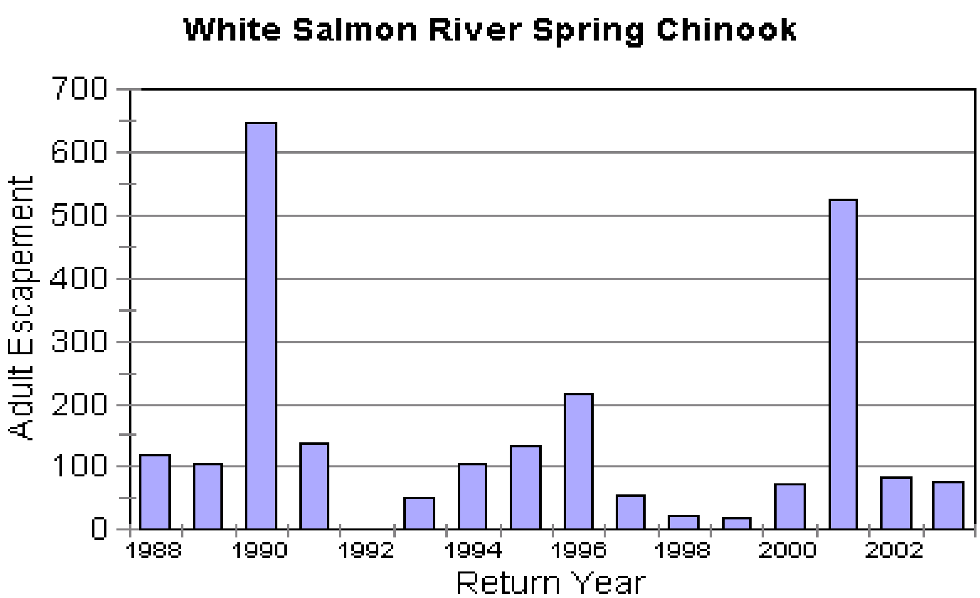

Figure 21 Spring chinook escapement in the White Salmon River.

The performance of fall and spring chinook salmon in the White Salmon subbasin as estimated by the EDT model is found in figure 25 and figure 26 and in table 16. Figure 23 depicts the EDT salmon performance parameters of productivity, capacity, and diversity (Lestelle et al. 1996). The diversity in the EDT model are the pathways through time and space used by anadromous salmonids over the life cycle. To estimate the diversity index, the EDT model is populated with spawners in each identified spawning reach. Each spawner represents the trajectory of a life history pathway. The diversity index is simply the number of successful trajectories divided by all trajectories.

The remaining parameters are spawner-recruit parameters derived from Beverton and Holt spawner curve (Beverton and Holt 1957). Productivity is the intrinsic productivity of a population or the density dependent survival (figure 24). This parameter represents the average resiliency of a population and is related to the quality of habitat. The capacity is the maximum number of recruits produced with an infinite number of spawners. This parameter controls the density dependence of the population and is linked to the quantity of habitat. The abundance is the average population size in the absence of harvest. The abundance point is where the spawner-recruit curve intersects the replacement line.

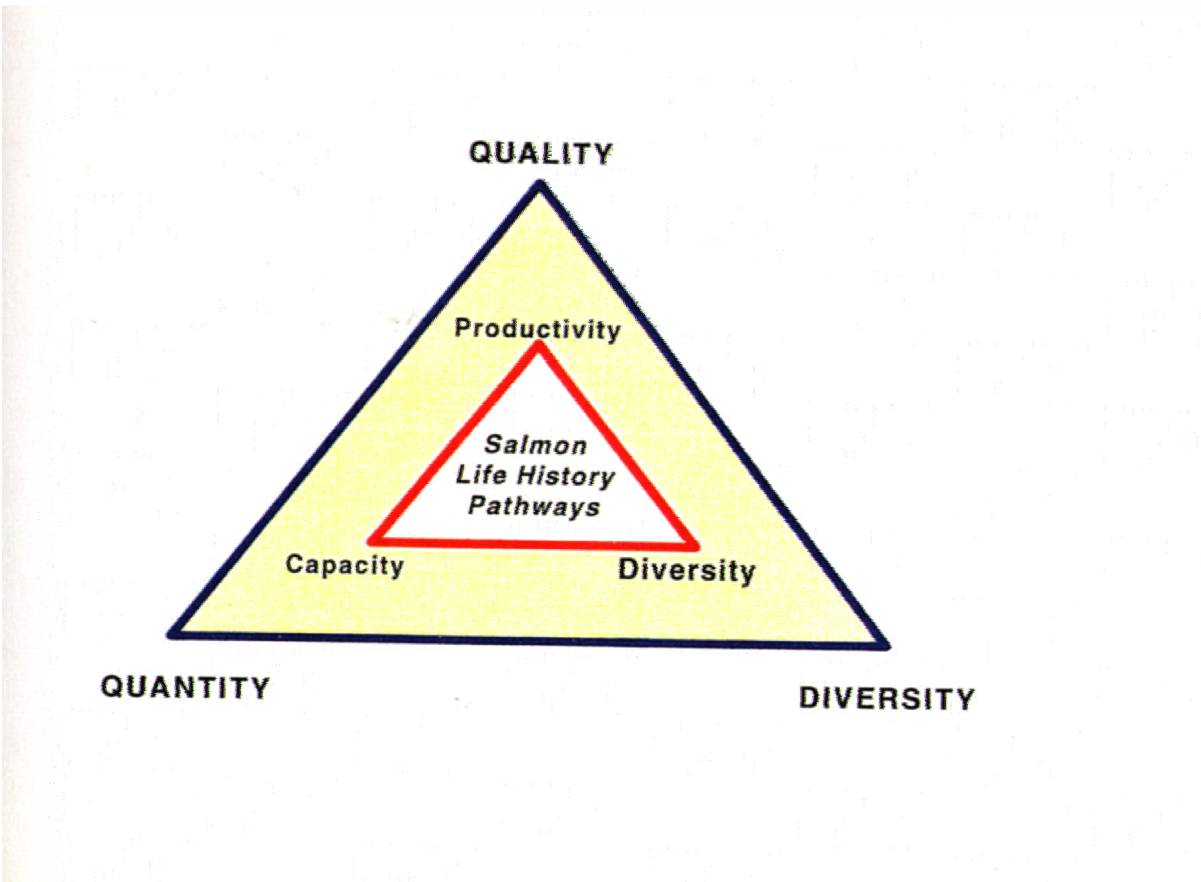

Figure 22 Salmon performance parameters from Lichatowich and Mobrand (1995)

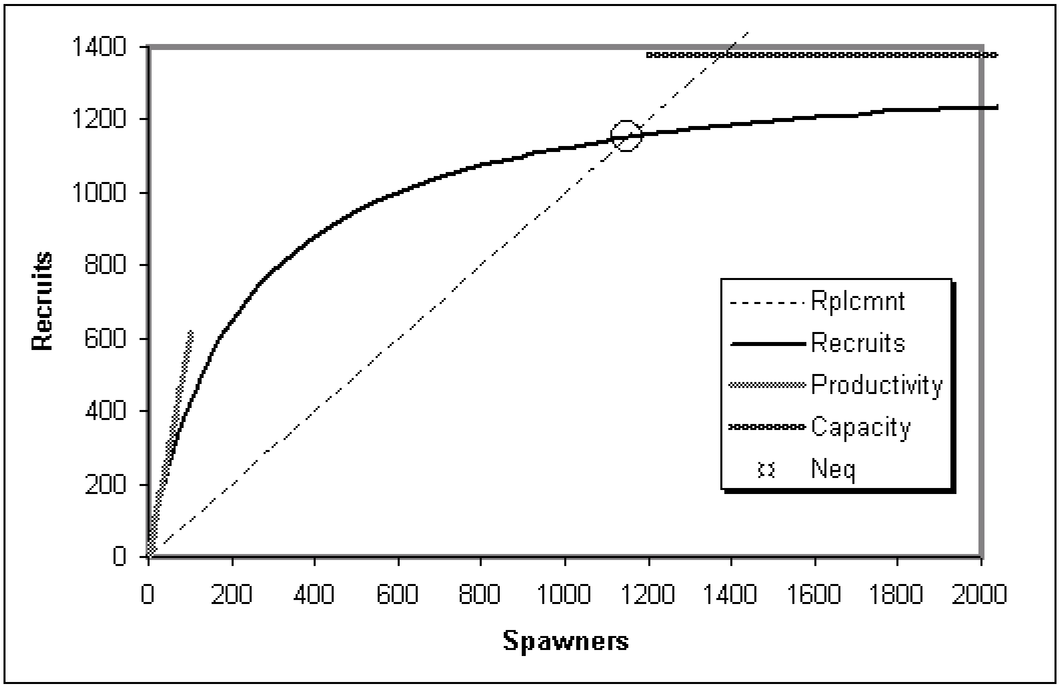

Figure 23 Example of Beverton-Holt spawner recruit relationship.

Currently, wild spring chinook salmon are not modeled to be sustainable. The current tule fall chinook abundance at equilibrium is expected to be 982 adults in the absence of harvest. The EDT modeling indicates wild spring chinook abundance in the absence of harvest has declined from 871 spawners in the historic condition to no fish currently. For tule fall chinook the modeled abundance increased from 745 to 982 from the patient to the template condition. The modeling suggest this increase is due to sediment storage behind Condit Dam, reduced peak flow in the bypass reach due to dam operation, and the creation of fall chinook rearing habitat in the lowest reach due to flooding from BON. However, the EDT model in the subbasin processes assumes historic condition for the tributaries and current condition for the mainstem. Therefore, the historic potential for chinook is even higher than depicted.

Table 16 Changes in the potential spring and fall chinook performance in the White Salmon Subbasin from historical to current conditions.

Population	Scenario	Diversity index	Productivity	Capacity	Abundance
Big White Salmon River Fall Chinook	Current without harvest	89%	6.2	1,170	982
	Historic potential	98%	7.1	868	745
Big White Salmon River Spring Chinook	Current without harvest	0%	0.0	0	0
	Historic potential	100%	7.2	1,012	871

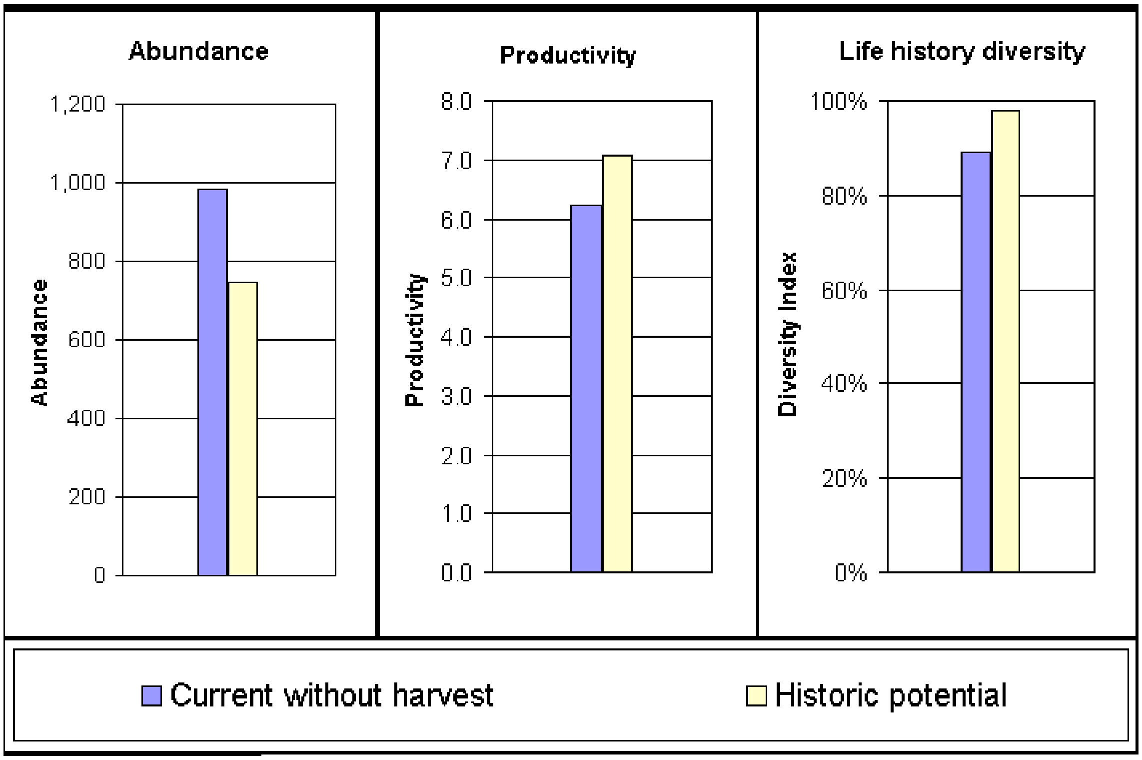

Figure 24 Current and historic potential fall chinook salmon performance in the White Salmon River Subbasin.

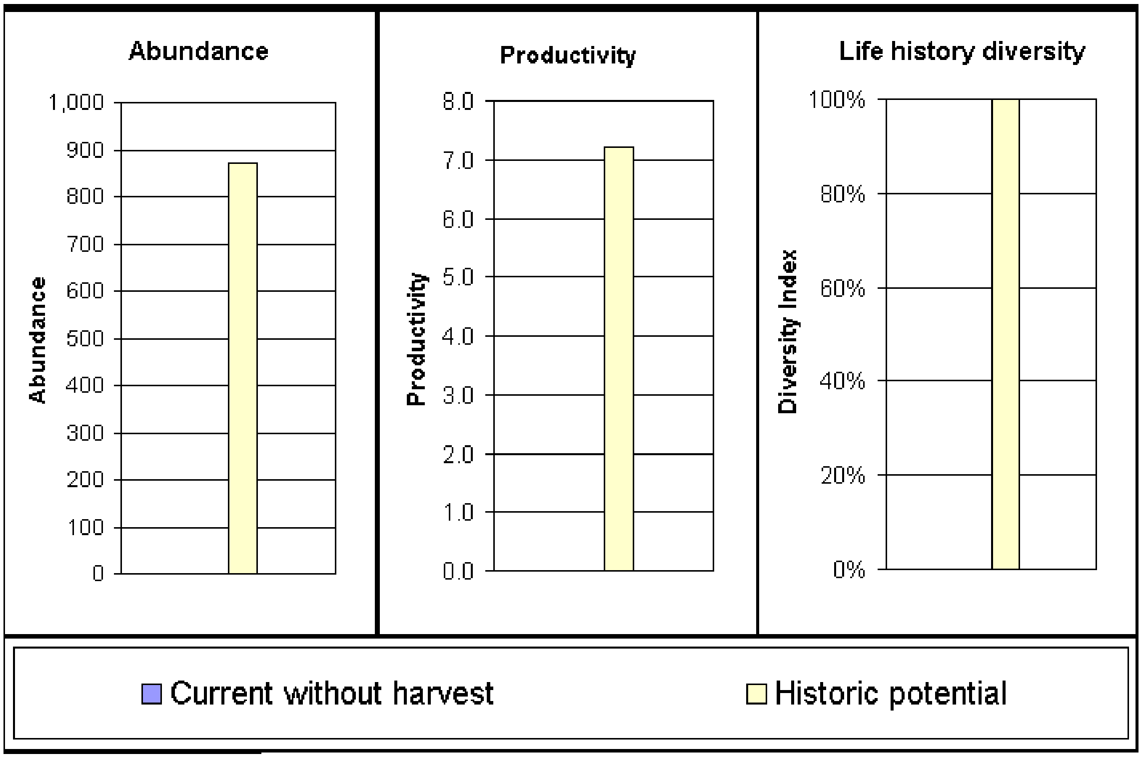

Figure 25 Current and historic potential spring chinook salmon performance in the White Salmon River Subbasin

There is estimated to be no current potential because these fish cannot access historical spawning areas.

Life history

Detailed life history and habitat requirements of chinook salmon can be found in various existing documents (e.g., Wydoski and Whitney 1979, Bjornn and Reiser 1991, Healy 1991, and Myers et al 1997) and will not be repeated here. The purpose of this section is to provide a brief overview of life history, life history stages, and key habitat.

The life history of chinook salmon is highly variable. Two races exist, spring and fall chinook salmon. Fall chinook enter rivers form August through October and are usually near final stages of maturity upon entry. Spring chinook return as immature fish between February and May. It is likely that both races were historically present in the White Salmon subbasin. Chinook can attain ages of 6 years or more but most Columbia River chinook salmon are 3 to 5 years of age. Fall chinook are further subdivided into tule and bright populations. Tules generally enter the Columbia River at a more mature state than brights and their skin coloration reflects this more advanced sexual maturity. The White Salmon River has both tule and bright populations. Tules are native to the White Salmon River and listed for protection under ESA and the brights are not native and not listed under the ESA.

White Salmon fall chinook are considered ocean type, that is they migrate to the ocean as subyearlings. Adult tule entry to the Columbia River begins in early August with the greatest abundance in the estuary between late August and early September. Counts of tules at Bonneville Dam generally peak between September 4 and September 9. Most adult tules mature at age 3 with very few 5 year olds. Spawning in the White Salmon River peaks in late September through early October. Fall chinook salmon tend to spawn in mainstem rivers and large tributaries. Since native spring chinook were extirpated in the White Salmon, their life history information was assumed to be consistent with Lower Columbia River ESU spring chinook. These spring chinook are considered ocean type, which outmigrate primarily as yearlings. Although recent trapping in the Cowlitz and Kalama rivers indicate some spring chinook migrate as subyearlings (Serl and Morrill 2001 and WDFW unpublished). Fecundity varies within and among chinook salmon populations. Spring chinook spawning occurs slightly earlier than fall chinook primarily in September.

For both races spawning rarely occurs in stream less than 10 feet wide. Redds are constructed in gravel and small cobble substrate in pool tailouts, riffles, and glides. Eggs remain in the gravel until emergence, which occurs from February to April depending on water temperatures. After emergence fry migrate to shallow water that has low velocities. After fry colonization juvenile chinook seek out slow water habitat types near velocity shears. Preferred areas are primary, backwater, and dammed pools, along with glides. Shortly after fry colonization tule juveniles begin their outmigration. Spring chinook juvenile can continue rearing until October. During the inactive or overwintering life stage, spring chinook juvenile prefer non-turbulent deep water habitat types (primary pools) in the main channel but also use slower large cobble riffles. Outmigration for yearlings occurs during the following spring. The yearling juvenile life history pattern described for stream type chinook is simplistic and typical. In reality juvenile life history patterns are complex and least four other patterns have been recognized for Columbia River spring chinook (Lichatowich and Mobrand 1995). Key habitat description by life stage are found in table 17.

Table 17 Definition of key habitat by life stage and time period for fall/spring chinook salmon from MBI 2001.

Life Stage	Relevant Months	Key Habitat Descriptions
Spawning	Tule Sep-Nov Spring Aug-Sep	Riffles, tailouts, and the swifter areas of glides containing a mixture of gravel and cobble sizes with flow of sufficient depth for spawning activity.
Incubation	Aug-May	Riffles, tailouts, and the swifter areas of glides as described for spawning with sufficient flow for egg and alevin development
Fry Colonization	Feb-May	Shallow, slow velocity areas within the stream channel, including backwater areas, often associated with stream margins and back eddies and usually in relatively low gradient reaches.
Active Rearing	Tule Feb-Jun Spring Mar-Oct	Relatively slow water habitat types, often near velocity shears, often associated with relatively low gradient stream channel reaches, including primary pools, backwaters, tailouts, glides, and beaver ponds.
Inactive Rearing	Oct-Mar	Non-turbulent habitat types, particularly deeper water types within the main channel, but also including slower portions of large cobble riffles.

Life Stage	Relevant Months	Key Habitat Descriptions
Migrant	Tule-Age0 Feb-Jun Spring-Age1 Mar-May	All habitat types having sufficient flow for free movement of juvenile migrants.
Prespawning Migrant	Tule Aug-Oct Spring Feb-Sep	All habitat types having sufficient flow for free movement of sexually mature adult migrants.
Prespawning Holding	Tule Aug-Nov Spring Apr-Sep	Relatively slow, deep water habitat types typically associated with (or immediately adjacent to) the main channel.

Genetic Diversity

Specific studies on chinook salmon in this basin do not exist. Spring chinook are extirpated and the hatchery fish found in this basin are from Carson stock, which is a mixture of upper Columbia and Snake River spring chinook collected at BON dam in the 1950s.

Since 1992 Spring Creek Hatchery tules have accounted for more than 30% of the natural spawning fish. The percentage of hatchery fish has ranged from 0% to 86% during this time period. Spring Creek Hatchery is located on the Columbia River approximately one mile below the mouth of the White Salmon River. This hatchery stock was founded with native tules from the White Salmon River and they have periodically been incorporated into the hatchery brood stock. Based on allozyme analysis, WDFW identified Spring Creek Hatchery tules as genetically different that all other tule stocks.

Harvest

Wild salmon and steelhead played an important role in native cultures. Chapman (1986) estimated that historic harvest rates of Columbia River chinook salmon exceeded 80% in the late 1800s during the development of the Columbia River fishery. Since the listing of chinook salmon for protection under the ESA in 1998, all fisheries have been substantially reduced. Today, wild chinook salmon are intercepted primarily in mainstem Columbia River ocean, commercial, tribal, and sport fisheries along with tributary sport fisheries.

Since steelhead and salmon in the White Salmon River basin are listed for protection under the ESA, tributary fisheries must be approved by NOAA-Fisheries. WDFW developed a Fisheries Monitoring and Evaluation Plan (FMEP) for steelhead and salmon fisheries in the Middle Columbia River ESU in 2001 and is in final consolation with NOAA-Fisheries for a section 4(d) permit for these activities. The estimated 0.3 percent impact on the Lower Columbia River. Chinook ESU from the tributary sport fishery is an overestimate of the total exploitation of the ESU as a whole. The spring chinook portion of the ESU were not included in the impact rate assessment. Ocean, mainstem Columbia River sport and commercial impacts are not estimated directly for White Salmon River tule chinook but are estimated for the entire group of tule stocks, which includes the White Salmon steelhead population. Ocean and Columbia River fisheries receive authorization through a section 7/10 consultation and biological opinion from NOAA-Fisheries.

Total recreational chinook caught in the White Salmon River is based on catch record cards (CRCs). Data recording errors and fish misidentification may be represented in these data, along with dip-in fish destined for upriver systems.

The exploitation rate of White Salmon River tule fall chinook during WDFW-regulated fisheries in the White Salmon River is less than 5 percent of the terminal run. The terminal run size is estimated based on the annual catch rate and spawning escapement estimate data collected since 1995. The annual catch of wild tule fall chinook is approximately 30 fish and the annual escapement estimate is 461, therefore the annual terminal run of White Salmon River tule fall chinook is approximately 491 fish. Total run size of the White Salmon River tule fall chinook and total fisheries impact can be extrapolated from these data. Using the estimated annual terminal run size and estimated annual exploitation from ocean and Columbia River mainstem fisheries, the estimated average total run size of White Salmon River tule fall chinook is 784 fish (K. Harlan, PSMFC, pers. comm.; NMFS 2002b). The WDFW fisheries in the White Salmon River will harvest approximately 4 percent of the total run of the White Salmon River tule fall chinook (30/784 = 0.04) (figure 29).

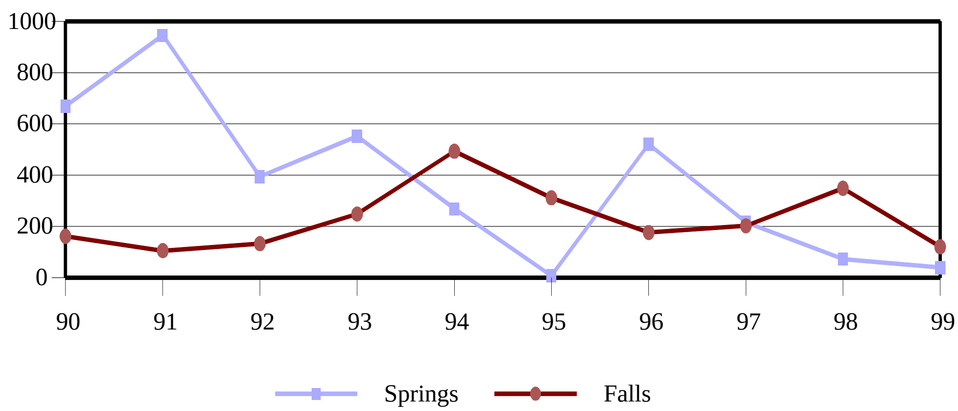

Figure 26 Total recreational chinook caught in the White Salmon River based on catch record cards (CRCs)

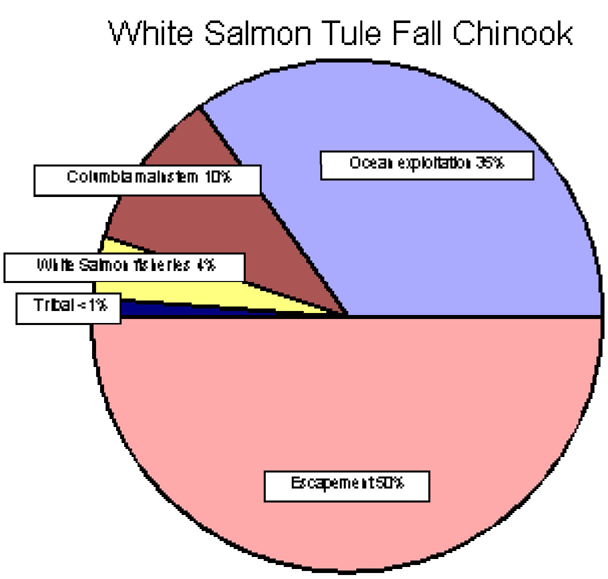

Figure 27 Distribution of the estimated annual White Salmon tule fall chinook run (n = 784)based on data collected since 1995 (K. Harlan, WDFW; NMFS 2002b)

The tule fall run lower Columbia chinook are heavily impacted by ocean fisheries. The exploitation rate on LCR tule fall chinook is expected to be 35 percent during the 2002 ocean fisheries (NMFS 2000). Mainstem Columbia River non-tribal recreational and commercial fisheries in 2002 account for an exploitation rate of 10 percent of tule fall chinook (NMFS 2002b). Tribal fisheries are not expected to have a significant impact on the entire tule fall chinook run but have a higher impact on the BON pool tule populations including the White Salmon River (NMFS 2000d). Tule fall chinook are harvested extensively in ocean and Columbia River mainstem fisheries, but are minimally impacted by tributary fisheries. Exploitation of lower Columbia River tule fall chinook during ocean and Columbia River mainstem fisheries has averaged 69.2 percent from 1980 through 1994 and 35.3 percent since 1995 (NMFS 2002b). These fisheries are estimated to exploit 45 percent of the 2002 LCR tule fall chinook run (NMFS 2002b). The White Salmon River tributary fishery accounts for less than 1 percent of the total run size of LCR fall chinook, and less than 4 percent of the White Salmon River tule fall chinook.

The NMFS has developed criteria for establishing harvest rates that are consistent with salmon recovery termed Recovery Exploitation Rates (RER) (NMFS 2000a). The RER for naturally produced LCR tule fall chinook is 49 percent (NMFS 2000a). This includes the impact from all fisheries: ocean, Columbia River, tribal, and recreational tributary. The expected exploitation rates for 2002 fisheries on LCR wild fall chinook as discussed by NMFS (2000a) are illustrated in figure 29.

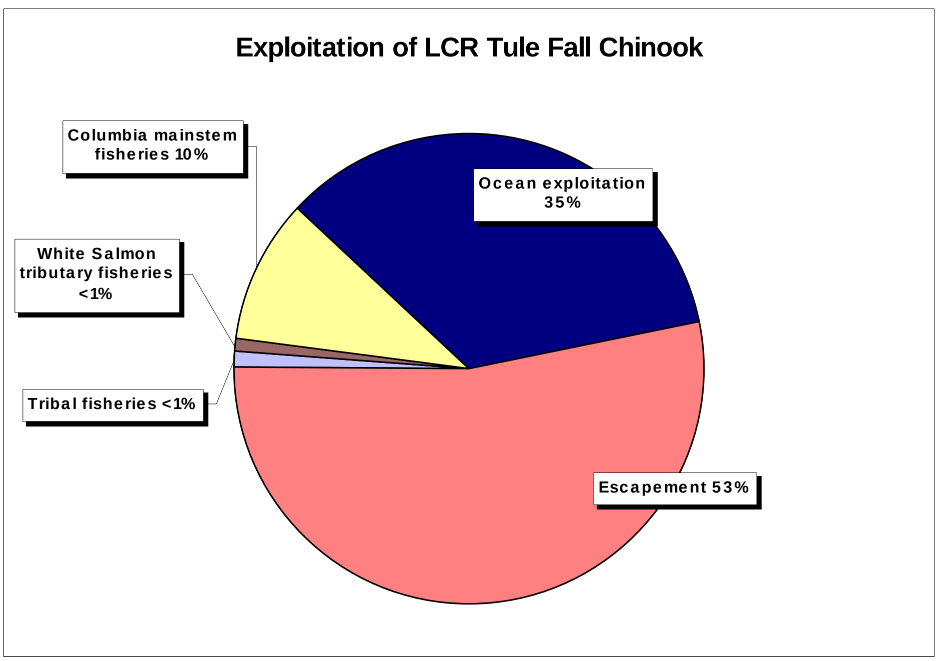

Figure 28 Distribution of the average annual LCR wild tule fall chinook run since 1995 (n = 11,343)

4.8.1 Environmental Conditions

Within Subbasin

Compared to many of the subbasins the size of the White Salmon River is small. Rather than assess at the sixth field HUC, assessments were made for the mainstem and each tributary.

However, many limiting factors overlapped between the mainstem and tributaries. The geographic areas used in the lower assessment unit analysis are found in figure 30.

The factors that led to the decline of White Salmon River salmon and steelhead include a combination of in and out of subbasin human impacts. The most limiting factor in this subbasin for anadromous salmonids is the construction and operation of Condit Dam. Steelhead, spring chinook, and coho salmon currently access only a small percentage of their historic spawning and rearing areas (table 18) Lack of access to areas above Condit Dam has stopped the marine derived nutrients cycle, which benefits fishes, mammals, birds, insects, and vegetation. Operation of the dam has altered the natural hydrologic regime including reduced rearing potential in the bypass reach since minimum flows are 30cfs compared to natural low flows of about 700 cfs. Power peaking causes diel flow variation, which has led to dewatering, stranding, and an increase in bioenergetics' losses due to movements associated with daily flow changes. Condit Dam also impairs watershed processes such as sediment and LWD transportation, which have reduced recruitment of spawning gravels and LWD below the project.

Table 18 River miles of habitat by species above and below Condit Dam

Species	Historic Distribution	Current Distribution	Percentage of Historic Access	Comments
Chum	1.2	1.2	100%	80% of spawning area flooded by Bonneville Dam
Fall Chinook	3.6	3.4	94%	6% above spawning areas above Condit Dam
Sp Chinook	12.8	0	0%	All spawning area above Condit Dam
Coho	21.1	3.4	16%	Majority of spawning area above Condit Dam
Steelhead	32.9	3.4	10%	Majority of spawning area above Condit Dam

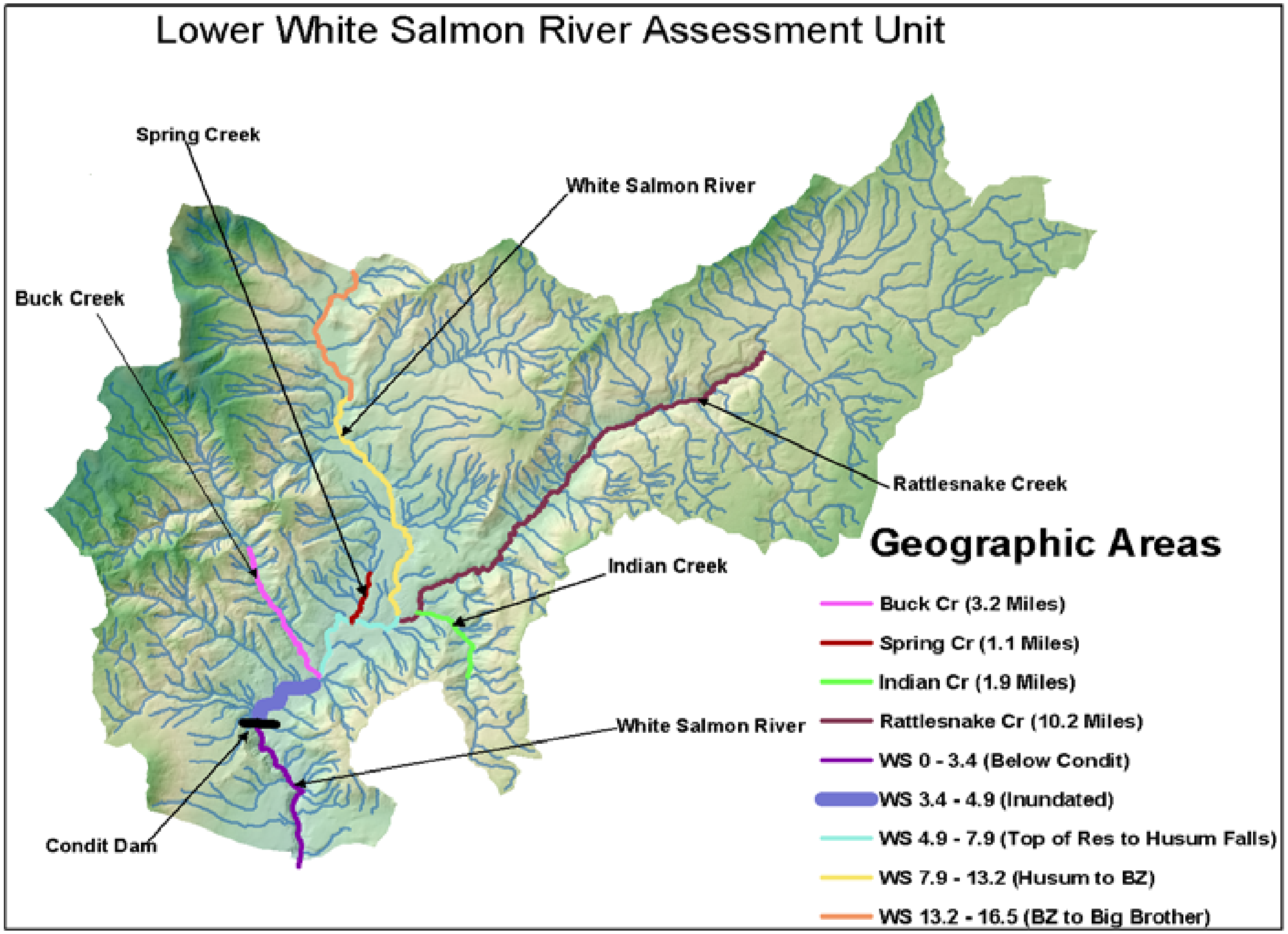

Figure 29 Map of geographic areas used in the EDT analysis

Upstream of the project, the hydrologic characteristics (peak flows and intra-annual flow) and sediment load (the percentage of fines in spawning gravel, embeddedness and turbidity) have increased due to roads, clearing of forest lands, and removal of trees from stream banks. A portion of the change in hydrologic and sediment transportation processes originates in the upper assessment unit.

Water quality in the mainstem remains very good, with maximum temperatures and dissolved oxygen levels remaining near optimum levels for salmonids. Maximum temperatures in tributaries have increased due to water withdrawals and lack of mature conifers in the riparian zone. Nutrient enhancement has increased slightly compared to historic levels in both the mainstem and tributaries, as measured by fecal coliform counts, due to agriculture and failed septic systems. Biological impacts (predation, competition, and disease) have increased above background levels but remain low due to limited hatchery releases in the Northwestern Reservoir and below Condit Dam. There has been an increase in abundance of predatory native and exotic fishes due to reservoir habitat created by BON dam.

The stream corridor has been altered primarily from a reduction in conifer densities and size in the riparian zone and the lack of large woody debris. Despite the degradation of subbasin habitat conditions, the current habitat below Condit Dam is capable of supporting fall chinook and coho salmon populations and the habitat above Condit Dam is capable of supporting spring chinook salmon, coho salmon, and steelhead populations.

Out-of-subbasin factors

Out-of-basin factors that have led to the decline of anadromous production include hydroelectric projects. Those factors increase adult and juvenile passage mortality and alter the natural hydrologic regime. The altered regime increases water temperatures, decreases spring flows, and changes riverine habitat to reservoir habitat. These changes have increased native predator abundance and effectiveness, and reduced Columbia River plume habitat. Degradation of mainstem habitat is apparent, especially in the estuary where 40% of tideland, wetlands, and swamps have been lost between 1870 and 1970 (Sherwood et al. 1990). The habitat lost reduces salmonid survival. Oout of basin chinook harvest rates exceeded 80% in the late 1800s but had been reduced to the RER of 49% or less by 2000.

The smolt to adult survival rate for Spring Creek Hatchery tule fall chinook salmon has varied tenfold from 0.2% to 2.5% (figure 31). Generally, the smolt to adult survival pattern of Spring Creek Hatchery fish tracks with the Pacific Decadal Ossilation (PDO). As with other Columbia River salmon and steelhead stocks, survivals were high in up until the late 1970s, they declined and remained low for a 20-year period, and have recently increased. This pattern will become more evident when complete returns are available for brood years after 1995. A similar pattern is evident for tule escapement in the White Salmon River (figure 29).

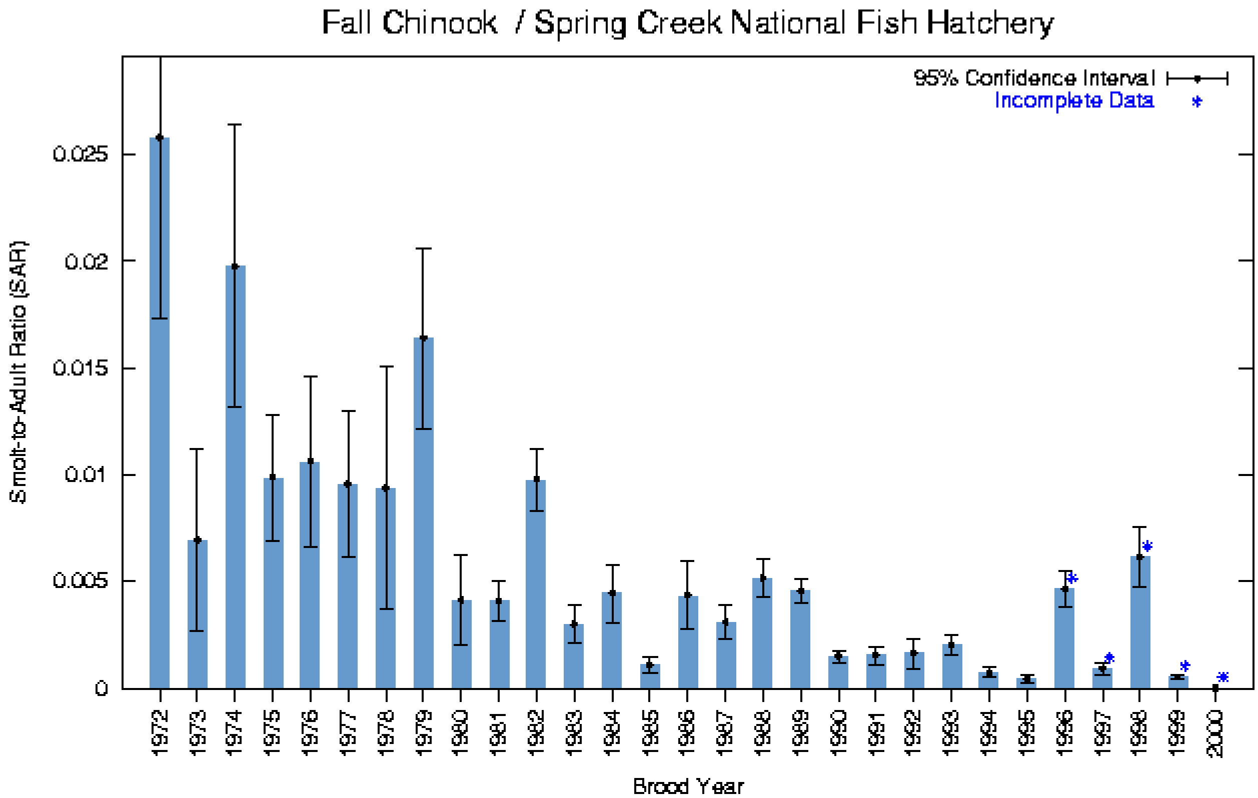

Figure 30 Smolt to adult return (SAR) for Spring Creek hatchery tule fall chinook salmon from University of Washington

School of Aquatic and Fisheries Science - Columbia Basin Research available at http://www.cqs.washington.edu/results.html

4.8.2 Environment/Population Relationship

The relationships for key habitat by life stage were presented above in table 17. A key assumption in this analysis is that the EDT dataset is based on dam removal. A proposal to removal Condit Dam is now pending before the FERC and awaiting a clean water certification from the WDOE. If the dam is removed, habitat conditions in the inundated reach and the reaches below the projects will go through a series of habitat change until the equilibrium conditions are met with its new environment. The short time-frame during which this analysis was produced did not allow the formulation of yearly assumptions concerning sediment load, fish habitat, riparian condition, LWD, and other attributes. Instead, river conditions were modeled at equilibrium, which it was assumed would occur at a decade or more. For more information on the assumptions see the EDT report in the appendix.

EDT analyses are based on "condition" scores assigned to each of 46 habitat attributes (level II attributes) for each EDT homogenous stream reach used by the population of interest. Reaches may vary widely in length. This information is organized into a database used as input to the EDT model. The level II attributes are rated under the current (patient) and historical (template) conditions. The EDT model translates the 46 level II attributes into 17 “habitat survival factors” (level III attributes) that represent hydrologic, stream corridor, water quality, and biological community characteristics. These 17 habitat survival factors are described in habitat factor analysis outputs.

Specific level III attributes affect particular life stages of salmonids. The impact to survival of each life stage in individual reaches is combined with information on available habitat area and then integrated across the various life history trajectories of the population in order to derive the population performance parameters of productivity (survival), abundance, and diversity. The number of different possible life history trajectories that a population exhibits determines an index of diversity.

EDT environmental analysis

The standard EDT environmental analysis presents the effect of habitat attributes on life stage survival for each life stage and each reach. These outputs are typically referred to as consumer reports. This is only one of several possible EDT applications, but it is perhaps the most basic. Comparing current/patient habitat conditions with optimum conditions in a historic/template baseline identifies key limiting habitat conditions. This analysis illustrates the specific habitat factors that, if restored, would yield the greatest benefit to population abundance. The habitat factor analysis depicts a greater level of detail than the reach analysis in that it looks at the specific habitat factors rather than the aggregate effect of all habitat factors. While this level of information is useful for salmon biologists, it is too detailed for the scope of this document. Consumer reports from representative reaches are used as examples to dicuss the changes by lifestage by attribute. For a subbasin summary, we used the geographic area summary report, and this attribute analysis summarizes all life stages within a reach. In this report for each attribute the largest difference in life stage-specific values between the patient and template condition were chosen. In this way, the degree of impact of a particular habitat factor in a particular reach can be compared to other habitat factors in the same reach as well as to habitat factors in other reaches.

The EDT reach and geographic analysis displays changes in survival by life stage between the historical and current condition. The importance of an environmental factors is displayed by the size of the black dot, the larger the dot the greater the decrease in survival from historic to current condition. A description of the survival factors is listed in table 19.

Table 19 Description of survival factors used in the reach scale analysis.

Level 3 Attribute	Description
Channel Stability	The stability of the reach with respect to its streambed, banks, and its channel shape and location
Chemicals	Concentrations of toxic chemical
Competition w/ hatchery fish	Competition with hatchery fish for food or space within the stream reach.
Competition w/ other species	Competition with other species for food or space
Flow	The amount of stream flow, or the pattern and extend of flow fluctuations within the stream reach
Food	The amount, diversity, and availability of food
Habitat Diversity	The extent of habitat complexity with the stream reach
Harassment	The extent of harassment or poaching within the stream reach
Key Habitat	The quantity of primary habitat utilized by a life stage
Pathogens	The abundance, concentration, or effect of pathogens in the stream reach
Obstructions	Physical obstruction that impede the use of the stream reach
Oxygen	Concentration of dissolved oxygen within the stream reach
Predation	The relative abundance of predators within the stream reach
Riparian Condition	The state of the vegetation component of the narrow strip of land bordering the stream.
Sediment Load	The amount of sediment, present in, passing through the stream reach
Temperature	Water temperatures within the stream reach
Withdrawals	Entrainment at water withdrawal structures.

The geographic area summary reports display a relatively uniform pattern for survival changes in mainstem areas, and the tributaries (figure 32). Since fall chinook juvenile leave the river shortly after emergence the egg incubation stage is the most critical. A decrease in channel stability, an increase in sediment load, and increase in peak flow have decreased fall chinook productivity below Condit Dam. The limiting factors for spring chinook salmon in the mainstem are the loss of habitat diversity, decrease in channel stability and increase in peak flow. The loss of key habitat at the spawning stage has decreased capacity. In addition to these limiting factors, there has been an increase in maximum water temperature in the tributaries.

Big White Salmon Fall Chinook
Protection and Restoration Strategic Priority Summary

Geographic area priority			Attribute class priority for restoration															
Geographic area	Protection benefit	Restoration benefit	*Channel stability/landsc.1/*	*Chemicals*	*Competition (w/ hatch)*	*Competition (other sp)*	*Flow*	*Food*	*Habitat diversity*	*Harassment/poaching*	*Obstructions*	*Oxygen*	*Pathogens*	*Predation*	*Sediment load*	*Temperature*	*Withdrawals*	*Key habitat quantity*
WS 0 - 3.4 (Below Condit)	◯	◯	•				•		●	•				•	●			
WS 3.4 - 4.9 (Inundated)	◯	◯	•				•		●	•					●			•

1/ "Channel stability" applies to freshwater areas; "channel landscape" applies to estuarine areas.

Key to strategic priority (corresponding Benefit Category letter also shown)

A	B	C	D & E
◯ / ⬤ High	○ / ● Medium	◦ / • Low	Indirect or General

Big White Salmon Spring Chinook
Protection and Restoration Strategic Priority Summary

Geographic area priority			Attribute class priority for restoration															
Geographic area	Protection benefit	Restoration benefit	*Channel stability/landsc.1/*	*Chemicals*	*Competition (w/ hatch)*	*Competition (other sp)*	*Flow*	*Food*	*Habitat diversity*	*Harassment/poaching*	*Obstructions*	*Oxygen*	*Pathogens*	*Predation*	*Sediment load*	*Temperature*	*Withdrawals*	*Key habitat quantity*
Buck Cr (3.2 Miles)	◯	◯	•				•		●						●	●		●
Spring Cr (1.1 Miles)	◯	◯							●						•			•
Rattlesnake Cr (10.2 Miles)	◯	◯	•				●		⬤	•			•		●	⬤		⬤
WS 0 - 3.4 (Below Condit)	◯	◯	•				•		●					•				
WS 3.4 - 4.9 (Inundated)	◯	◯	•				•		●						●			•
WS 4.9 - 7.9 (Top of Res to Husum Falls)	◯	◯	•				•		•	•					●			
WS 7.9 - 13.2 (Husum to BZ)	◯	◯	•				•		●	•					●			•

1/ "Channel stability" applies to freshwater areas; "channel landscape" applies to estuarine areas.

Key to strategic priority (corresponding Benefit Category letter also shown)

A	B	C	D & E
◯ / ⬤ High	○ / ● Medium	◦ / • Low	Indirect or General

Figure 31 Summary of survival factors by geographic area have reduced potential chinook productivity from the historic condition.

Representative reach analysis

The mainstem reach between Spring Creek and just below Rattlesnake Creek was chosen for spring chinook and a lower reach, below the powerhouse, was chosen for fall chinook as representative reaches to illustrate the scale of survival changes and attributes contributing to these changes according to the EDT model (figure 33). This is a patient/template analysis that compares survival by life stages under current conditions to the survival in the historic condition. The life stages that are most affected are incubation, inactive rearing, and active rearing.

In the mainstem White Salmon, the combined loss in survival from patient to template during the egg incubation stage survival decreased by 33% below Condit Dam and 42% above the project primarily due to an increase in sediment and channel instability. During the inactive rearing stage survival is 28% less for the over wintering period due to lack of habitat diversity (wood) and increased peak flows, both of which combine to decrease channel stability. The decrease in survival during the active rearing age 0 life stage is 3% for above and below the project, respectively. Minor decreases in survival occurred during the adult life stages (10%) and during fry colonization (5%). This was due to increase in harassment and decrease in habitat diversity for adults and loss of habitat diversity and increase in peak flow for fry colonization.

Geographic Area:	WS 7.9 - 13.2 (Husum to BZ)	**Stream:**	Big White Salmon
Reach:	Spring Ck. to Deadman's Corner	**Reach Length (mi):**	0.70
		Reach Code:	WS11

Life stage	**Relevant months**	**% of life history trajectories affected**	**Productivity change (%)**	Life Stage Rank	**Change in attribute impact on survival** Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Spawning	Sep	6.5%	-5.8%	6							●	●					•			●
Egg incubation	Sep-Apr	6.5%	-42.4%	1	●							•					⬤			●
Fry colonization	Mar-May	25.6%	-6.9%	2	●				●		⬤									
0-age active rearing	Mar-Oct	17.7%	-3.9%	4							●									
0-age migrant	Oct-Nov	2.6%	-2.0%	8							●									
0-age inactive	Oct-Mar	2.3%	-28.0%	3	●				●		⬤									
1-age active rearing	Mar-May	2.3%	-3.6%	7					•		●									
1-age migrant	Mar-Jun	11.8%	-0.1%	9							●									
1-age transient rearing																				
2+-age transient rearing																				
Prespawning migrant	Apr-Aug	47.3%	0.0%	10							•	•								
Prespawning holding	May-Sep	6.5%	-5.8%	5					•		●	•								
All Stages Combined		47.3%																		

1/ Ranking based on effect over entire geographic area. 2/ Value shown is for overall population performance.

Notes: Changes in key habitat can be caused by either a change in percent key habitat or in stream width.

Potential % changes in performance measures for reaches upstream of dams were computed with full passage allowed at dams (though reservoir effects still in place).

KEY

NA = Not applicable

	Loss	Gain
None		
Small	•	∘
Moderate	●	○
High	⬤	◯
Extreme	⬤	◯

Figure 32 Reach scale analysis for spring chinook in the mainstem White Salmon below Rattlesnake CR

Geographic Area:	WS 0 - 3.4 (Below Condit)	Stream:	Big White Salmon
Reach:	End of BON pool influence to Powerhouse	Reach Length (mi):	0.95
		Reach Code:	WS2

Life stage	Relevant months	% of life history trajectories affected	Productivity change (%)	Life Stage Rank	Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
					Change in attribute impact on survival															
Spawning	Oct-Nov	22.6%	-6.1%	3							Moderate loss	Moderate loss								Moderate loss
Egg incubation	Nov-May	22.6%	-33.2%	1	Moderate loss							Small loss					High loss			Moderate loss
Fry colonization	Apr-May	48.7%	-5.0%	2	Moderate loss				Moderate loss		High loss					Small loss				Moderate gain
0-age active rearing	Mar-Oct	3.5%	-3.4%	5	Small loss		Small loss				Moderate loss				Small loss					High loss
0-age migrant																				
0-age inactive																				
1-age active rearing																				
1-age migrant																				
1-age transient rearing																				
2+-age transient rearing																				
Prespawning migrant	Sep-Oct	49.0%	0.0%	6							Small loss	Small loss								
Prespawning holding	Oct-Nov	22.6%	-4.9%	4					Small loss		Moderate loss	Small loss								High loss
All Stages Combined		49.0%																		

1/ Ranking based on effect over entire geographic area. 2/ Value shown is for overall population performance.

Notes: Changes in key habitat can be caused by either a change in percent key habitat or in stream width.

Potential % changes in performance measures for reaches upstream of dams were computed with full passage allowed at dams (though reservoir effects still in place).

KEY

NA = Not applicable

	Loss	Gain
None		
Small	•	∘
Moderate	●	○
High	⬤	◯
Extreme	⬤	◯

Figure 33 Reach scale analysis for chinook in the mainstem White Salmon below below Condit Dam

Synthesis and Analysis

The EDT model identifies limiting environmental attribute at the reach scale. However, correcting reach scale limiting factors is like "treating the symptoms and not the causes" because watershed processes create reach scale habitat conditions. Figure 34 links chinook salmon survival by life stage to reach scale limiting factors to watershed processes. This table is a synthesis and interpretation of the habitat assessment in the Lower White Salmon Assessment Unit. This indicates that spring and fall chinook salmon survival has been reduced due to road building and forest removal. These activities have resulted in increased peak flows and sediment transport. The riparian conditions in most of the mainstem White Salmon River are good but the riparian area is more degraded in the tributaries. Degraded riparian conditions and wood removal from streams has decrease critical habitat for juvenile rearing. In addition the survival of chinook salmon will be impacted by increased sediment from dam removal in the lowest reaches.

4.8.3 Synthesis And Interpretation of Habitat And Watershed Processes on Chinook Salmon Productivity

Table 20 The synthesis and interpretation of habitat and watershed processes on chinook salmon productivity.

Life Stage (reduction in productivity)	EDT Level 3 Survival Factors	Primary EDT Level 2 attribute affecting survival	EDT Level 2 Definition	Watershed Process: Working Hypothesis
Egg Incubation (-33% WS < Condit) (-42% WS > Condit)	Channel Stability (Primary)	Bed Scour	The average depth of bed scour in salmonid spawning areas during the annual peak flow event over a ten-year period.	**Watershed Process: Hydrology modified by riparian.** Estimated 10% increase in peak flow (Q2yr) at the Underwood Gauge (RM 2) due to increased road densities and to a less extent logging and conversion of forest to agriculture and residential. The depth of bed scour has increased due to peak flows, which leads to an increase in dislodged eggs. A modifying factor is that a decrease in wood levels, leave more egg pockets unprotected.
	Sediment Load (Primary)	Fine Sediment	The percentage of fine sediment within salmon spawning substrate.	**Watershed Process: Sediment Transport.** Road densities increase fine sediment in spawning gravels but isolated areas of bank instability may also increase fines. An increase in % fines reduces respiration and may cause entombment.
Fry Colonization (-5% WS < Condit) (-7% WS > Condit)	Habitat Diversity (Primary)	Gradient	Average gradient. Since there was no change in this attribute, the decrease in productivity is related to hydro-confinement, wood, and riparian function.	**Watershed Process: Riparian.** Fewer pieces of wood have slightly decreased slow water needed for fry colonization.
	Flow (Secondary)	High Flow	Change in intra-annual variability in high flows.	**Watershed Process: Hydrology.** Estimated 10% increase in peak flow (Q2yr) at the Underwood Gauge (RM 2) due to increased road densities and to a less extent logging and conversion of forest to agriculture and residential. Increased peak flows displace juveniles to less favorable locations. This is more important for fall spawners (salmon) because they emerge in the winter/spring. Steelhead are not effected since they emerge during the summer.
	Channel Stability (Secondary)	Bed Scour	The average depth of bed scour in salmonid spawning areas during the annual peak flow event	**Watershed Process: Hydrology modified by riparian.** Estimated 10% increase in peak flow (Q2yr) at the Underwood Gauge (RM 2) due to increased road densities and to a less extent logging and conversion of forest to agriculture and residential. Increased peak flows and reduced wood

Life Stage (reduction in productivity)	EDT Level 3 Survival Factors	Primary EDT Level 2 attribute affecting survival	EDT Level 2 Definition	Watershed Process: Working Hypothesis
			over a ten year period.	levels decrease channel stability, and juveniles may be displace downstream to less favorable locations
Active Age 0 (-3% WS < Condit) (-4% WS > Condit)	Habitat Diversity (Primary)	Gradient	Average gradient. Since there was no change in this attribute, the decrease in productivity is related to hydro-confinement, wood, and riparian function.	**Watershed Process: Riparian.** Fewer pieces of wood have significantly decreased slow water needed for active rearing.
	Temperature (Primary in Rattlesnake)	Maximum Water Temperature	Maximum water temperatures within the stream reach during a month	**Watershed Process: Riparian.** Degraded riparian zone has reduced stream shade leading to an increase in maximum water temperatures.
Inactive Age 0,1 (-28% WS > Condit)	Habitat Diversity (Primary)	Gradient	Average gradient. Since there was no change in this attribute, the decrease in productivity is related to hydro-confinement, wood, and riparian function.	**Watershed Process: Riparian.** Fewer pieces of wood have slightly decreased slow water needed for overwintering habitat.
	Flow (Secondary)	High Flow	Change in intra-annual variability in high flows.	**Watershed Process: Hydrology.** Estimated 10% increase in peak flow (Q2yr) at the Underwood Gauge (RM 2) due to increased road densities and to a less extent logging and conversion of forest to agriculture and residential. Increased peak flows displace juveniles to less favorable locations. This is more important for fall spawners (salmon) because they emerge in the winter/spring. Steelhead are not as affected since they emerge during the summer.
	Channel Stability (Secondary)	Bed Scour	The average depth of bed scour in salmonid spawning areas during the annual peak flow event over a ten-year period.	**Watershed Process: Hydrology modified by riparian.** Estimated 10% increase in peak flow (Q2yr) at the Underwood Gauge (RM 2) due to increased road densities and to a less extent logging and conversion of forest to agriculture and residential. Increased peak flows and reduced wood levels decrease channel stability, and juveniles may be displace downstream to less favorable locations
Adult Stage including	Harassment	Harassment	The relative extent of	**Watershed Process: Recreation**

Life Stage (reduction in productivity)	EDT Level 3 Survival Factors	Primary EDT Level 2 attribute affecting survival	EDT Level 2 Definition	Watershed Process: Working Hypothesis
: migrant prespawner, holding prespawner, and spawner (-11% WS < Condit) (-11% WS > Condit)			poaching or harassment. Modified by primary pools, riparian function, turbidity, and wood.	An increase in recreational activity has led to a potential increase in poaching of adult salmon and steelhead and harassment of adults prior to and during spawning once they have access to the area above Condit Dam.

4.8.4 Ecological Relationships

The key ecological relationships that have been identified in this plan are: winter/summer steelhead, spring/fall chinook, rainbow trout/ steelhead, and salmon carcasses. Anadromous salmonids have co-evolved in these basins and these ecological relationships between different anadromous salmonids are not discussed. However, competition between races of the same species and the role of carcasses is covered.

It should be noted that when summer and winter steelhead and spring and fall chinook salmon evolve in a basin, the distribution of spring chinook and summer steelhead spawning is more toward the headwaters and distribution of winter steelhead and fall chinook salmon spawning is closer to the mouth. Meyers et al. (2003) noted that summer steelhead in the Lower Columbia River evolved to access habitat above waterfalls that are a barrier to winter steelhead.

Since Condit Dam inundated a gorge in the White Salmon River it is unclear if barrier waterfalls existed to maintain this separation. Since steelhead summer and winter steelhead have the same juvenile life history pattern in freshwater, a combined “steelhead population” was modeled in the EDT model. The habitat below Condit Dam is more important for winter steelhead and the areas above Husum Falls are more important for summer steelhead. There is probably a transition zone in between these sites where the habitat is important for both races.

Fall chinook and spring chinook were assumed to have different life history patterns. Tule fall chinook have a spring migrant pattern, in which most juvenile leave the basin within 3 weeks after emergence. A smaller percentage are transient and rear as they migrate. For spring chinook, we assumed a yearling and subyearling pattern. Data from the Kalama and Cowlitz Rivers suggested that a both patterns occurred (Serl and Morrill 2001 and WDFW unpublished). For the purposes of EDT modeling, the mouth of Little Buck Creek was chosen to separate the two chinook races.

Interactions between tule and bright chinook salmon.

Races of chinook salmon within the same watershed have evolved to support themselves through habitat partitioning. Prefered spring chinook habitat in the Lewis and Cowlitz Rivers was toward the headwaters, and fall chinook habitat toward the mouth of the river. The construction of dams in both these basins limited natural spring chinook production to the lower river. In both basins successful spring chinook salmon production does not occur. It may be due to lack of preferred habitat, loss of local adaptation by hatchery fish, or superimposition of redds. Tule salmon production on the White Salmon River is unknown but tule spawning time peaks in late September and bright spawning time peaks almost two months later in November. Since spawning area is limited, superimposition of bright redds on top of tule redds occurs annually, and the stronger the bright escapement the more likely superimposition occurs (Kelly Harlan, PSMFC).

Role of salmon and salmon carcasses.A review of ecological relationship between Pacific salmon and wildlife populations is found in Cederholm et al. (2000) and will not be repeated here. The purpose of this section is to provide the overview of this relationship. The life history of anadromous salmon is split between freshwater and the ocean. Salmon spawning, incubation, and early rearing occurs in freshwater, while later rearing and the majority of their growth occurs in saltwater. Salmon feed on a wide variety of prey items and intern are prey for a wide variety invertebrate and vertebrate predators. Salmon serve as an ecological vector transporting marine derived nutrients to the freshwater environment. Johnson et al. 2000 found that 137 species of birds, mammals, amphibians, and reptiles preyed or scavenged salmon at one or more life history stages. Juvenile salmonids feed on salmon eggs, carcass flesh, and invertebrates which have previously fed on carcasses (Bilby et al. 1996 and 1998). Since Condit Dam blocked all anadromous salmonids, the salmon and wildlife ecological relationships above Condit Dam are lacking. Below Condit Dam out of basin hatchery salmon and natural fish from the subbasin spawn in sufficient numbers so that salmon carcasses are present at or above historical numbers.

4.9 Fish Focal Species: Steelhead

Species characterization and status

Characterization

Steelhead trout are native to the White Salmon River (WDF et al. 1993) and their historical distribution extended from the mouth up to RM 16 in the mainstem, and Buck, Spring, Indian, and Rattlesnake Creeks (figure 35). The current distribution is limited to the area below Condit Dam (RM 3.4).

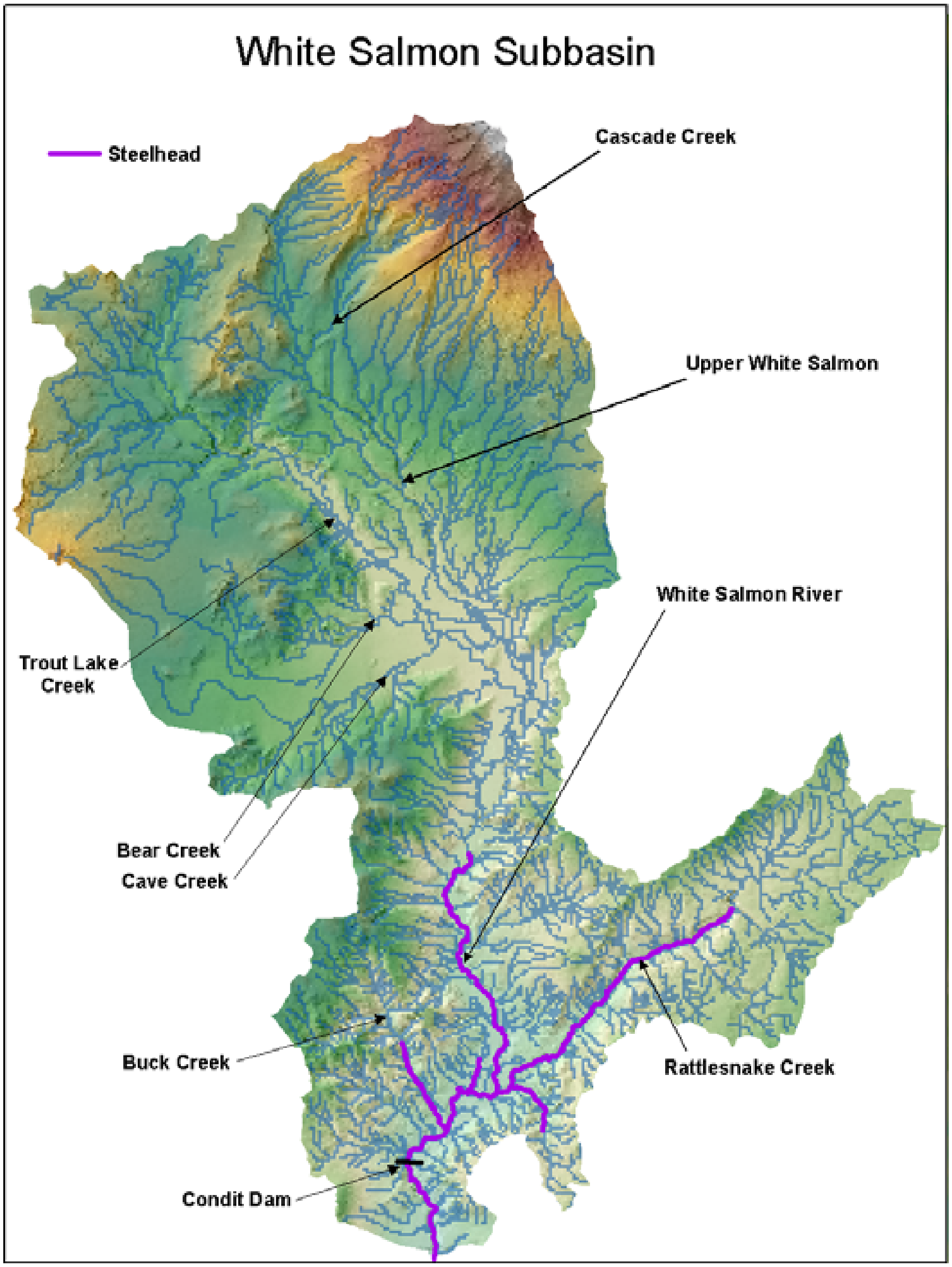

Figure 34 Historic spawning distribution of steelhead in the White Salmon River. Current spawning distribution is limited to the area below Condit Dam.

Steelhead and rainbow trout in the Pacific Northwest have been split into inland and coastal forms or MAL (Leider et al 1994). Coastal fish inhabit watersheds west of the Cascade Crest and inland populations are found in the east of the Cascade Crest. White Salmon steelhead and rainbow trout have been identified as inland steelhead and/or redband rainbow trout based on genetic analysis (Phelps et al. 1990 and Phelps et al. 1994). The White Salmon steelhead are considered to be part of the Middle Columbia GDU, which includes Washington steeelhead populations between the White Salmon and Walla Walla Rivers (Leider et al. 1995) and NMFS has included this population in the Middle Columbia River Evolutionary Significant Unit (ESU). Currently, state and federal agencies have documented resident, fluvial, adfluvial, and anadromous life history forms in this basin. The anadromous form is isolated to the lower 3.4 miles of river below Condit Dam. Subpopulation structure of O. mykiss in the subbasin is unknown.

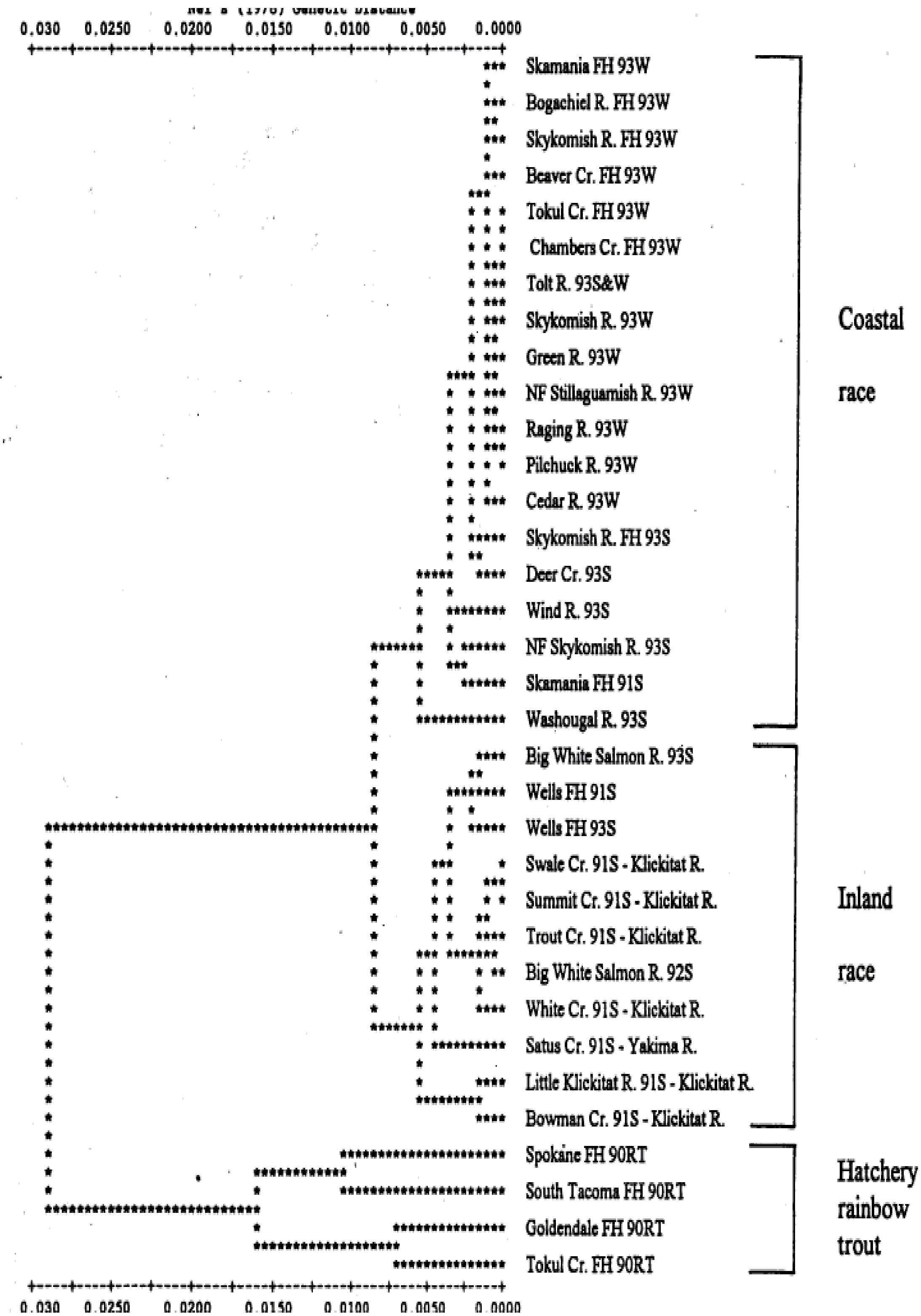

Figure 35 UPGMA dendopgram of Nei's (1978) genetic distance among steelhead and hatchery rainbow trout populations based on 56 variable loci from Phelps et al. (1994)

Status

The status of steelhead in the White Salmon River is listed as depressed due to the lack of access to historical spawning areas (WDF et al. 1993). Since population monitoring for the White Salmon River does not occur, the status may be inferred from estimates of wild Middle Columbia River summer steelhead abundance, wild A-run abundance, and the EDT model. Summer steelhead above BON are considered B-run steelhead if they originate from portions of the Clearwater and Salmon rivers in Idaho, and are considered A-run if they originate from other areas. (TAC 1996). B-run fish tend to be later timed and larger then A-run steelhead. Wild steelhead abundance is estimated by US v Oregon TAC annual and these are found in figure 37. Kassler et al. 2003 estimated the abundance of wild origin Middle Columbia River steelhead passing BON between 1997 and 2001 and these estimates are also displayed in figure 37. A-run abundance declined from the mid 1980s to a low in the mid-1990s, and has recently rebounded. Middle Columbia steelhead appear to follow the same pattern and comprise about 25% of the A-run abundance between 1997 and 2001. The portion of White Salmon summer steelhead in these counts is unknown but believed to be very small.

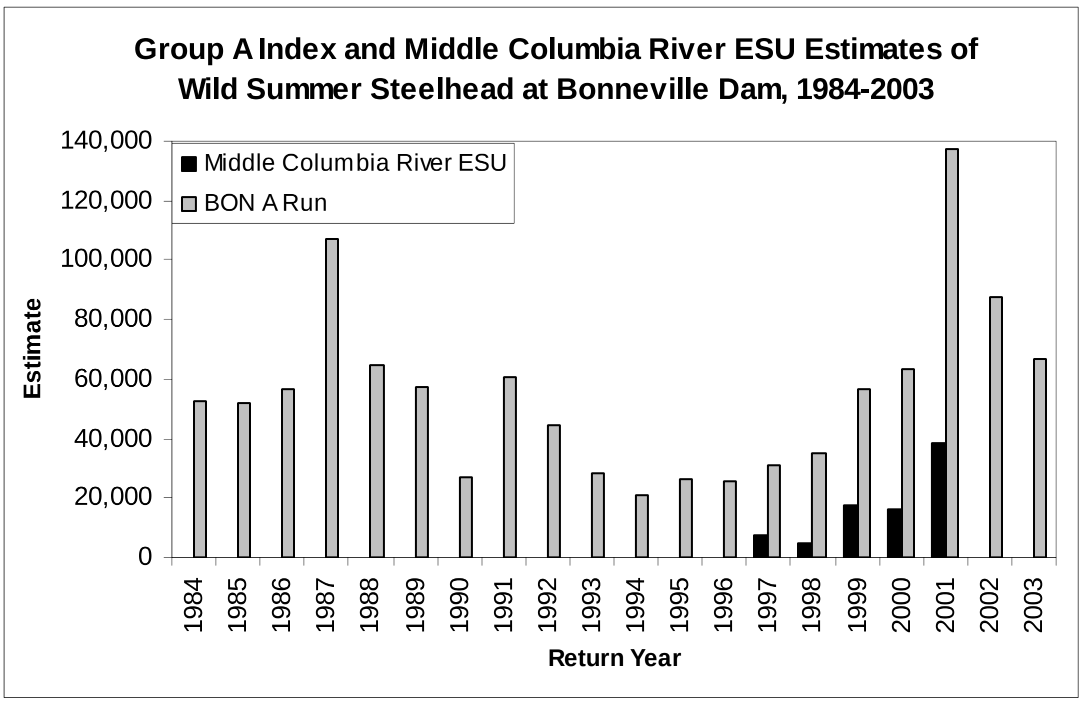

Figure 36 Abundance trends in wild A-run and Middle Columbia River ESU steelhead

Steelhead performance can be inferred from the EDT model. The steelhead performance in another Gorge Province subbasin, the Wind River, and its major tributary – Trout Creek, are known in part due to a BPA funded monitoring program. The empirical productivity and capacity for Wind River and Trout Creek steelhead estimated from spawning escapement and smolt trap data are similar to the EDT predicted values (Rawding 2004). Since the rationale developed on the Wind River for using derived information and expanding empirical data was also incorporated into the development of the White Salmon River EDT dataset, it is believed the EDT assessment of current steelhead performance on the White Salmon River is reasonable.

The performance of steelhead in the White Salmon subbasin as estimated by the EDT model is found in table 21 and figure 38 the current steelhead abundance at equilibrium is expected to be 20 steelhead in the absence of harvest. The EDT modeling indicates wild steelhead abundance in the absence of harvest has declined from 1,137 spawners to less than 20 spawners. However, the EDT model in the subbasin processes assumes historic condition for the tributaries and current condition for the maisntem. Therefore, the historic potential for steelhead is even higher than depicted.

Table 21 Changes in the potential steelhead performance in the White Salmon Subbasin from historical to current conditions.

Population	Scenario	Diversity index	Productivity	Capacity	Abundance
Big White Salmon River Steelhead	Current without harvest	4%	4.1	26	20
	Historic potential	95%	20.4	1,196	1,137

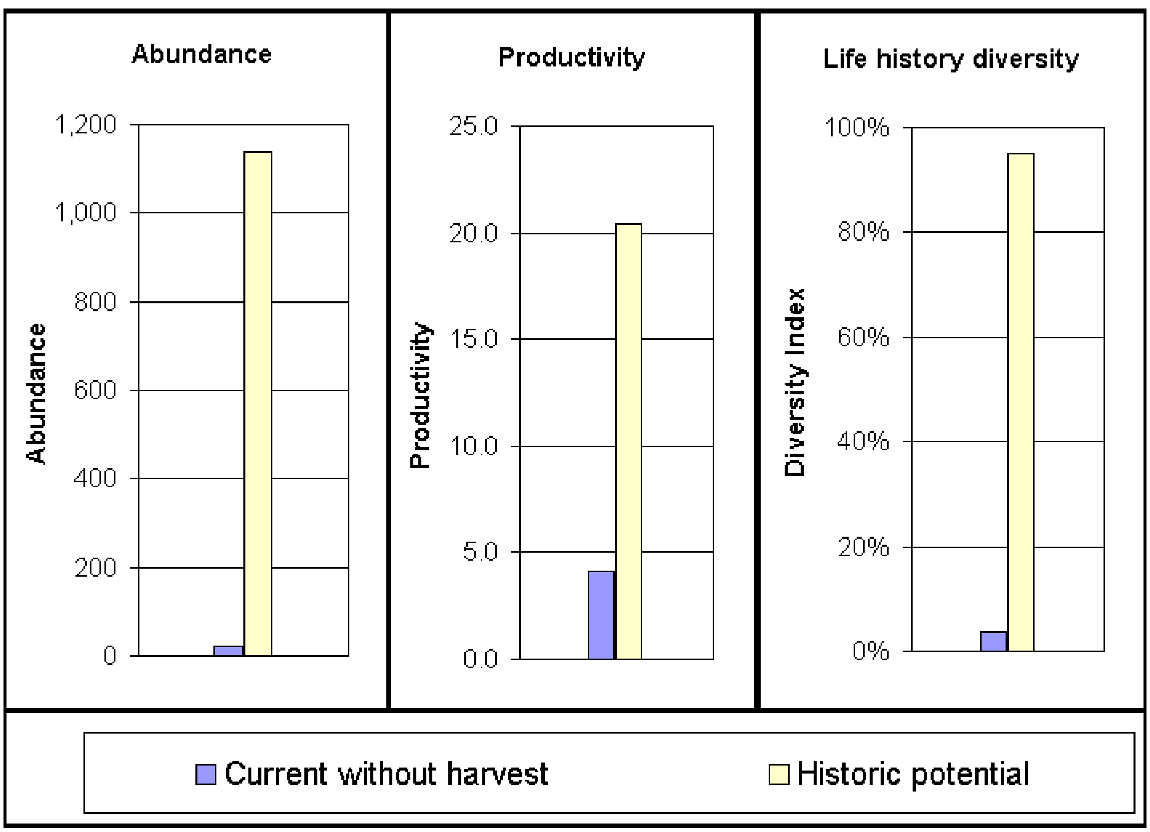

Figure 37 Current and historic potential salmon performance in the White Salmon River Subbasin

Life history

Detailed steelhead life history and habitat requirements of steelhead can be found in various existing documents (e.g., Wydoski and Whitney 1979, Bjornn and Reiser 1991, Behnke 1992, Burgner et al. 1992, and Busby et al 1996) and will not be repeated here. The purpose of this section is to provide a brief overview of life history, life history stages, and key habitat.

The life history of steelhead and rainbow trout is highly variable. Two races of steelhead exist, winter and summer steelhead. Winter steelhead enter rivers form November to May and are usually near final stages of maturity upon entry. Summer steelhead return as immature fish between April and October, although some summer steelhead holdover in the Columbia River through out the year and enter tributaries as they approach spawning. It is likely that both races were historically present in the White Salmon subbasin.

Steelhead can attain ages of 9 years or more but most Columbia River steelhead are 4 to 6 years of age. At least 9 initial and 13 repeat spawning age classes have been identified for Lower Columbia River steelhead (Leider et al. 1986). Steelhead typically spend one to three years at sea. Steelhead are iteroparus and have been documented to spawn at least three times. Most repeat spawners are females.

Wild steelhead from both races spawn from February through June, with peak spawning in April. Hatchery stocks used in the White Salmon subbasin typically spawn from December through February, with peak activity in January. Redds are constructed in gravel 0.5 to 4.5 inches in diameter, in pool tailouts, riffles, and glides. Eggs hatch in four to seven weeks depending on water temperature. After emergence fry seek shallow water with low velocities.

As steelhead juveniles age they move into water with increasing depth and velocities. Large cobble, boulders, and wood provide habitat diversity and cover for juvenile steelhead. In this active rearing stage, juvenile steelhead tend to be found in moderate to fast water with sufficient depth behind boulder, large cobble, and wood in riffles or near the top of pools. During fall steelhead seek out interstical spaces between cobble and boulders for cover and remain in this habitat until March. In April they return to active rearing life stage and seek out suitable habitat types. Steelhead typically spend two or three years as juvenile in freshwater before outmigrating to the ocean. Outmigration takes place during the spring and typically peaks in early May. Steelhead spawning and rearing occurs in both mainstem and tributary habitats. Key habitats for rainbow trout and steelhead are the same until rainbow reach the adult stage. During this life stage they often prefer similar habitats as adult steelhead. Key habitat description by life stage are found in table 22.

Table 22 Definition of key habitat by life stage and time period for steelhead/rainbow trout

Life Stage	Relevant Months	Key Habitat Descriptions
Spawning	Mar-Jun	Tailouts, riffles, and glides containing a mixture of gravel and cobble sizes with flow of sufficient depth for spawning activity.
Incubation	Mar-Jul	Area as described for spawning with sufficient flow for egg and alevin development
Fry Colonization	May-Jul	Shallow, slow velocity areas within the stream channel, often associated with stream margins.

Life Stage	Relevant Months	Key Habitat Descriptions
Active Rearing	0-age May-Jul 1-age Mar-Oct 2+-age Mar-Oct	Gravel and cobble substrates with sufficient depth and velocity and boulder/large cobble/wood obstruction to reduce flow and concentrate food.
Inactive Rearing	0,1-age Oct-Mar	Stable cobble/boulder substrates with intersticial spaces
Migrant	1-age Mar-Jun 2+-age Mar-Jun	All habitat types having sufficient flow for free movement of juvenile migrants.
Prespawning Migrant	Winter Nov-Apr Summer All	All habitat types having sufficient flow for free movement of sexually mature adult migrants.
Prespawning Holding	Winter Dec-May Summer All Adult Trout All	Relatively slow, deep water habitat types typically associated with (or immediately adjacent to) the main channel. Feeding rainbow trout will also utilize riffle habitats.

Genetic Diversity

The habitat models predicted the stream reaches below the dam are capable of supporting a steelhead run size under average ocean conditions of 20 to 50 adults. Under poor ocean conditions run size may be reduced by 50%. These levels are below quasi-extinction threshold of 50 spawners used by the Willamette and Lower Columbia Technical Recovery Team formed by NOAA Fisheries and genetic guidelines in the State of Washington's Wild Salmonid Policy of 600 spawners for populations with this age structure. It is likely that the genetic diversity and fitness of wild steelhead in this basin has been reduced due to low carrying capacity below Condit Dam, hatchery introgression from releases to meet mitigation locations specified in US v Oregon, and decreased spawners due to in and out-of basin subbasin fisheries. Phelps et al. (1990) found that introgression from hatchery rainbow plants was not evident in wild rainbow trout samples and high levels of genetic diversity still exist in this population. Sieler and Neuhuaser (1985) caught more steelhead smolts than were predicted by the modeling. One hypothesis is that the steelhead smolts were produced from resident rainbow trout above Condit Dam, and the genetic diversity and fitness of anadromous O. mykiss has been maintained.

To mitigate for lost steelhead production, Mitchell Act facilities release approximately 20,000 winter and 20,000 summer steelhead. Summer steelhead are Skamania Stock, which originated from the Washougal and Klickitat Rivers. The hatchery winter steelhead stock released into the White Salmon River originated in Chambers Creek in Puget Sound. The reproductive success of Skamania and Chambers Creek hatchery stocks in the Kalama River was only 16% and 12% of wild steelhead in this basin due to advanced spawn time and domestication (Chilcote et al. 1986, Leida et al 1990, and Hulett et al 1996). WDFW uses differential spawning times to reduce risks to wild steelhead populations from hatchery programs. Genetic analysis from allozymes collected from O. mykiss parr below Condit Dam, which were presumably from steelhead, indicated this stock grouped most closely with inland steelhead from the upper Columbia River and not with the hatchery steelhead or rainbow stocks used in the basin (Phelps et al. 1994).

Harvest

Wild salmon and steelhead played an important role in native cultures. Harvest of steelhead, while locally important, was likely less important than salmon harvest due to lower abundances and spawning times that coincided with higher flows. Chapman (1986) estimated that historic harvest rates of Columbia River steelhead exceeded 80% in the late 1800s during the development of the Columbia River fishery. Commercial harvests of steelhead was prohibited in Washington in 1913 and in Oregon in 1974. Since, 1986 sport fisheries in the Columbia River and Washington tributaries have been regulated under wild steelhead release. Since the listing of steelhead for protection under the ESA in 1998, all fisheries have been substantially reduced. Today, wild steelhead are intercepted primarily in mainstem Columbia River tribal, commercial, and sport fisheries along with tributary sport fisheries.

Since steelhead and salmon in the White Salmon River basin are listed for protection under the ESA, tributary fisheries must be approved by NOAA-Fisheries. WDFW developed a Fisheries Monitoring and Evaluation Plan (FMEP) for steelhead and salmon fisheries in the Middle Columbia River ESU in 2001 and is in final consolation with NOAA-Fisheries for a section 4(d) permit for these activities. Although not monitored directly, the mortality of catch and release fisheries for steelhead in the White Salmon River is estimated from hooking mortality studies and fishing effort in other basins within southwest Washington (Rawding 1998). Estimates of wild steelhead harvest in the White Salmon are similar to those in the Kalama Subbasin (figure 39). It is assumed sport fishery wild steelhead harvest rates in the White Salmon River are similar to the Kalama River. Wild summer steelhead impact were substantially reduced in 1986 after wild steelhead release regulation were enacted. Current impacts from tributary sport fisheries are estimated to be 4% for summer steelhead and 4% for winter steelhead.

Mainstem Columbia River sport and commercial impacts are not estimated directly for White Salmon River steelhead but are estimated for the Middle Columbia River ESU, which includes the White Salmon steelhead population. Middle Columbia River impacts are less than 2% and these impacts occur mainly in the spring chinook tangle net fishery and the summer steelhead sport fishery. WDFW receives authorization for these fisheries through a section 7/10 consultation and biological opinion from NOAA-Fisheries.

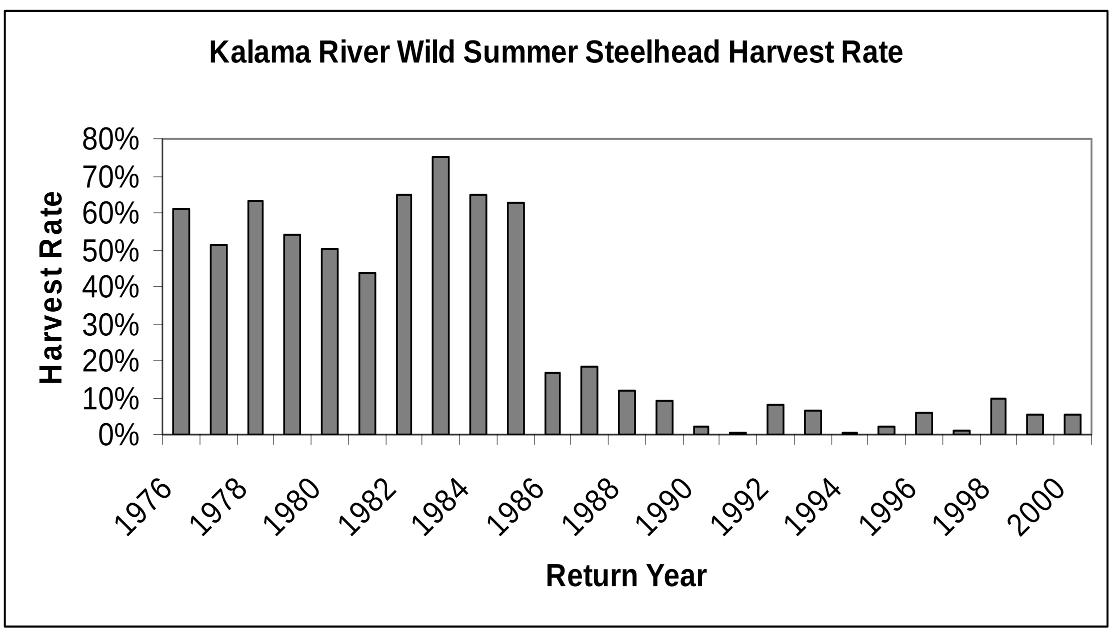

Figure 38 Estimated wild steelhead impacts with wild steelhead harvest sport fishery (before 1986) and with catch and release regulations for wild steelhead in the Kalama River.

Tribal fisheries impact both summer and winter steelhead. These fisheries are authorized through a section 7/10 consultation and biological opinion from NOAA-Fisheries. Tribal fisheries target salmon stocks and steelhead are incidentally taken when salmon fishing. Winter steelhead are caught primarily in the winter fishery and the spring chinook fishery. Summer steelhead are caught primarily in the fall fishery, with fewer fish caught in other fisheries. Both winter and summer stocks are intercepted in ceremonial and subsistence fisheries. In 2003, the projected impacts to wild Middle Columbia River steelhead from tribal fisheries was 4% and the maximum impact was 9% (Reference). The annual cumulative impact from all fisheries are likely to range from 11% to a maximum of 16% of run size (figure40).

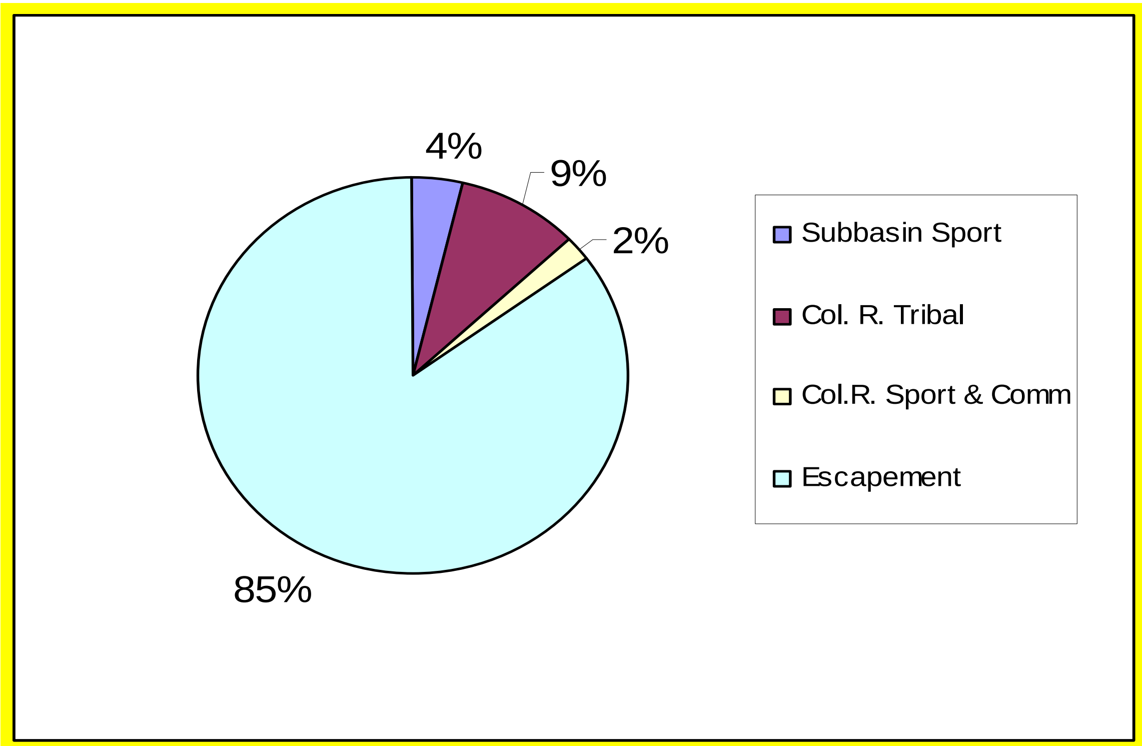

Figure 39 Estimated harvest rate by fisheries for White Salmon Subbasin wild steelhead

4.9.1 Environmental Conditions

Within Subbasin

Compared to many of the subbasins the size of the White Salmon River is small. Rather than assess at the sixth field, HUC assessments were made for the mainstem and each tributary. However, many limiting factors overlapped between the mainstem and tributaries. The geographic areas used in this analysis are found in figure 41.

The factors that led to the decline of White Salmon River salmon and steelhead include a combination of in and out of basin human impacts. The most limiting factor in this subbasin for anadromous salmonids is the construction and operation of Condit Dam. Steelhead, spring chinook, and coho salmon currently access only a small percentage of their historic spawning and rearing areas (table 23) Lack of access to areas above Condit Dam has stopped the marine derived nutrients cycle, which benefits fishes, mammals, birds, insects, and vegetation. Operation of the dam has altered the natural hydrologic regime including reduced rearing potential in the bypass reach since minimum flows are 30cfs compared to natural low flows of about 700 cfs. Power peaking causes diel flow variation which has lead to dewatering, stranding, and an increase in bioenergetics' losses due to movements associated with daily flow changes. Condit Dam also impairs watershed processes such as sediment and LWD transportation, which has reduced recruitment of spawning gravels and LWD below the project.

Table 23 River miles of habitat by species above and below Condit Dam

Species	Historic Distribution	Current Distribution	Percentage of Historic Access	Comments
Chum	1.2	1.2	100%	80% of spawning area flooded by Bonneville Dam
Fall Chinook	3.6	3.4	94%	6% above spawning areas above Condit Dam
Sp Chinook	12.8	0	0%	All spawning area above Condit Dam
Coho	21.1	3.4	16%	Majority of spawning area above Condit Dam
Steelhead	32.9	3.4	10%	Majority of spawning area above Condit Dam

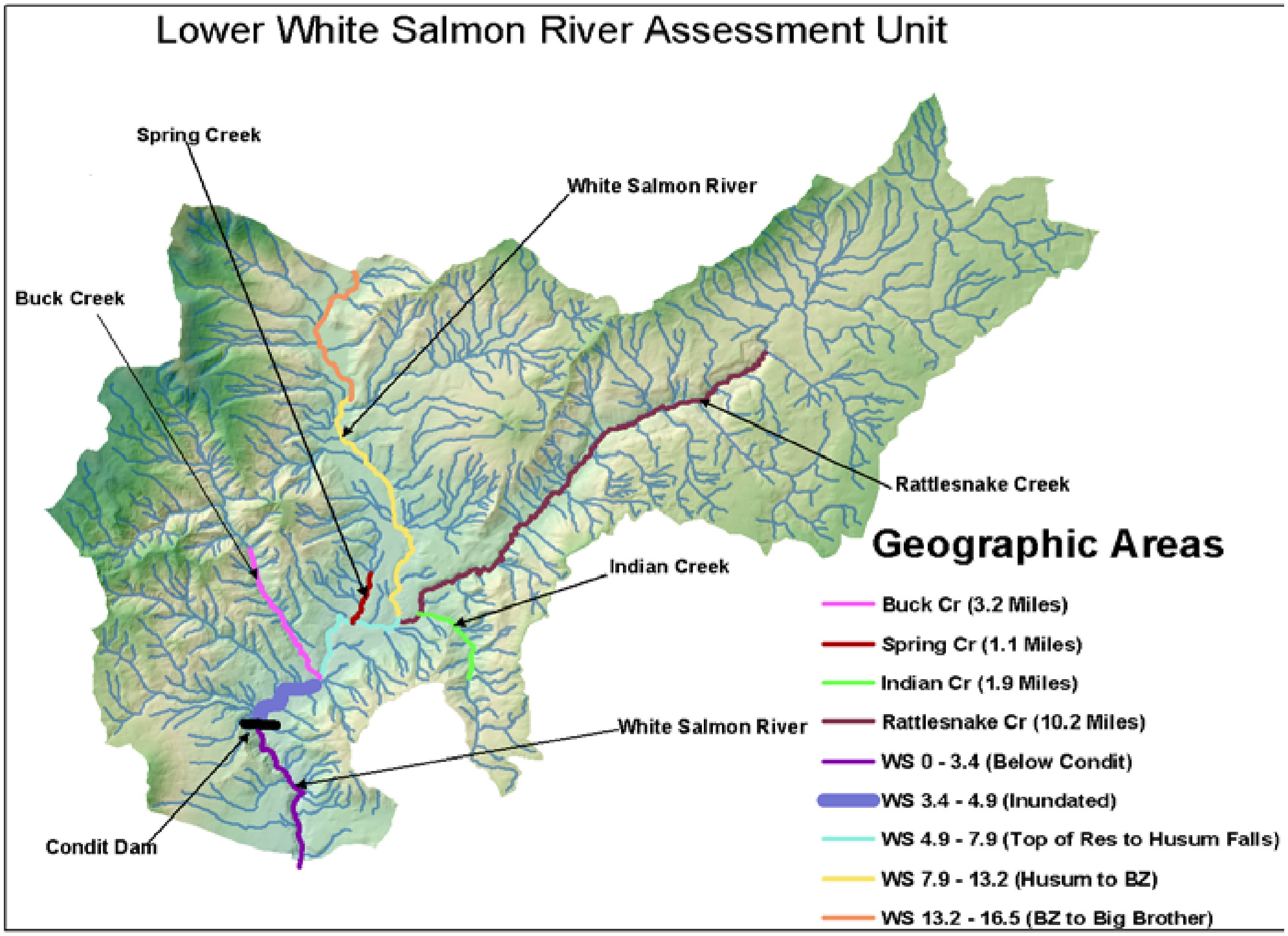

Figure 40 Map of geographic areas used in the EDT analysis

Upstream of the project, the hydrologic characteristics (peak flows and intra-annual flow) and sediment load (the percentage of fines in spawning gravel, embeddedness and turbidity) have increased due to roads, clearing of forest lands, and removal of trees from stream banks. A portion of the change in hydrologic and sediment transportation processes in the lower assessment unit originates upstream. Water quality in the mainstem remains very good, with maximum temperatures and dissolved oxygen levels remaining near optimum levels for salmonids.

Maximum temperatures in tributaries have increased due to water withdrawals and lack of mature conifers in the riparian zone. Nutrient enhancement has increased slightly compared to historic levels in both the mainstem and tributaries, as measured by fecal coliform counts, due to agriculture and failed septic systems. Biological impacts (predation, competition, and disease) have increased above background levels but remain low due to limited hatchery releases in the Northwestern Reservoir and below Condit Dam. There has been an increase in abundance of native and exotic fishes due to reservoir habitat created by BON dam. The stream corridor has been altered primarily from a reduction in conifer densities and size in the riparian zone and lack of large woody debris. Despite the degradation of subbasin habitat conditions, the current habitat below Condit Dam is capable of supporting fall chinook and coho salmon populations and the habitat above Condit Dam is capable of supporting spring chinook salmon, coho salmon, and steelhead populations.

Out of Subbasin

Out of basin factors include hydroelectric projects which increase adult and juvenile passage mortality and which alter the natural hydrologic regime. The altered regime increases water temperatures, decreases spring flows, and changes riverine habitat to reservoir habitat. These changes have increased native predator abundance and effectiveness, and reduced Columbia River plume habitat. Degradation of mainstem habitat is evident, especially in the estuary where 40% of tideland, wetlands, and swamps were lost between 1870 and 1970 (Sherwood et al. 1990). That has reduced salmonid survival. Oout of basin steelhead harvest rates exceeded 80% in the late 1800s, but are now greatly reduced. In the early 1900s the State of Washington eliminated commercial harvest and in the 1970s the State of Oregon eliminated commercial harvest. In the mid-1980s wild steelhead release regulations were adopted for the recreational fisheries. Harvest was to approximately 15 % or less after listing of steelhead for protection under ESA in the late 1990s.

Spawner-recruit analysis for Columbia River steelhead suggests recent fluctuations are primarily due to variation in marine survival (Rawding 2001 and Chilcote 2000). The smolt to adult survival rate for Kalama River hatchery summer steelhead has varied tenfold from 1.6% to 18% (figure 42). Generally, the smolt to adult survival pattern of Kalama River summer steelhead tracks with the A-run adult abundance data. Therefore, it is likely, that wild steelhead abundance in the White Salmon has shown similar variation. During period of low ocean productivity steelhead population levels are modeled to drop below the quasi-extinction threshold of 50 adults used by the WLC-TRT.

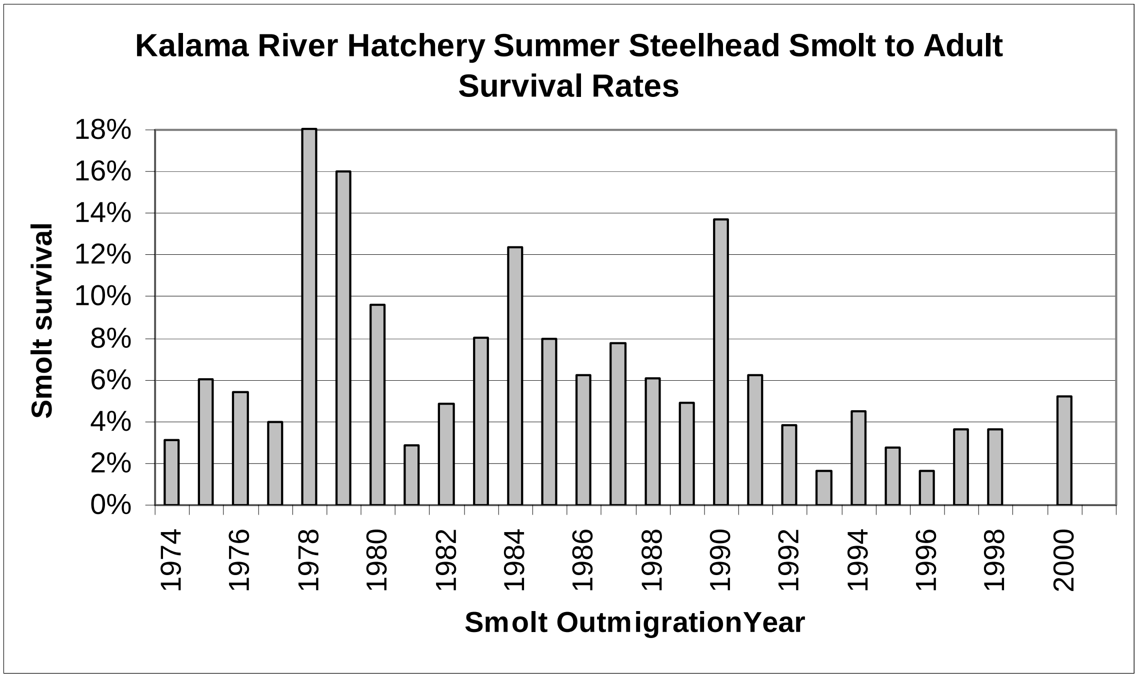

Figure 41 Kalama Hatchery steelhead smolt to adult survival rates

4.9.2 Environment/Population Relationship

The relationships for key habitat by life stage were presented above in Table 22. A key assumption in this analysis is the EDT data set is based on dam removal, a proposal being considered by FERC as a part of the relicensing process for the privately owned project. If the dam is removed, habitat conditions in the inundated reach and the reaches below the projects will go through a series of habitat change until the equilibrium conditions are met with its new environment. The limited time available for this analysis did not allow for the development of yearly assumptions concerning sediment load, fish habitat, riparian condition, LWD, and other attributes. Instead, river conditions were modeled at equilibrium, which modelers assumed would occur at a decade or more. For more information on the assumptions see the EDT report in the appendix.

EDT Environmental Analysis

The EDT reach analysis displays changes in survival by life stage between the historical and current condition. The importance of an environmental factors is displayed by the size of the black dot, the larger the dot the greater the decrease in survival from historic to current condition.

The geographic area summary reports display a relatively uniform pattern for survival changes in mainstem areas, eastside tributaries of Indian and Rattlesnake Creeks, and Westside tributaries of Spring and Buck Creeks (figure 43) All reaches have a protection and restoration potential. The loss of habitat diversity, decrease in channel stability, and increase in peak flow have decreased steelhead productivity in all areas. The loss of key habitat has decreased capacity in these same areas. The largest difference between the mainstem and tributaries habitat was an increase in maximum water temperature and a decrease in summer low flow for tributaries.

Figure 42 Summary of survival factors by geographic area have reduced potential steelhead productivity from the historic condition.

Geographic area priority			Attribute class priority for restoration															
Geographic area	Protection benefit	Restoration benefit	Channel stability/landsc.1/	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Buck Cr (4.2 Miles)	○	○	•				•		•						●	•		●
Spring Cr (1.1 Miles)	○	○							●		⬤				•			●
Indian Cr (1.9 Miles)	○	○					•		•				•		●	●		●
Rattlesnake Cr (10.9 Miles)	○	○					•		•				•		●	●		●
WS 0 - 3.4 (Below Condit)	○	○	•		•		•		●	•			•	●	⬤			●
WS 3.4 - 4.9 (Inundated)	○	○	•				•		●	•					●			●
4.9 - 7.9 (Top of Res to Husum Falls)	○	○	•				•		•	•					●			
WS 7.9 - 13.2 (Husum to BZ)	○	○	•				•		•	•					●			•
WS 13.2 - 16.5 (BZ to Big Brother)	○	○	•				•		•						●			•

1/ "Channel stability" applies to freshwater areas; "channel landscape" applies to estuarine areas.

Key to strategic priority (corresponding Benefit Category letter also shown)

A	B	C	D & E
○ / ⬤ High	○ / ● Medium	○ / • Low	Indirect or General

Representative Reach Analysis

The mainstem reach between Spring Creek and just below Rattlesnake Creek and the lowest reach in Rattlesnake Creek were chosen as representative reaches to illustrate the scale of survival changes and attributes contributing to these changes according to the EDT model (Figures 44 and 45). This is a patient/template analysis that compares survival by life stages under current conditions to the survival in the historic condition. The life stages that are most affected are inactive rearing, incubation, and active rearing.

In the mainstem White Salmon, the combined loss in survival from patient to template during the inactive rearing stage is 18% for each of the two over wintering period due to lack of habitat diversity (wood) and increased peak flows; both of which combine to decrease channel stability. The decrease in survival during the active rearing age 0 and age 1 life stages is 12% and 9%, respectively. During the egg incubation stage survival decreased by 31% primarily due to an increase in sediment and channel instability. Minor decreases in survival occurred during the adult life stages (6%) and during fry colonization (5%). This was due to increase in harassment and decrease in habitat diversity for adults and loss of habitat diversity and increase in peak flow for fry colonization.

Life stage	Relevant months	% of life history trajectories affected	Productivity change (%)	Life Stage Rank	Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
					Change in attribute impact on survival															
Spawning	Mar-Jun	2.7%	-5.2%	7							Moderate	Moderate								Moderate
Egg incubation	Mar-Jul	2.7%	-31.1%	2	Moderate							Small					High			Moderate
Fry colonization	May-Jul	5.2%	-4.8%	6	Small				Moderate		Moderate									
0-age active rearing	May-Jul	2.1%	-12.1%	5	Small						Moderate									
0,1-age inactive	Oct-Mar	8.3%	-18.9%	2	Small				Moderate		Moderate									
1-age migrant	Mar-Jun	26.2%	-0.4%	9							Small									
1-age active rearing	Mar-Oct	9.4%	-8.9%	3					Small		Moderate									
2+-age active rearing	Mar-Oct	2.1%	-4.8%	8					Small		Moderate									
2+-age migrant	Mar-Jun	30.7%	-0.1%	14							Small									
2+-age transient rearing																				
Prespawning migrant	Nov-Apr	65.3%	-0.1%	12								Small								
Prespawning holding	Dec-May	2.7%	-1.0%	13								Small								
All Stages Combined		65.3%																		

1/ Ranking based on effect over entire geographic area. 2/ Value shown is for overall population performance.

Notes: Changes in key habitat can be caused by either a change in percent key habitat or in stream width.

Potential % changes in performance measures for reaches upstream of dams were computed with full passage allowed at dams (though reservoir effects still in place).

KEY

NA = Not applicable

	Loss	Gain
None		
Small	◆	◇
Moderate	●	○
High	⬤	◯
Extreme	⬤	◯

Figure 43 Reach Scale analysis for steelhead in the mainstem White Salmon below Rattlesnake CR

Life stage	Relevant months	% of life history trajectories affected	Productivity change (%)	Life Stage Rank	Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
					Change in attribute impact on survival															
Spawning	Mar-Jun	1.6%	-5.6%								Moderate	Moderate						Small		Extreme
Egg incubation	Mar-Jul	1.6%	-45.4%		Moderate												High	High		Extreme
Fry colonization	May-Jul	5.1%	-16.5%		Small				Moderate	Small	Moderate					Small		High		
0-age active rearing	May-Jul	3.6%	-42.7%		Small		Small		Moderate		Moderate				Moderate	Small		High		
0,1-age inactive	Oct-Mar	3.4%	-19.5%		Moderate				Moderate		Moderate									
1-age migrant	Mar-Jun	9.4%	-0.5%								Moderate									
1-age active rearing	Mar-Oct	2.7%	-21.1%		Small		Small		Moderate		Moderate							Moderate		
2+-age active rearing	Mar-Oct	1.3%	-4.1%						Small		Small									
2+-age migrant	Mar-Jun	9.5%	-0.1%								Moderate									
2+-age transient rearing																				
Prespawning migrant	Nov-Apr	27.4%	0.0%								Small	Small								
Prespawning holding	Dec-May	1.6%	-1.6%								Small	Small								Moderate
All Stages Combined		27.4%																		

1/ Ranking based on effect over entire geographic area. 2/ Value shown is for overall population performance.

Notes: Changes in key habitat can be caused by either a change in percent key habitat or in stream width.

Potential % changes in performance measures for reaches upstream of dams were computed with full passage allowed at dams (though reservoir effects still in place).

KEY

NA = Not applicable

	Loss	Gain
None		
Small	◆	◇
Moderate	●	○
High	⬤	◯
Extreme	⬤	◯

Figure 44 Reach scale analysis for steelhead in lower Rattlesnake Creek

Synthesis and analysis

The EDT model identifies limiting environmental attribute at the reach scale. However, correcting reach scale limiting factors is like "treating the symptoms and not the causes" because watershed processes create reach scale habitat conditions. Table 24 links steelhead survival by life stage to reach scale limiting factors to watershed processes. This table is a synthesis and interpretation of the habitat assessment in the Lower White Salmon Assessment Unit. The key findings indicate the steelhead survival has been reduced due to road building and forest removal. These activities have resulted in increased peak flows and sediment transport. The riparian conditions in most of the mainstem White Salmon River are good but the riparian area is more degraded in the tributaries. Degraded riparian conditions and wood removal from streams has decrease critical habitat for juvenile rearing.

4.9.3 Synthesis And Interpretation of Habitat And Watershed Processes on Steelhead Productivity

Table 24 The synthesis and interpretation of habitat and watershed processes on steelhead productivity

Life Stage (reduction in productivity)	EDT Level 3 Survival Factors	Primary EDT Level 2 attribute affecting survival	EDT Level 2 Definition	Watershed Process: Working Hypothesis
Egg Incubation (-31% White Sal) (-46% Rattlesnake)	Channel Stability (Primary)	Bed Scour	The average depth of bed scour in salmonid spawning areas during the annual peak flow event over a ten-year period.	**Watershed Process: Hydrology modified by riparian.** Estimated 10% increase in peak flow (Q2yr) at the Underwood Gauge (RM 2) due to increased road densities and to a less extent logging and conversion of forest to agriculture and residential. The depth of bed scour has increased due to peak flows, which leads to an increase in dislodged eggs. A modifying factor is that a decrease in wood levels, leave more egg pockets unprotected.
	Sediment Load (Primary)	Fine Sediment	The percentage of fine sediment within salmon spawning substrate.	**Watershed Process: Sediment Transport.** Road densities increase fine sediment in spawning gravels but isolated areas of bank instability may also increase fines. An increase in % fines reduces respiration and may cause entombment.
Fry Colonization (-5% White Sal) (-5% Rattlesnake)	Habitat Diversity (Primary)	Gradient	Average gradient. Since there was no change in this attribute, the decrease in productivity is related to hydro-confinement, wood, and riparian function.	**Watershed Process: Riparian.** Fewer pieces of wood have slightly decreased slow water needed for fry colonization.
	Flow (Secondary)	High Flow	Change in intra-annual variability in high flows.	**Watershed Process: Hydrology.** Estimated 10% increase in peak flow (Q2yr) at the Underwood Gauge (RM 2) due to increased road densities and to a less extent logging and conversion of forest to agriculture and residential. Increased peak flows displace juveniles to less favorable locations. This is more important for fall spawners (salmon) because they emerge in the winter/spring. Steelhead are not effected since they emerge during the summer.
	Channel Stability (Secondary)	Bed Scour	The average depth of bed scour in salmonid spawning areas during the annual peak flow event over a ten year period.	**Watershed Process: Hydrology modified by riparian.** Estimated 10% increase in peak flow (Q2yr) at the Underwood Gauge (RM 2) due to increased road densities and to a less extent logging and conversion of forest to agriculture and residential. Increased peak flows

Life Stage (reduction in productivity)	EDT Level 3 Survival Factors	Primary EDT Level 2 attribute affecting survival	EDT Level 2 Definition	Watershed Process: Working Hypothesis
				and reduced wood levels decrease channel stability, and juveniles may be displace downstream to less favorable locations
Active Age 0 (-12% White Sal) (-20% Rattlesnake)	Habitat Diversity (Primary)	Gradient	Average gradient. Since there was no change in this attribute, the decrease in productivity is related to hydro-confinement, wood, and riparian function.	**Watershed Process: Riparian.** Fewer pieces of wood have significantly decreased slow water needed for active rearing.
	Temperature (Primary in Rattlesnake)	Maximum Water Temperature	Maximum water temperatures within the stream reach during a month	**Watershed Process: Riparian.** Degraded riparian zone has reduced stream shade leading to an increase in maximum water temperatures.
Inactive Age 0,1 (-18% White Sal) (-21% Rattlesnake)	Habitat Diversity (Primary)	Gradient	Average gradient. Since there was no change in this attribute, the decrease in productivity is related to hydro-confinement, wood, and riparian function.	**Watershed Process: Riparian.** Fewer pieces of wood have slightly decreased slow water needed for overwintering habitat.
	Flow (Secondary)	High Flow	Change in intra-annual variability in high flows.	**Watershed Process: Hydrology.** Estimated 10% increase in peak flow (Q2yr) at the Underwood Gauge (RM 2) due to increased road densities and to a less extent logging and conversion of forest to agriculture and residential. Increased peak flows displace juveniles to less favorable locations. This is more important for fall spawners (salmon) because they emerge in the winter/spring. Steelhead are not as affected since they emerge during the summer.
	Channel Stability (Secondary)	Bed Scour	The average depth of bed scour in salmonid spawning areas during the annual peak flow event over a ten-year period.	**Watershed Process: Hydrology modified by riparian.** Estimated 10% increase in peak flow (Q2yr) at the Underwood Gauge (RM 2) due to increased road densities and to a less extent logging and conversion of forest to agriculture and residential. Increased peak flows and reduced wood levels decrease channel stability, and juveniles may be displace downstream to less favorable locations
Adult Stage including : migrant prespawner, holding	Harassment	Harassment	The relative extent of poaching or harassment. Modified by primary pools, riparian function, turbidity,	**Watershed Process: Recreation** An increase in recreational activity has led to a potential increase in poaching of adult salmon and steelhead and harassment of adults prior to

Life Stage (reduction in productivity)	EDT Level 3 Survival Factors	Primary EDT Level 2 attribute affecting survival	EDT Level 2 Definition	Watershed Process: Working Hypothesis
prespawner, and spawner (-6% White Sal) (-7% Rattlesnake)			and wood.	and during spawning one they have access to the area above Condit Dam.

4.9.4 Ecological Relationships

The key ecological relationships for competition between salmon races, salmon carcasses, salmon and wildlife, and bright/tule fall chinook have been covered in other sections.

4.10 Fish Focal Species: Coho

Species characterization and status

Characterization

Coho salmon are native to the White Salmon River (WDF et al. 1993) and their historical distribution extended from the mouth up to RM 14 in the mainstem, and Buck, Spring, Indian, and Rattlesnake Creeks (figure 46). The current distribution is limited to the area below Condit Dam (RM 3.4).

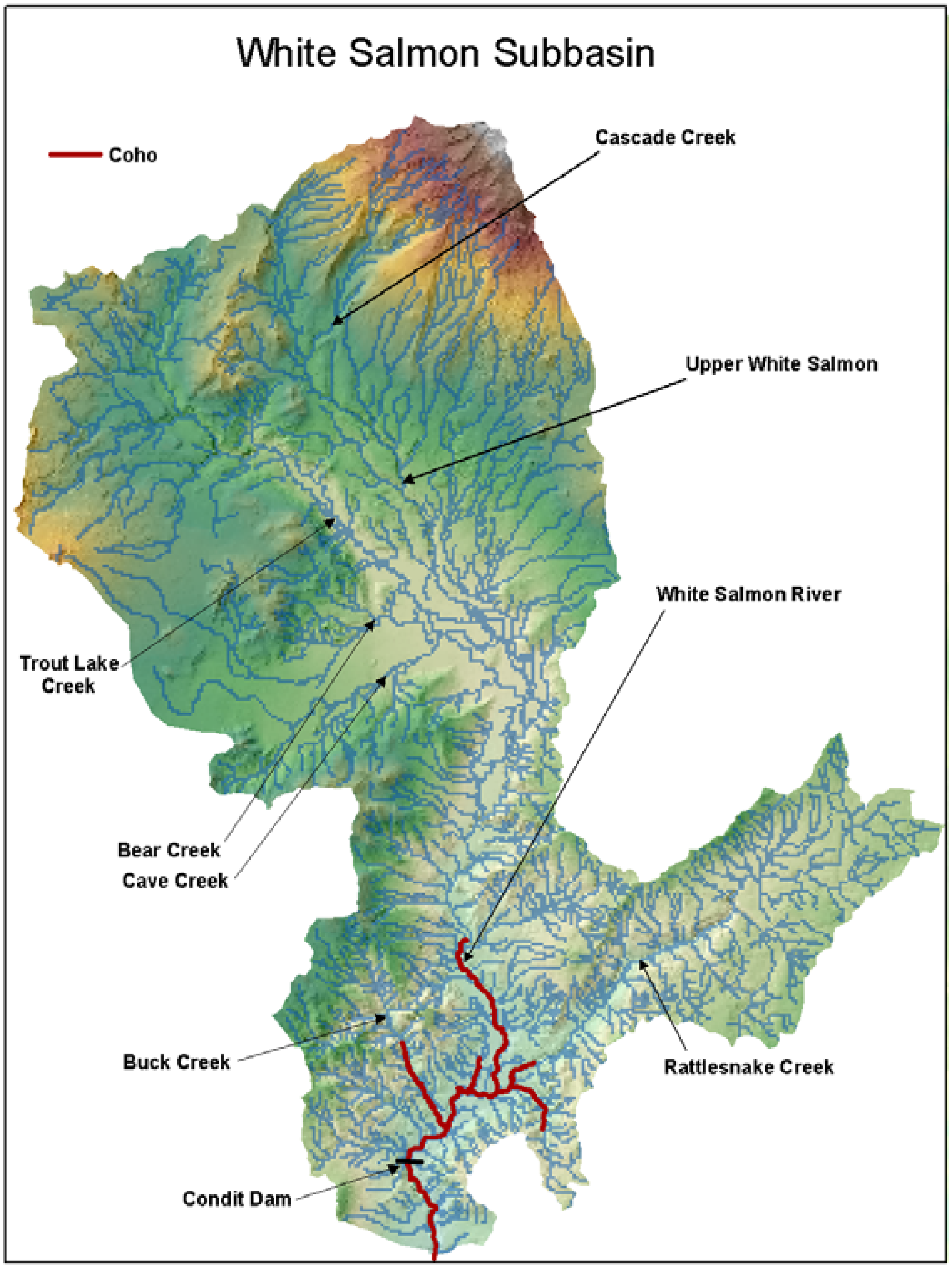

Figure 45 Historic spawning distribution of steelhead in the White Salmon River. Current spawning distribution is limited to the area below Condit Dam

Coho salmon are considered to be part of the LowerColumbia River/Southwest Washington Coast ESU, which includes Washington populations from the mouth of the Columbia to below the Klickitat River (Weitkamp et al. 1995).

Status

The status of coho salmon in the White Salmon River is listed unknown. WDF et al. (1993) did not list White Salmon River coho salmon as a stock during the Salmon and Steelhead Stock Inventory. Since their historical distribution is similar to steelhead, and Condit Dam has stopped historical access since 1913. Their status should be similar to steelhead, which is depressed. Since population monitoring for the White Salmon River does not occur, the status may be inferred from estimates of the EDT model.

The performance of steelhead in the White Salmon subbasin as estimated by the EDT model is found in table 25 and figure 45. The current coho salmon abundance at equilibrium is expected to be 470 coho salmon in the absence of harvest. The EDT modeling indicates wild steelhead abundance in the absence of harvest has declined from 1,278 spawners to less than 470 spawners. However, the EDT model in the subbasin processes assumes historic condition for the tributaries and current condition for the mainstem. Therefore, the historic potential for coho salmon is even higher than depicted.

Table 25 Changes in the potential steelhead performance in the White Salmon Subbasin from historical to current conditions.

Population	Scenario	Diversity index	Productivity	Capacity	Abundance
Big White Salmon River Coho	Current without harvest	6%	3.7	643	470
	Historic potential	70%	4.1	1,694	1,278

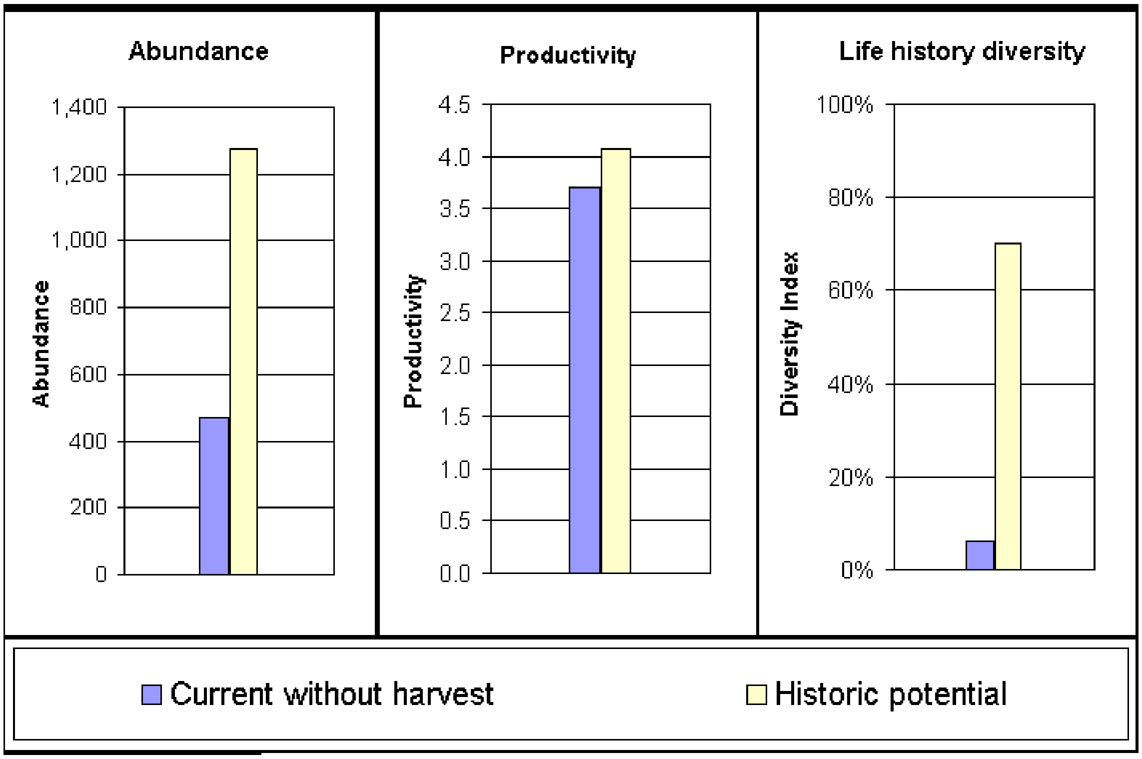

Figure 46 Current and historic potential coho salmon performance in the White Salmon River Subbasin

Life history

Detailed steelhead life history and habitat requirements of steelhead can be found in various existing documents (e.g., Wydoski and Whitney 1979, Bjornn and Reiser 1991, Sandercok 1991, and Nichelson et al. 1993, and Reeves et al. 1989) and will not be repeated here. The purpose of this section is to provide a brief overview of life history, life history stages, and key habitat.

Compared to chinook salmon and steelhead, the life history of coho salmon is not as variable. Adults enter the Columbia River from August through December, with wild populations peaking in October and November. Spawning occurs from October through January, peaking in November. Adult coho are 3 year olds (age 1.2) and jacks are age 2 (1.1). Some coho smolts in the Lewis River migrate as subyearlings.

Coho salmon in the White Salmon subbasin typically spawn from October through January, with peak activity in November. Redds are constructed in gravel and small cobble substrate in pool tailouts, riffles, and glides. Eggs remain in the gravel until emergence, which occurs from February to April depending on water temperatures. After emergence fry migrate to shallow water with low velocities associated with stream margins and back eddies. After fry colonization juvenile coho salmon seek out slow water habitat types. Preferred areas are primary, backwater, and dammed pools. Shortly after fry colonization juveniles continue rearing until October. During the inactive or overwintering life stage, juveniles prefer off channel pool habitat over primary pool habitat. Outmigration occurs for yearlings during the following spring, peaking in May. The yearling juvenile life history pattern described is simplistic and typical. In reality juvenile life history patterns are complex and considerable instream movement of coho juveniles occurs during freshets. Key habitat description by life stage are found in table 26.

Table 26 Definition of key habitat by life stage and time period for coho salmon from Mobrand et al 1998.

Life Stage	Relevant Months	Key Habitat Descriptions
Spawning	Oct-Jan	Riffles, tailouts, and the swifter areas of glides containing a mixture of gravel and cobble sizes with flow of sufficient depth for spawning activity.
Incubation	Oct-May	Riffles, tailouts, and the swifter areas of glides as described for spawning with sufficient flow for egg and alevin development
Fry Colonization	Mar-May	Shallow, slow velocity areas within the stream channel, including backwater areas, often associated with stream margins and back eddies and usually in relatively low gradient reaches. Water depth usually < 2 ft. Movement may occur at night toward the shoreline to even shallower and quieter areas.
Active Rearing	0-age Mar-Oct 1-age Mar-May	Pool type habitat, often associated with relatively low gradient stream channel reaches, including backwaters, beaver ponds, off-channel sloughs, and slow eddies.
Inactive Rearing	Oct-Mar	All slow water habitat types (Level I types defined by Hawkins et al. 1993.) It is recognized that beaver ponds and backwater pools (Level II as defined by Hawkins et al. 1993) are more strongly preferred than primary pools in this life stage.
Migrant	Mar-Jun	All habitat types having sufficient flow for free movement of juvenile migrants.
Prespawning Migrant	Sep-Nov	All habitat types having sufficient flow for free movement of sexually mature adult migrants.
Prespawning Holding	Oct-Dec	Relatively slow, deep water habitat types typically associated with (or immediately adjacent to) the main channel.

Genetic Diversity

The habitat models predicted the stream reaches below the dam are capable of supporting a coho salmon run size under average ocean conditions of more than 400 adults. Under poor ocean conditions run size may be reduced by 50%. These levels are above quasi-extinction threshold of 50 spawners used by the WLC-TRT but below genetic guidelines in the State of Washington's Wild Salmonid Policy of 1,000 spawners for populations with this age structure. It is likely that the genetic diversity and fitness of wild coho salmon in this basin has been reduced due to low carrying capacity below Condit Dam, hatchery introgression from releases to meet mitigation locations specified in US v Oregon, and decreased spawners due to in and out-of basin subbasin fisheries. In recent years PSMFC has collected scales collected during in conjunction with fall chinook salmon surveys in late September/early October and then again in November. These are collected below the Powerhouse (RM 2). In 2002 98% of the 145 fish sampled in this area were aged as hatchery coho salmon due to accelerated freshwater growth. Since coho are sampled incidental to chinook no surveys take place in the bypass reach, which is wherewe would expect to see higher numbers of natural coho. Most of the hatchery coho salmon are from Willard Hatchery based on CWT expansion (Kelly Harlan, PSMFC).

Harvest

Wild salmon and steelhead played an important role in native cultures. Harvest of steelhead, while locally important, was likely less important than salmon harvest due to lower abundances and spawning times that coincided with higher flows. Chapman (1986) estimated that historic harvest rates of Columbia River coho exceeded 80% in the late 1800s during the development of the Columbia River fishery. Harvest rates for coho salmon declined after this period but increased when Mitchell Act hatchery production became available. From 1970 to 1983 harvest rates for Columbia River coho salmon ranged from 70% to 90%. Recently, commercial and recreational harvests of coho salmon have been reduce to protect wild coho salmon from the Clackamas River and the Oregon Coast. Harvest rates of ESA listed coho salmon were less than 15% between 1999 and 2002. Current coho salmon harvest in the ocean, Columbia River, and tributaries is managed to meet hatchery escapement objectives and meet rebuilding objectives for the Clackamas River population. Harvest rates of White Salmon River coho salmon are unknown.

4.10.1 Environmental Conditions

Within Subbasin

Compared to many of the subbasins the size of the White Salmon River is small. Rather than assess at the sixth field HUC, assessments were made for the mainstem and each tributary. However, many limiting factors overlapped between the mainstem and tributaries. The geographic areas used in the lower assessment unit analysis are found in figure 46.

The factors that led to the decline of White Salmon River salmon and steelhead include a combination of in and out of basin human impacts. The most limiting factor in this subbasin for anadromous salmonids is the construction and operation of Condit Dam. Steelhead, spring chinook, and coho salmon currently access only a small percentage of their historic spawning and rearing areas (table 27). Lack of access to areas above Condit Dam has stopped the marine derived nutrients cycle, which benefits fishes, mammals, birds, insects, and vegetation. Operation of the dam has altered the natural hydrologic regime including reduced rearing potential in the bypass reach since minimum flows are 30cfs compared to natural low flows of about 700 cfs. Power peaking causes diel flow variation, which has led to dewatering, stranding, and an increase in bioenergetics' losses due to movements associated with daily flow changes. Condit Dam also impairs watershed processes such as sediment and LWD transportation, which have reduced recruitment of spawning gravels and LWD below the project.

Table 27 River miles of habitat by species above and below Condit Dam.

Species	Historic Distribution	Current Distribution	Percentage of Historic Access	Comments
Chum	1.2	1.2	100%	80% of spawning area flooded by Bonneville Dam
Fall Chinook	3.6	3.4	94%	6% above spawning areas above Condit Dam
Sp Chinook	12.8	0	0%	All spawning area above Condit Dam
Coho	21.1	3.4	16%	Majority of spawning area above Condit Dam
Steelhead	32.9	3.4	10%	Majority of spawning area above Condit Dam

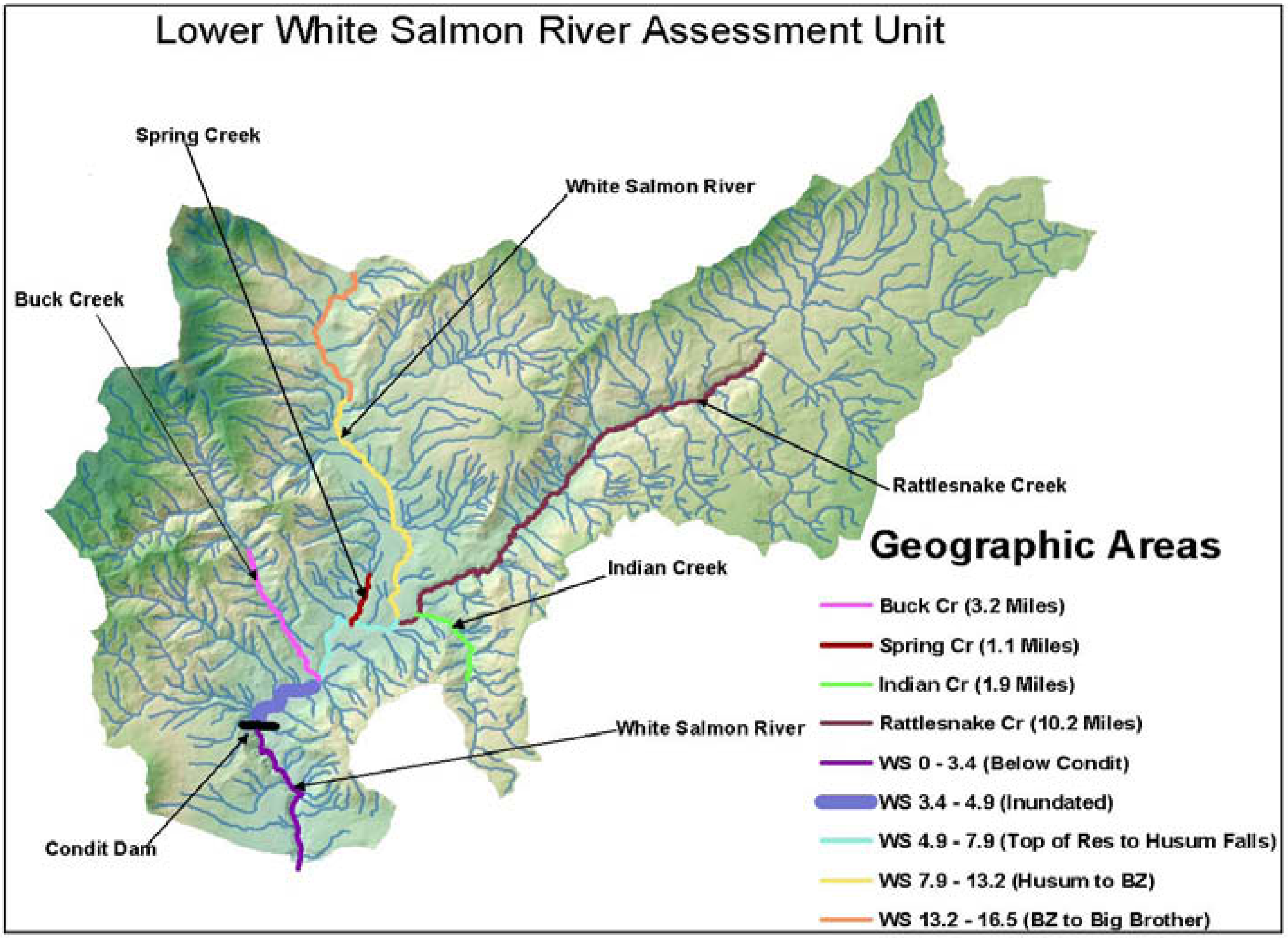

Figure 47 Map of geographic areas used in the EDT analysis

Upstream of the project, the hydrologic characteristics (peak flows and intra-annual flow) and sediment load (the percentage of fines in spawning gravel, embeddedness and turbidity) have increased due to roads, clearing of forest lands, and removal of trees from stream banks. A portion of the change in hydrologic and sediment transportation processes lower assessment unit originates in the upper assessment unit.

Water quality in the mainstem remains very good, with maximum temperatures and dissolved oxygen levels remaining near optimum levels for salmonids. Maximum temperatures in tributaries have increased due to water withdrawals and lack of mature conifers in the riparian zone. Nutrient enhancement has increased slightly compared to historic levels in both the mainstem and tributaries, as measured by fecal coliform counts, due to agriculture and failed septic systems. Biological impacts (predation, competition, and disease) have increased above background levels but remain low due to limited hatchery releases in the Northwestern Reservoir and below Condit Dam. There has been an increase in abundance of native and exotic fishes due to reservoir habitat created by BON dam.

The stream corridor has been altered primarily from a reduction in conifer densities and size in the riparian zone and lack of large woody debris. Despite the degradation of subbasin habitat conditions, the current habitat below Condit Dam is capable of supporting fall chinook and coho salmon populations and the habitat above Condit Dam is capable of supporting spring chinook salmon, coho salmon, and steelhead populations.

Out of Subbasin

Out of basin factors include hydroelectric projects which increase adult and juvenile passage mortality and which alter the natural hydrologic regime. The altered regime increases water temperatures, decreases spring flows, and changes riverine habitat to reservoir habitat. These changes have increased native predator abundance and effectiveness, and reduced Columbia River plume habitat. Degradation of mainstem habitat is evident, especially in the estuary where 40% of the tidelands, wetlands, and swamps were lost between 1870 and 1970 (Sherwood et al. 1990). That has resulted in reduced salmonid survival. Out of basin steelhead harvest rates exceeded 80% in the late 1800s, but have since been reduced to 15 % or less after the listing of Oregon Coastal coho salmon for protection under ESA in the late 1990s.

4.10.2 Environment/Population Relationship

The relationships for key habitat by life stage were presented above in table 26. A key assumption in this analysis is the EDT data set is based on dam removal, which has been approved by the Federal Energy Regulatory Commission (FERC) and awaiting a clean water certification from the Washington Department of Ecology (DOE). As a dam is removed, habitat conditions in the inundated reach and the reaches below the projects will go through a series of habitat change until the equilibrium conditions are met with its new environment. Time did not allow for yearly assumptions concerning sediment load, fish habitat, riparian condition, LWD, and other attributes. Instead, river conditions were modeled at equilibrium, which we assumed would occur at a decade or more. For more information on the assumptions see the EDT report in the appendix.

EDT Environmental Analysis

The EDT reach analysis displays changes in survival by life stage between the historical and current condition. The importance of an environmental factors is displayed by the size of the black dot, the larger the dot the greater the decrease in survival from historic to current condition. The geographic area summary reports display a relatively uniform pattern for survival changes in mainstem areas, eastside tributaries of Indian and Rattlesnake Creeks, and Westside tributaries of Spring and Buck Creeks (figure 49). All reaches have a protection and restoration potential. The loss of habitat diversity, decrease in channel stability, and increase in peak flow have decreased steelhead productivity in all areas. The loss of key habitat has decreased capacity in these same areas. The largest difference between the mainstem and tributaries habitat was an increase in maximum water temperature and a decrease in summer low flow for tributaries.

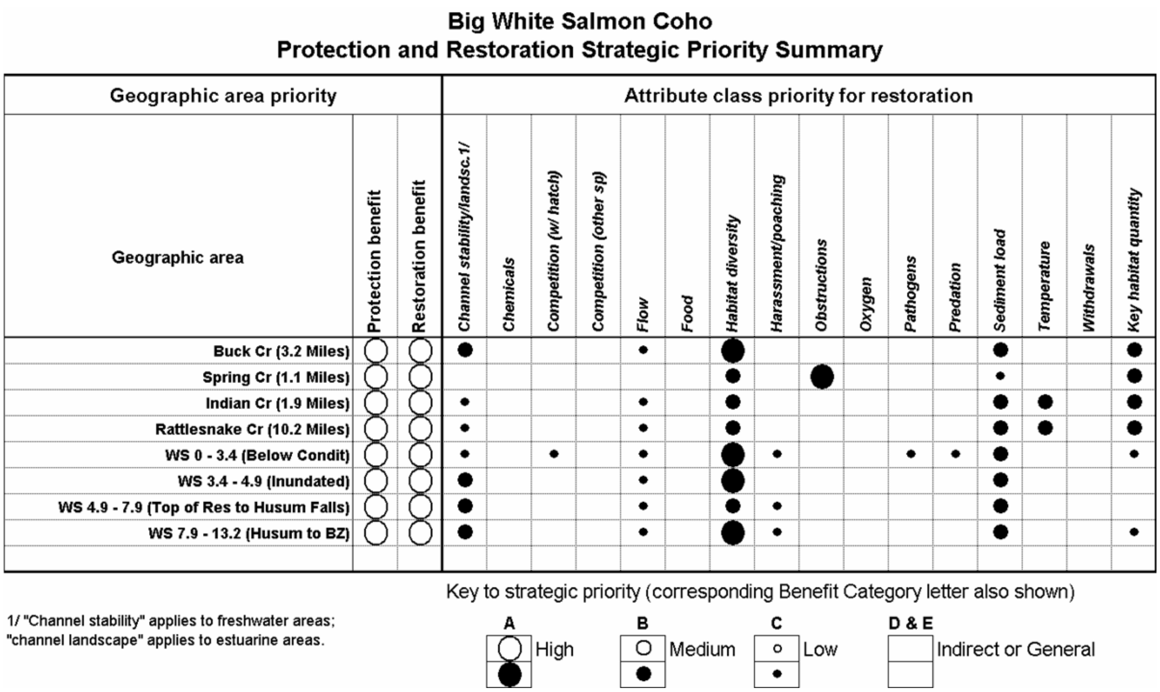

Figure 48 Summary of survival factors by geographic area have reduced potential coho salmon productivity from the historic condition

Representative Reach Analysis

The mainstem reach between Spring Creek and just below Rattlesnake Creek and the lowest reach in Buck Creek were chosen as representative reaches to illustrate the scale of survival changes and attributes contributing to these changes according to the EDT model (figures 50 and 51). This is a patient/template analysis that compares survival by life stages under current conditions to the survival in the historic condition. The life stages that are most affected are inactive rearing, incubation, and active rearing. In the mainstem White Salmon, the combined loss in survival from patient to template during the inactive rearing stage is 89% in the mainstem and 63% in the Buck Creek during the over wintering period due to lack of habitat diversity (wood) and increased peak flows; both of which combine to decrease channel stability. The decrease in survival during the active rearing age 0 and age 1 life stages is ~40% and 16%, respectively. During the egg incubation stage survival decreased by 40% primarily due to an increase in sediment and channel instability. Minor decreases in survival occurred during the adult life stages (6%) and during fry colonization (9%). This was due to increase in harassment and decrease in habitat diversity for adults and loss of habitat diversity and increase in peak flow for fry colonization.

Geographic Area:	WS 7.9 - 13.2 (Husum to BZ)	**Stream:**	Big White Salmon
Reach:	Spring Ck. to Deadman's Corner	**Reach Length (mi):**	0.70
		Reach Code:	WS11

Life stage	Relevant months	% of life history trajectories affected	Productivity change (%)	Life Stage Rank	Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
					Change in attribute impact on survival															
Spawning	Oct-Jan	2.4%	-3.9%	6							Moderate	Moderate								
Egg incubation	Oct-May	2.4%	-39.4%	2	High							Small					High			
Fry colonization	Mar-May	13.7%	-5.6%	4	Moderate				Moderate		High									
0-age active rearing	Mar-Oct	2.6%	-38.5%	3	Small						High									
0-age migrant	Oct-Nov	3.1%	-1.5%	8							Moderate									
0-age inactive	Oct-Mar	2.5%	-89.8%	1	Small				Moderate		Extreme									
1-age active rearing	Mar-May	2.5%	-14.8%	5	Small				Moderate		High									Small
1-age migrant	Mar-Jun	9.8%	-0.2%	9							Moderate									
1-age transient rearing																				
2+-age transient rearing																				
Prespawning migrant	Sep-Nov	21.6%	0.0%	10								Small								
Prespawning holding	Oct-Dec	2.4%	-3.0%	7								Moderate								
All Stages Combined		21.6%																		

1/ Ranking based on effect over entire geographic area. 2/ Value shown is for overall population performance.

Notes: Changes in key habitat can be caused by either a change in percent key habitat or in stream width.

Potential % changes in performance measures for reaches upstream of dams were computed with full passage allowed at dams (though reservoir effects still in place).

KEY

NA = Not applicable

	Loss	Gain
None		
Small	● (small)	○ (small)
Moderate	● (moderate)	○ (moderate)
High	● (large)	○ (large)
Extreme	● (largest)	○ (largest)

Figure 49 Reach scale analysis for coho salmon between Spring Creek and just below Rattlesnake Creek

Geographic Area:	Buck Cr (3.2 Miles)	Stream:	Big White Salmon
Reach:	Buck Ck. mouth to diversion intake	Reach Length (mi):	2.01
		Reach Code:	B1

Life stage	Relevant months	% of life history trajectories affected	Productivity change (%)	Life Stage Rank	Change in attribute impact on survival															
					Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Spawning	Oct-Jan	4.5%	-2.0%	7							•									•
Egg incubation	Oct-May	4.5%	-43.6%	2	●												●			•
Fry colonization	Mar-May	6.4%	-13.0%	4	•				•	•	●									●
0-age active rearing	Mar-Oct	0.3%	-41.0%	3	•				•		●							•		●
0-age migrant	Oct-Nov	0.3%	-2.9%	6							•									
0-age inactive	Oct-Mar	0.3%	-63.5%	1	•				•		⬤									●
1-age active rearing	Mar-May	0.3%	-16.2%	5	•				•		●									●
1-age migrant	Mar-Jun	0.3%	-0.6%	9							•									
1-age transient rearing																				
2+-age transient rearing																				
Prespawning migrant	Sep-Nov	6.4%	0.0%	10							•									
Prespawning holding	Oct-Dec	4.5%	-1.2%	8							•									●
All Stages Combined		6.4%																		

1/ Ranking based on effect over entire geographic area. 2/ Value shown is for overall population performance.

Notes: Changes in key habitat can be caused by either a change in percent key habitat or in stream width.

Potential % changes in performance measures for reaches upstream of dams were computed with full passage allowed at dams (though reservoir effects still in place).

NA = Not applicable

KEY

	Loss	Gain
None		
Small	•	∘
Moderate	•	○
High	●	○
Extreme	⬤	◯

Figure 50 Reach scale analysis for coho salmon in lower Buck Creek

Synthesis and Analysis

The EDT model identifies limiting environmental attribute at the reach scale. However, correcting reach scale limiting factors is like "treating the symptoms and not the causes" because watershed processes create reach scale habitat conditions. Table 28 links coho salmon survival by life stage to reach scale limiting factors to watershed processes. This table is a synthesis and interpretation of the habitat assessment in the Lower White Salmon Assessment Unit. The key findings indicate the coho salmon survival has been reduced due to road building and forest removal. These activities have resulted in increased peak flows and sediment transport. The riparian conditions in most of the mainstem White Salmon River are good but the riparian area is more degraded in the tributaries. Degraded riparian conditions and wood removal from streams has decrease critical habitat for juvenile rearing.

4.10.3 Synthesis and Interpretation of Habitat and Watershed Processes on Coho Salmon Productivity

Table 28 The synthesis and interpretation of habitat and watershed processes on coho salmon productivity

Life Stage (reduction in productivity)	EDT Level 3 Survival Factors	Primary EDT Level 2 attribute affecting survival	EDT Level 2 Definition	Watershed Process: Working Hypothesis
Egg Incubation (-39% White Sal) (-44% Buck)	Channel Stability (Primary)	Bed Scour	The average depth of bed scour in salmonid spawning areas during the annual peak flow event over a ten-year period.	**Watershed Process: Hydrology modified by riparian.** Estimated 10% increase in peak flow (Q2yr) at the Underwood Gauge (RM 2) due to increased road densities and to a less extent logging and conversion of forest to agriculture and residential. The depth of bed scour has increased due to peak flows, which leads to an increase in dislodged eggs. A modifying factor is that a decrease in wood levels, leave more egg pockets unprotected.
	Sediment Load (Primary)	Fine Sediment	The percentage of fine sediment within salmon spawning substrate.	**Watershed Process: Sediment Transport.** Road densities increase fine sediment in spawning gravels but isolated areas of bank instability may also increase fines. An increase in % fines reduces respiration and may cause entombment.
Fry Colonization (-6% White Sal) (-13% Buck)	Habitat Diversity (Primary)	Gradient	Average gradient. Since there was no change in this attribute, the decrease in productivity is related to hydro-confinement, wood, and riparian function.	**Watershed Process: Riparian.** Fewer pieces of wood have slightly decreased slow water needed for fry colonization.
	Flow (Secondar y)	High Flow	Change in intra-annual variability in high flows.	**Watershed Process: Hydrology.** Estimated 10% increase in peak flow (Q2yr) at the Underwood Gauge (RM 2) due to increased road densities and to a less extent logging and conversion of forest to agriculture and residential. Increased peak flows displace juveniles to less favorable locations. This is more important for fall spawners (salmon) because they emerge in the winter/spring. Steelhead are not effected since they emerge during the summer.
	Channel Stability (Secondar y)	Bed Scour	The average depth of bed scour in salmonid spawning areas during the annual peak flow event over a ten year period.	**Watershed Process: Hydrology modified by riparian.** Estimated 10% increase in peak flow (Q2yr) at the Underwood Gauge (RM 2) due to increased road densities and to a less extent logging and conversion of forest to agriculture and residential. Increased peak flows and reduced wood levels decrease channel stability, and juveniles may be displace downstream to less favorable locations

Life Stage (reduction in productivity)	EDT Level 3 Survival Factors	Primary EDT Level 2 attribute affecting survival	EDT Level 2 Definition	Watershed Process: Working Hypothesis
Active Age 0 (-39% White Sal) (-41% Buck)	Habitat Diversity (Primary)	Gradient	Average gradient. Since there was no change in this attribute, the decrease in productivity is related to hydro-confinement, wood, and riparian function.	**Watershed Process: Riparian.** Fewer pieces of wood have significantly decreased slow water needed for active rearing.
	Temperature (Primary in Rattlesnake)	Maximum Water Temperature	Maximum water temperatures within the stream reach during a month	**Watershed Process: Riparian.** Degraded riparian zone has reduced stream shade leading to an increase in maximum water temperatures.
Inactive Age 0,1 (-90% White Sal) (-64% Buck)	Habitat Diversity (Primary)	Gradient	Average gradient. Since there was no change in this attribute, the decrease in productivity is related to hydro-confinement, wood, and riparian function.	**Watershed Process: Riparian.** Fewer pieces of wood have slightly decreased slow water needed for overwintering habitat.
	Flow (Secondary)	High Flow	Change in intra-annual variability in high flows.	**Watershed Process: Hydrology.** Estimated 10% increase in peak flow (Q2yr) at the Underwood Gauge (RM 2) due to increased road densities and to a less extent logging and conversion of forest to agriculture and residential. Increased peak flows displace juveniles to less favorable locations. This is more important for fall spawners (salmon) because they emerge in the winter/spring. Steelhead are not as affected since they emerge during the summer.
	Channel Stability (Secondary)	Bed Scour	The average depth of bed scour in salmonid spawning areas during the annual peak flow event over a ten-year period.	**Watershed Process: Hydrology modified by riparian.** Estimated 10% increase in peak flow (Q2yr) at the Underwood Gauge (RM 2) due to increased road densities and to a less extent logging and conversion of forest to agriculture and residential. Increased peak flows and reduced wood levels decrease channel stability, and juveniles may be displace downstream to less favorable locations
Adult Stage including : migrant prespawner, holding prespawner, and	Harassment	Harassment	The relative extent of poaching or harassment. Modified by primary pools,	**Watershed Process: Recreation** An increase in recreational activity has led to a potential increase in poaching of adult

Life Stage (reduction in productivity)	EDT Level 3 Survival Factors	Primary EDT Level 2 attribute affecting survival	EDT Level 2 Definition	Watershed Process: Working Hypothesis
spawner (-7% White Sal) (-3% Buck)			riparian function, turbidity, and wood.	salmon and steelhead and harassment of adults prior to and during spawning one they have access to the area above Condit Dam.

4.10.4 Ecological Relationships

The key ecological relationships for competeition between salmon races, salmon carcasses, salmon and wildlife, and bright/tule fall chinook have been covered in other focal species sections.

4.10.5 Key Findings–White Salmon River Mouth to River Mile 16 Assessment Unit

Previous adult and juvenile population monitoring programs in the White Salmon River were not statistically adequate to describe the status of focal species. Smolt monitoring was funded in 1983-84 but discontinued due to lack of resources. For adult escapement peak live and dead counts are conducted for tule and bright fall chinook salmon. Due to uncertainty in observer efficiency and the lack of mass marking hatchery releases, the variance associated with these estimates is likely to be high. Spring chinook estimates are likely from hatchery releases and estimates are made based on a peak redd count. Adult coho and steelhead escapement is not estimated and counts occur only when conducting chinook surveys.

In this assessment, the status of White Salmon River salmon and steelhead populations is inferred from models by Chapman (1991), WDFW et al. (1989) and the current EDT model. Status is determined on performance parameters of productivity, capacity, and abundance. These analysis indicate the current chinook salmon performance is slightly better than the historical performance due to a decrease in peak flows and sediment in the bypass reach and an increase in rearing area in the lowest reach caused by BON dam. The performance of the remaining species is well below historical levels due to the lack of access.

The same rules for EDT have been used on the Wind and White Salmon rivers but actual population performance on the Wind River and its major tributary -- Trout Creek -- is known in part due to a BPA-funded monitoring program. Actual and predicted steelhead productivity and capacity for Wind River and Trout Creek are similar, giving modelers confidence that predictions for nearby White Salmon River are reasonable.

The major cause for the decline of steelhead performance is lack of access to spawning and rearing areas that were blocked off with the construction of Condit Dam in 1913. The facility lacks adult and juvenile passage systems. Spring chinook, steelhead, coho, and fall chinook now only have access to 0%, 10%, 16%, and 94% of their historic spawning and rearing habitat, respectively.

The EDT model predicts that the current habitat in the White Salmon River subbasin is supporting a fall chinook run but not capable of supporting a self sustaining spring chinook, coho, and steelhead runs below the dam. Current estimates of abundance for the habitat below Condit Dam are 982, 470, 20, and 0 for fall chinook salmon, coho salmon, steelhead and spring chinook salmon.

Habitat in the White Salmon mainstem has been degraded from the removal of large woody debris and lack of wood recruitment, increased peak flows and sediment due to road densities and the removal of mature trees for logging and development. Human-caused impacts have significantly reduced the overwintering, incubation, and active rearing survival of juvenile coho, steelhead and chinook. Tributary impacts are more varied and include reduced riparian function, decreased large woody debris, increased summer temperatures, water withdrawals, increased sedimentation and increased peak flows. Those changes from historical conditions reduced productivity, abundance, and diversity of all focal species.

A settlement agreement to remove Condit Dam in 2006 is now pending with the Federal Energy Regulatory Commission. Its implementation would restore steelhead access to historical White Salmon and tributary areas. The EDT model predicts after dam removal the equilibrium abundance without harvest will be 952, 792, 301, and 570 for coho salmon, fall chinook salmon, steelhead and spring chinook salmon, respectively.

It is likely that the genetic diversity and fitness of wild steelhead, coho, and spring chinook in the White Salmon basin has been reduced due to hatchery spawners in the lower river. Given the low wild production potential, Mitchell Act hatchery steelhead are released to meet mitigation responsibilities above Bonneville Dam as part of the U.S. v Oregon process and for subbasin and out-of-basin fisheries. Approximately 20,000 winter and 20,000 summer steelhead are released annually. Summer steelhead are Skamania stock, which originated from the Washougal and Klickitat Rivers. Winter steelhead are also Skamania stock, but it originated from Chambers Creek in the Puget Sound. Hatchery spring chinook are also released into the river and fall chinook and coho salmon stray from USFWS hatcheries located just downstream of the White Salmon River.

WDFW found that introgression from hatchery rainbow plants was not evident in wild rainbow trout samples and high levels of genetic diveristy still exists in this population. WDF, when assessing juvenile coho salmon mortality at Condit Dam in 1983 and 1984 caught more steelhead smolts than modeling had predicted would be in evidence. One possible explanation is that the steelhead smolts were produced from resident rainbow trout above Condit Dam, and the genetic diversity and fitness of anadomous O. mykiss has been maintained.

The genetic integrity of spring chinook salmon is lost since these fish were extirpated after construction of Condit Dam. In limited sampling hatchery coho salmon significantly outnumber wild coho salmon spawners. The genetic diversity of this population may be low. The genetic diversity of tule fall chinook is believed to be in moderate or good condition, since the hatchery tule fall chinook sampled on the spawning grounds are from Spring Creek Hatchery, which was founded from this population.

Wild salmon and steelhead harvest for this population was estimated to be over 80%. Current harvest estimates are managed to be less than 49% for fall chinook, less than 16% for steelhead, and not quanitified for coho or spring chinook salmon. Recreational, commercial, and tribal harvest rates have been reduced to limit impacts on ESA listed stocks. Recreational fisheries are selective when hatchery fish are marked. Selective sport fisheries require the release of unmarked (or adipose intact) fish.

Out of basin habitat and hydro-electric development continue to cause significant losses. Primary causes are adult and juvenile passage at BON, loss of estuary habitat, increased Columbia River water temperatures, and increased predation by piscivorous fishes, birds, and marine mammals. Current EDT modeling was controlled not to allow assessment of these losses, since the historical condition was historical habitat in the tributaries and current habitat in the Columbia River mainstem.

Cyclic ocean conditions effect salmon and steelhead performance in this basin. Since the EDT model on the web site is a deterministic model, changes in ocean productivity were not modeled. To ensure our model runs were not overly optimistic or pessimistic, the standard smolt to adult survival that were developed for the Lower Columbia River EDT analysis were used. There represented median smolt to adult survivals over the range of productive and non-productive ocean conditions.

Specific key findings and working hypotheses for habitat and watershed processes are listed in the focal species section and not repeated here.

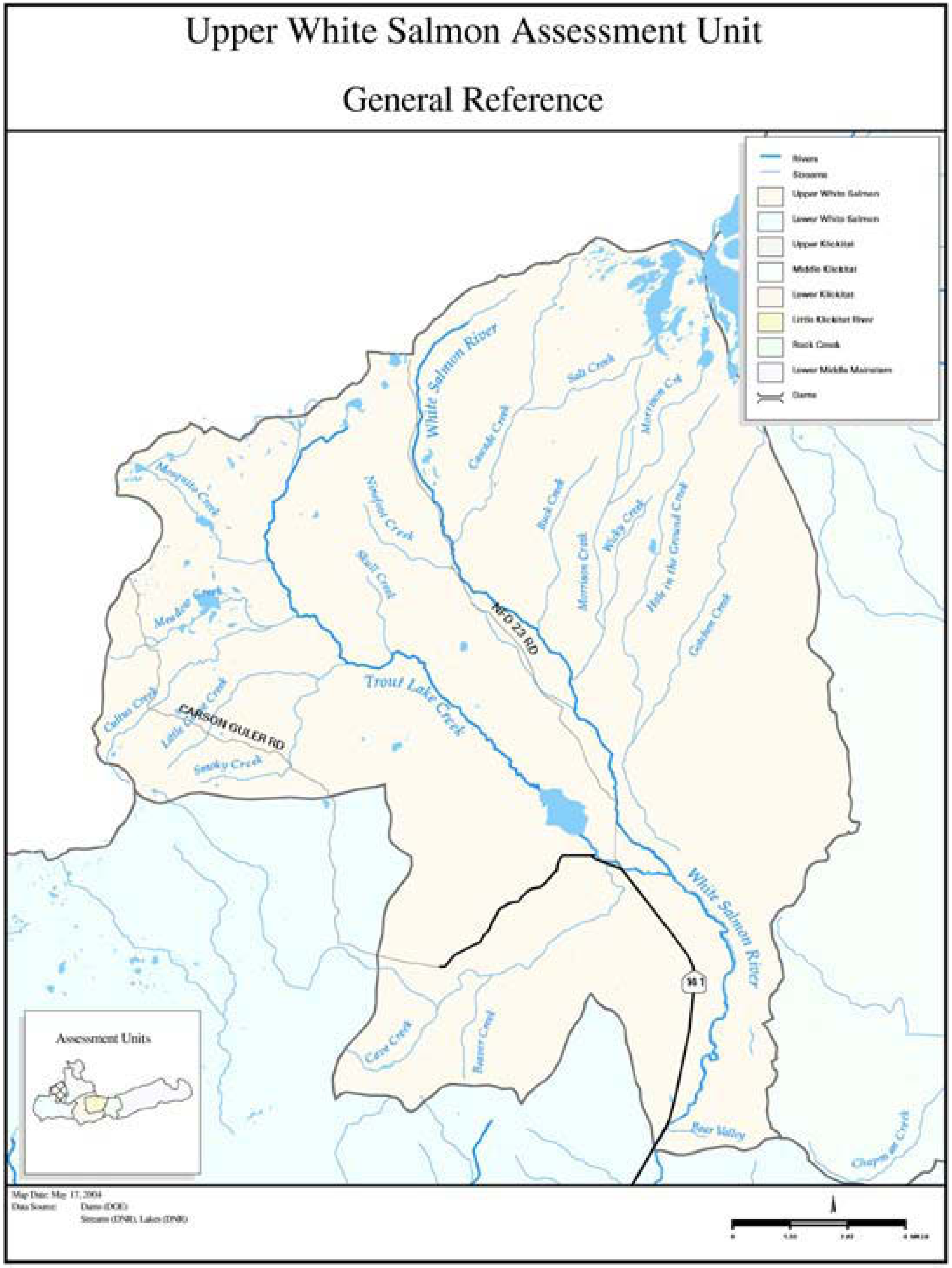

Figure 51 Upper White Salmon Assessment Unit reference map

4.11 White Salmon River Assessment Unit Above River Mile 16

Due to resource constraints and the lack of analytical tools for evaluating non-andromous salmonids, the aquatic assessment in this unit is limited. However, the extensive analysis is the lower assessment unit indicated that impaired watershed processes, such as riparian, sediment, and hydrologic, in the upper assessment unit contributed to the decline in salmon and steelhead performance in the lower assessment unit. Key documents for this assessment are USFS watershed analysis in the upper White Salmon, Trout Lake Creek, and Cave/Bear Creeks (USFS 1996, USFS 1997, and USFS 1998)

Topography and Climate

A series of four falls (6, 8, 12, and 21 feet) exist between RM 16.0 and 16.3 which are a natural boundary in the White Salmon river system and mark the lower boundary of this assessment unit. (figure 52) The upper boundary begins as glacial runoff from Mount Adams. A number of small tributaries enter the river upstream of the Forest Service boundary at RM 31 and Trout Lake Creek enters near RM 26. Below this confluence the river first widens as it passes through the Trout Lake Valley before narrowing into an area of box canyons where intermittent streams and many springs join the mainstem (Envirovision 2003).

Strong maritime influences affect the climate, and temperatures are relatively moderate throughout the year. Winter precipitation brings snow to the upper elevations and rain to the lower, while summers are fairly dry (Envirovision 2003).

Vegetation Patterns

Most of the assessment unit contains a mix of Douglas fir, western hemlock and western red cedar, typical of the western Cascades, and ponderosa pine and Oregon white oak, typical of the eastern Cascades. Major understory vegetation includes Oregon grape, dogwood, vine maple, willow, blackberry, elderberry, huckleberry, mock orange, wild cherry, soapbrush, and manzanita. There are large concentration of pasture/hayland in Trout Lake Valley (Haring 2003).

Demographics and Land Use

The USFS manages most of the land in the assessment unit for timber, grazing, and recreation. A rural agricultural community owns property in the valley surrounding the town of Trout Lake (Haring 2003).

4.12 Fish Focal Species: Rainbow Trout

Selection

Rainbow trout in White Salmon River are listed as one of the outstanding remarkable resources in the wild and scenic portion of the river. This designation affords a high level of protection for these fish (Rawding 2000). Rainbow trout range throughout the subbasin and have similar physical chemical, and biological requirements of anadroumous fish. Consequently the species is an indicator of ecological health. The species figures significantly into the local sport fishery.

Characterization and Status

Resident rainbow trout are native to the White Salmon River drainage and inhabit the White Salmon River up to RM 42.5 where the stream becomes a barrier due to steep gradient and low flow (Rawding 2000). Records show that rainbow trout inhabited Wicky and Morrison Creeks in the 1940s-1950s, but none have been found in electrofishing surveys in recent years (Betsy Scott, USFS). A waterfall barrier exists at the mouth of Wicky Creek, which eliminates upstream migration of trout from the White Salmon River (Haring 2003). Population abundance is unknown.

Table 29 Fish Bearing Streams in the upper White Salmon River Watershed

Stream	Fish species present	Presently stocked	Date first stocked	First species stocked	Natural population
Upper White Salmon River	rainbow and brook trout	No	1934	Rainbow	rainbow cutthroat
Green Canyon	rainbow	No	None known	NA	Unknown
Ninefoot Creek	rainbow	No	None known	NA	Rainbow
Trib. A	rainbow	No	None known	NA	Unknown
Wicky Creek	rainbow (1940- 1953)	No	None known	NA	Rainbow
Cascade Creek	rainbow	No	1942	Rainbow	Unknown

Rawding 2000

Life history

Detailed life history and habitat requirements of steelhead and rainbow trout can be can be found in various existing documents (e.g., Wydoski and Whitney 1979, Bjornn and Reiser 1991, Busby et al 1996) and are discussed in the steelhead focal species section.

Genetic Diversity

Stocking of rainbow trout began in the White Salmon River as early as 1934, and in Cascade Creek in 1942. These are the USFS' and WDFW's earliest records found, yet stocking may have occurred before these dates. Hatchery rainbow trout have been stocked into this watershed, but these releases were terminated in the 1990s except for 10-40,000 fingerling rainbow trout that are stocked annually in Northwestern Lake for recreational angling opportunities (Rawding 2000). Rainbow trout were the predominant species stocked and were last planted in Trout Lake in 1993. The White Salmon River also was planted with rainbow trout in the 1970s. The upper White Salmon River is no longer stocked, nor is Trout Lake (Haring 2003).

In 1990, the WDFW conducted a genetic study of rainbow trout in the White Salmon River drainage (Phelps, 1990). Samples were collected from five locations throughout the drainage. The analysis indicated the wild rainbow trout populations to be genetically distinct from each other and from Washington State hatchery rainbow trout strains. The study concluded that hatchery supplementation of rainbow trout in the drainage has not caused a loss of distinct wild populations (Rawding 2000).

Harvest

White Salmon River sport fishing regulations are designed to allow at least one full age class of female rainbow trout to spawn at least once to maintain the population's reproductive potential.

Regulations vary due to growth rates, fishing effort, and angler preferences. Trout fishing in the upper assessment unit is open from from June 1 through Oct. 31. Minimum size is 8 inches and the daily limit is two trout (WDFW 2003). This regulation applies to all the tributaries in the lower assessment unit as well. Regulations below RM 12 include selective fishing rules (no bait and barbless hooks) with a 12 inch minimum size and two fish daily limit. Below Condit Dam season extends from July 1 to March 31 but the minimum size is increased to 14 inches. Closures occur in the bypass reach to protect spawning salmon.

4.12.1 Environmental Conditions

Within Subbasin

Minimal water quality concerns have been identified for this assessment unit. Water temperatures are always cold, due to the glacier fed nature of the watershed. Over 15 years of monitoring in the upper White Salmon River approximately 1 mile downstream of the USFS boundary indicate that annual peak water temperatures average 52.8oF and occur primarily in August (USFS 1998). State water quality standard for maximum water temperature has not been exceeded during the period of monitoring (Haring 2003). However, below Trout Lake water temperatures and fecal coliform levels have exceeded water quality standards.

Glacial melt sustains relatively high summer and spring flows in Cascade Creek, Wicky Creek, Morrison Creek, and the mainstem (USFS 1998). Conversely, Gotchen and Hole-in-the-Ground creeks are completely dry throughout much of the year (Haring 2003). Glacier Spring, a large year-round spring just downstream of the USFS boundary, has been developed as the municipal water supply for the town of Trout Lake. When sampled in summer 1993, ~1,100 cfs was being pumped to the municipal water supply (Hennelly et al. 1994).

The largest input of spring flows in the lower White Salmon River is in the reach extending for ~2 miles below Weingarten Bridge (RM 17.15), where there are 67 springs and 20 tributaries (Hennelly et al. 1994). A porous basalt layer, about 40 feet below the top of the canyon pours water out of both banks. Observations at this location in summer 1993 indicated a 700 cfs flow contribution from springs at these locations, comprising >50% of average low flow (Haring 2003). From this point downstream water temperatures do not exceed water quality standards.

Riparian regeneration is naturally occurring on commercial forest and USFS lands, and some active riparian restoration efforts have occurred on tributaries (Haring 2003). Some riparian areas downstream of the USFS boundary are in need of restoration. The lack of LWD from riparian areas has created a loss of substrate roughness, increasing flow energy, resulting in washout of limited streambed gravels, increased bank erosion, and channel incision. This in turn has reduced floodplain connectivity, and may have reduced summer base flows (Haring 2003).

Environmental/Population Relationships/Limiting Factors

The only known culvert fish passage barrier in the assessment unit is at Ninefoot Creek (Betsy Scott, USFS). In 1990, a parasitic copepod was found in high numbers on the rainbow trout sampled below the culvert and in the White Salmon River adjacent to the mouth of Ninefoot Creek (USFS 1998). The parasite was not present on fish upstream of the culvert. As a result, providing fish passage at the culvert was not recommended in the past in order to prevent parasite infestation of rainbow upstream of the culvert (Haring 2003).

Other factors limiting resident fish include past riparian timber harvests, past removal of log jams, road building, grazing, agriculture, and regeneration harvest within the rain on snow zone. Implementation of current federal forest management plans and protection of riparian reserves is anticipated to restore high quality salmonid habitat over time, but there is little anticipation of significant LWD recruitment for possibly 75-120 years. (Haring 2003).

Few of the surface water diversions or pumps are screened to prevent entrainment of juvenile salmonids. It is also unclear whether the screened diversions are utilizing the most current screening design criteria adopted by WDFW. The salmonid mortality associated with irrigation diversions has not been assessed, but is believed to be significant (Haring 2003).

Much of the irrigation in the assessment unit is flood irrigation. Flood irrigation has been associated with elevated fecal coliform bacteria (e.g., Cave/Bear Creek) and elevated nutrients (e.g., Gilmer Creek) levels, and irrigation return flow erosion problems (Haring 2003). Trout production potential in several of the tributaries including Trout Lake Creek and Cave Creek is noted as being limited by low summer flows. Further assessment is needed to determine to what extent limiting summer low flows are directly attributable to, or exacerbated by, the irrigation diversions (Haring 2003).

The USFS (1997) conducted a watershed analysis on Cave-Bear creeks. These were the only two streams that fish were observed. The remainder of the streams are dry through out most of the year. However, it is believed the lava flows are porous in this subwatershed and supply most of the water to springs around RM 16. Road densities average 3.8 mi/mi^2 , which are above the densities of 2 recommended by NMFS as properly functioning conditions. Peak flow modeling predicts a 10% increase. There is less late successional forest than there was historically and only 34% of riparian areas are comprised of this vegetation type. Wood is lacking in these creeks. A watershed analysis on Trout Lake Creek (USFS 1996) had similar findings and found water temperatures and fecal coliform levels exceed state water quality standards below the USFS boundary. The Upper White Salmon watershed analysis indicated that stream habitat and watershed processes for these subwatersheds are in the best shape and are approaching properly functioning conditions (USFS 1998).

4.12.2 Key Findings–White Salmon Assessment Unit Above River Mile 16

Based on USFS watershead analysis the habitat in this unit is likely to be moderately impaired. This implies the habitat is functional and capable of supporting trout but key habitat attributes and watershed processes have some level of impairment. Habitat attributes that are impaired are wood, riparian function, maximum temperature, percentage of fines in spawning gravel, peak flow, and channel stability. The watershed processes that control these attributes are riparian, sediment, and hydrology. The riparian process is in good shape except for isolated areas below the USFS boundary. There is a lack of wood in all reaches due to reduced recruitment and removal. The sediment and hydrology processes are controlled by roads and forest clearing have increased peak flow and sediment delivery.