4 Assessment

The assessment for the UMM Subbasin consists of terrestrial/wildlife and aquatic/fish sections that were analyzed using different methodologies and processes. Wildlife was assessed using two primary sources of information: IBIS and Washington GAP analysis. WDFW staff assembled and reviewed that data and compiled species information from numerous sources to develop the course level assessment. Fish species were analyzed for two different hydrologic systems; the mainstem Columbia River and the small tributaries. The mainstem was primarily examined through existing documents for HCPs and FERC licensing from the three public utility districts in Chelan, Douglas, and Grant Counties. No suitable modeling processes were found to be useable on the subbasin scale for the Columbia River. The tributaries were assessed using existing documents, such as limiting factors analysis, watershed planning unit (2514) produced documents, and other state and federal agency documents. Information was also provided by the GCPUD to assist with the assessment. In addition, WDFW staff field examined several tributaries where little or no information exists. All of these sources were used to complete a Qualitative Habitat Assessment for the small tributaries. Ecosystem, Diagnosis and Treatment (EDT) was not deemed appropriate for the small tributaries given the limited amount of information, limited fish use, and/or size of watersheds. Details of both of the processes are decribed below and were used for development of the management plan objectives and strategies.

4.1 Focal Species

4.1.1 Introduction

A total of 391 fish and wildlife species are likely to inhabit the UMM Subbasin (Tables 2 - 4, Appendix B). Eight wildlife and two fish species were chosen as focal species to represent three focal wildlife and four focal aquatic habitats within the UMM Subbasin. Habitat attributes required by the focal species represent conditions and features of a properly functioning ecosystem and desired future conditions for focal habitats that will direct planners in developing and implementing habitat management goals and activities for the UMM Subbasin.

4.1.2 Focal Species Selection and Rationale

Lambeck (1997) defined focal species as a suite of species whose requirements for persistence define the habitat attributes that must be present if a landscape is to meet the requirements for all species that occur there (Figure 7). The key characteristic of a focal species is that its status and trend provide insights to the integrity of the larger ecological system to which it belongs (USFS 2000).

Subbasin planners refer to these species as “focal species” because they are the focus for describing desired habitat conditions and attributes and needed management strategies and/or actions. The rationale for using focal species is to draw immediate attention to habitat features and conditions most in need of conservation or most important in a functioning ecosystem. The corollary is that factors that affect habitat quality and integrity within the CCP also impact wildlife species, hence, the decision by subbasin planners to focus on focal habitats with focal species in a supporting role (Ashley and Stovall, unpub. rpt., 2004).

CCP planners consider focal species' life requirements representative of habitat conditions or features that are important within a properly functioning focal habitat type. In some instances, extirpated or nearly extirpated species (e.g., sharp-tailed grouse) were included as focal species if subbasin planners believed they could potentially be reestablished and/or are highly indicative of some desirable habitat condition (Ashley and Stovall, unpub. rpt., 2004).

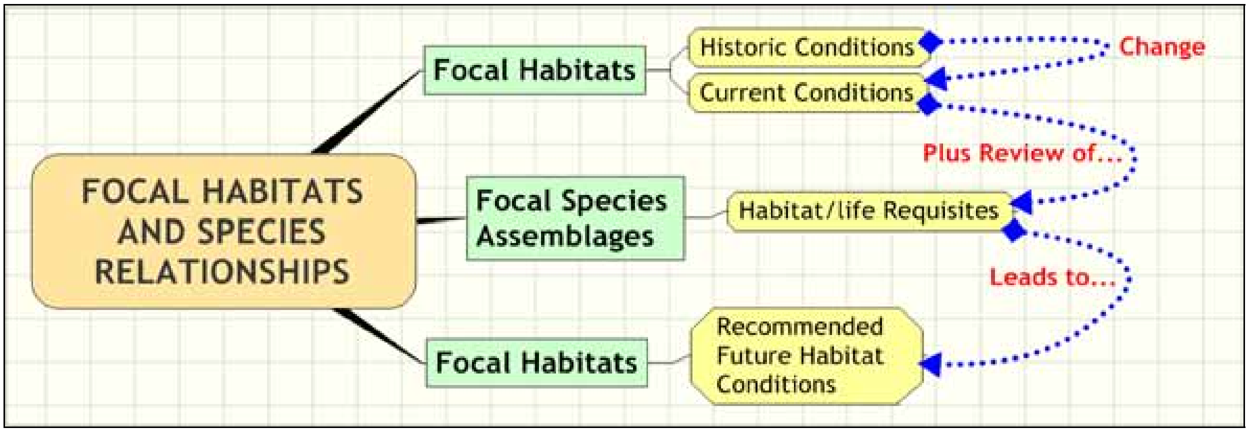


Figure 7 Focal habitats and species assemblage relationships

Terrestrial / Wildlife

There are an estimated 349 wildlife species that likely occur in the UMM Subbasin (Tables 2 and 3, Appendix B). Of these species, 111 (31%) are closely associated with riparian and wetland habitat and 74 (21%) consume salmonids during some portion of their life cycle (Table 8). Three wildlife species that occur in the Subbasin are listed federally and 30 species are listed in Washington as Threatened, Endangered, or Candidate species (Table 5, Appendix B). A total of 98 bird species are listed as Washington or Idaho State Partners in Flight priority and focal species (Table 6, Appendix B). A total of 50 wildlife species are managed as game species in Washington (Table 7, Appendix B). Species richness and associations for the UMM Subbasin are described in Table **8**).

For wildlife and terrestrial habitat resources, CCP/Subbasin planners identified a focal species assemblage (i.e., species that inhabit the same habitat type and require similar habitat attributes) for each focal habitat type (Table 9). Six bird species and two mammalian species were selected to represent three focal habitats (Shrubsteppe, Eastside [Interior] Riparian Wetland, and Herbaceous Wetland) in the UMM Subbasin: pygmy rabbit, sage grouse (*Centrocercus urophasianus*), sage thrasher (*Oreoscoptes montanus*), sharp-tailed grouse (*Tympanuchus phasianellus*), willow flycatcher (*Empidonax traillii*), beaver (*Castor canadensis*), Lewis' woodpecker (*Melanerpes lewis*), and red-winged blackbird (*Agelaius phoeniceus*).

Table 8 Species richness and associations for the UMM Subbasin, WA.

Class	Upper Middle Mainstem	% of Total	Total (CCP)
Amphibians	15	88	17
Birds	230	98	234
Mammals	86	89	97

Class	Upper Middle Mainstem	% of Total	Total (CCP)
Reptiles	18	95	19
Total Species	**349**	**95**	**367**
Association			
Riparian Wetlands	75	96	78
Other Wetlands (Herbaceous and Montane Coniferous)	36	95	38
All Wetlands	111	96	116
Consume Salmonids	74	90	82

(IBIS 2003)

Table 9 Focal species selection matrix for the CCP, WA.

Common Name	Focal Habitat1	Status2		Native Species	PHS	Partners in Flight	Game Species
		Federal	State				
Sage thrasher	SS	n/a	C	Yes	Yes	Yes	No
Brewer's sparrow		n/a	n/a	Yes	No	Yes	No
Grasshopper sparrow		n/a	n/a	Yes	No	Yes	No
Sharp-tailed grouse		SC	T	Yes	Yes	Yes	No
Sage grouse		C	T	Yes	Yes	No	No
Pygmy rabbit		E	E	Yes	Yes	No	No
Mule deer		n/a	n/a	Yes	Yes	No	Yes
Willow flycatcher	RW	SC	n/a	Yes	No	Yes	No
Lewis woodpecker		n/a	C	Yes	Yes	Yes	No
Red-eyed vireo		n/a	n/a	Yes	No	No	No
Yellow-breasted chat		n/a	n/a	Yes	No	No	No
American beaver		n/a	n/a	Yes	No	No	Yes
Pygmy nuthatch	PP	n/a	n/a	Yes	No	No	No
Gray flycatcher		n/a	n/a	Yes	No	No	No
White-headed woodpecker		n/a	C	Yes	Yes	Yes	No
Flammulated owl		n/a	C	Yes	Yes	Yes	No
Red-winged blackbird	HW	n/a	n/a	Yes	No	No	No

Common Name	Focal Habitat1	Status2		Native Species	PHS	Partners in Flight	Game Species
		Federal	State				
1 SS = Shrubsteppe; RW = Riparian Wetlands; PP = Ponderosa pine; HW = Herbaceous Wetlands 2 C = Candidate; SC = Species of Concern; T = Threatened; E = Endangered							

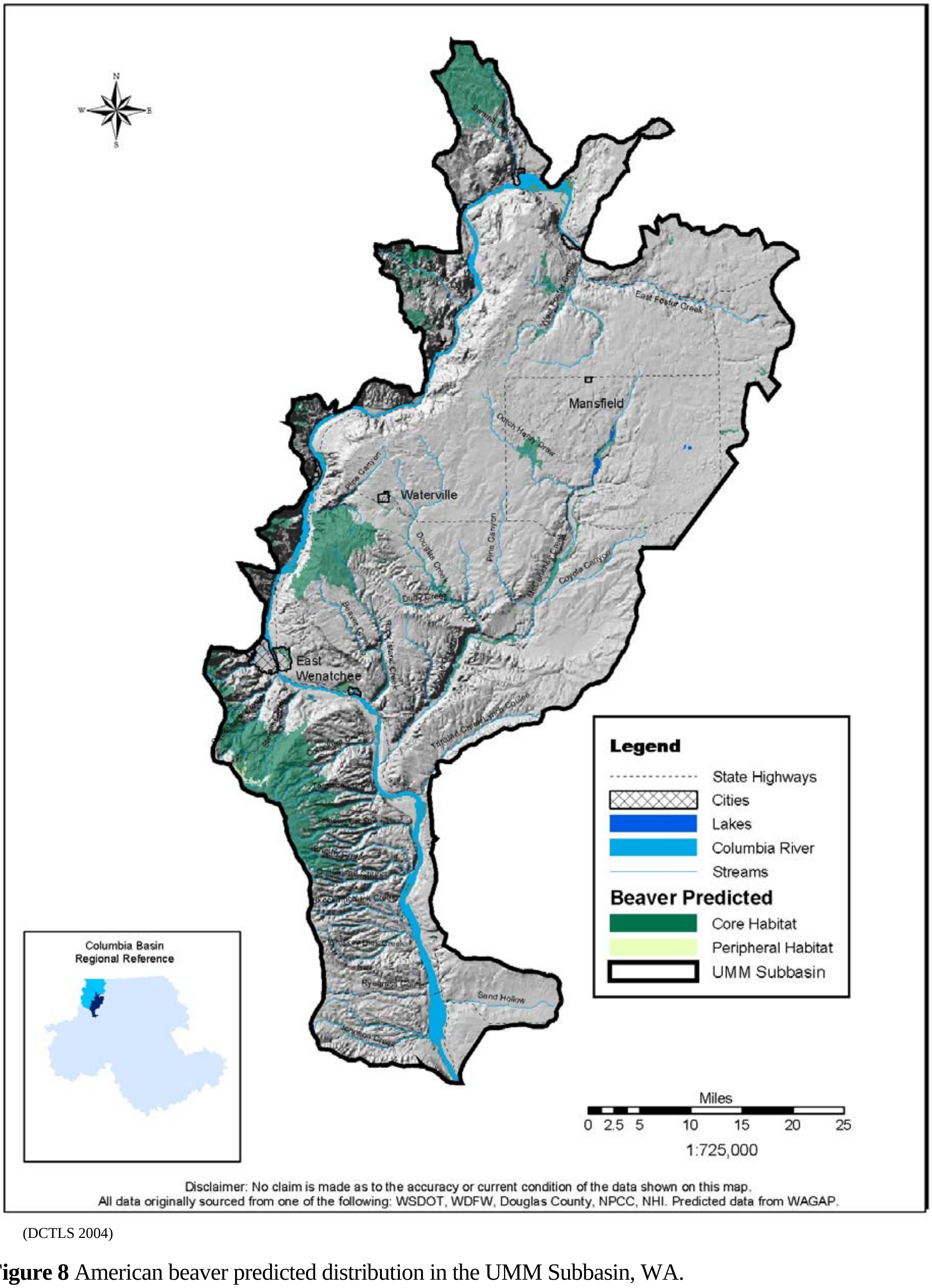
(Ashley and Stovall, unpub. rpt., 2004)

Life requisite habitat attributes for each species assemblage were then pooled to characterize a "range of management conditions", to guide planners in development of future habitat management strategies, goals, and objectives (Ashley and Stovall, unpub. rpt., 2004). Establishing habitat conditions favorable to focal species will benefit a wider group of species with similar habitat requirements. Wildlife species associated with focal habitats including agriculture are listed in Table 2 (Appendix B).

Life History of Wildlife Focal Species

General habitat requirements, limiting factors, distribution, population trends, and analyses of structural conditions, key ecological functions, and key ecological correlates for individual focal species except red-winged blackbird are included in Ashley and Stovall (unpub. rpt., 2004). Red-winged blackbird information is in Appendix C . Figure 8 to Figure 17 Sharp-tailed grouse predicted distribution in the UMM Subbasin, WA.

below depict the distribution of focal wildlife species in the UMM Subbasin. The reader is encouraged to review additional focal species life history information in Appendix F in Ashley and Stovall (unpub. rpt., 2004).



(DCTLS 2004)

Figure 8 American beaver predicted distribution in the UMM Subbasin, WA.

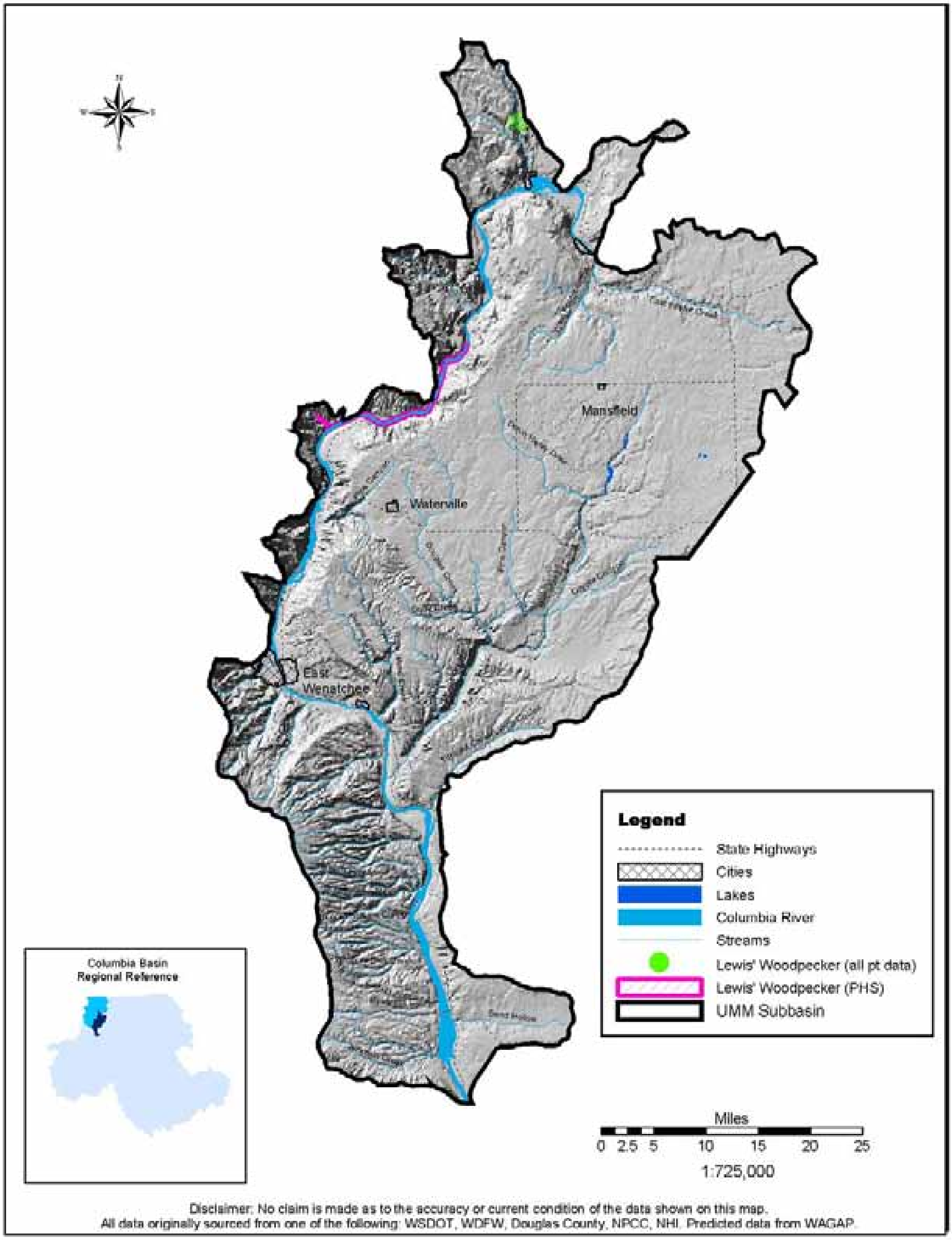


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Figure 9 Lewis' Woodpecker known distribution in the UMM Subbasin, WA.

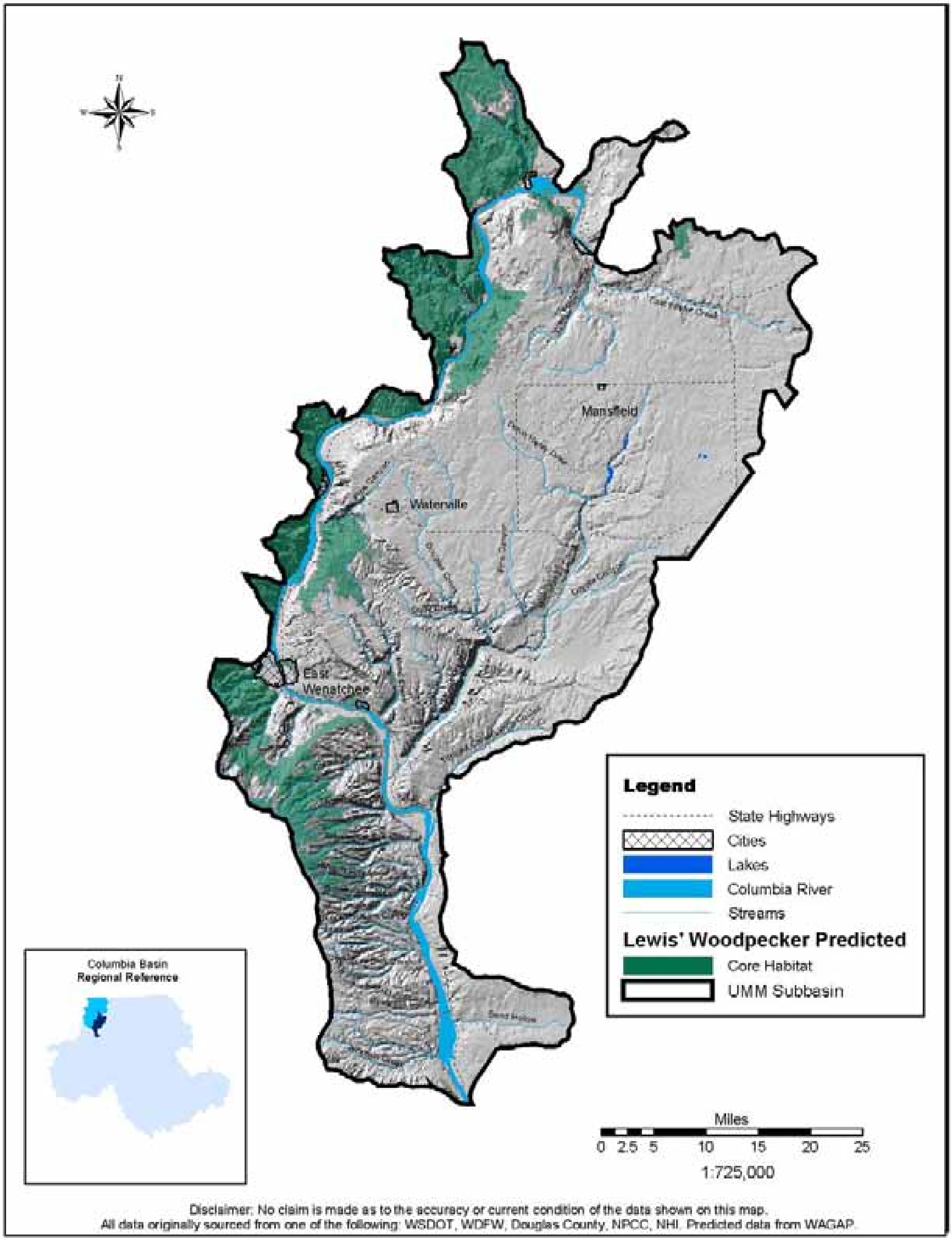

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Figure 10 Lewis' woodpecker predicted distribution in the UMM Subbasin, WA.

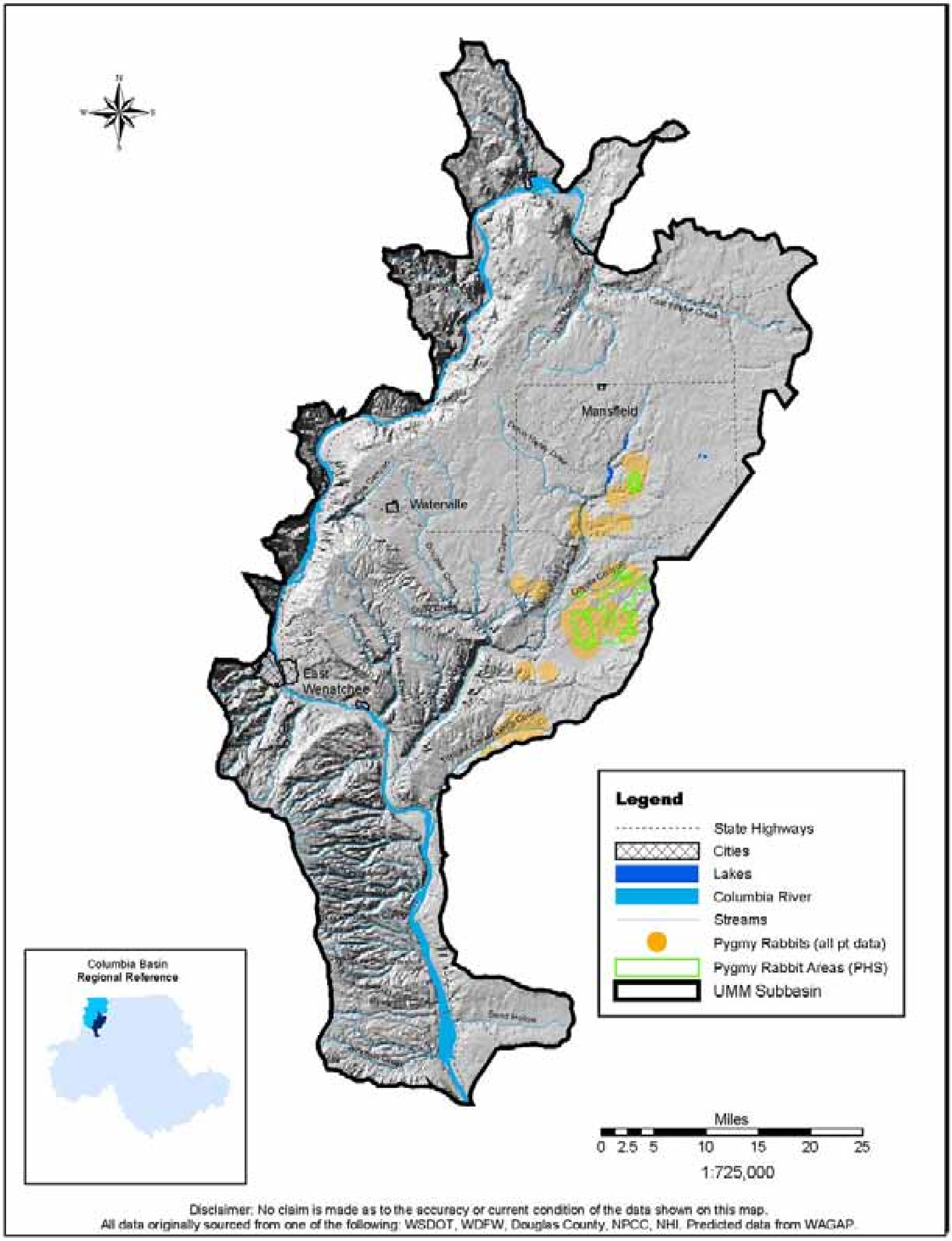

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Figure 11 Pygmy rabbit known distribution in the UMM Subbasin, WA.

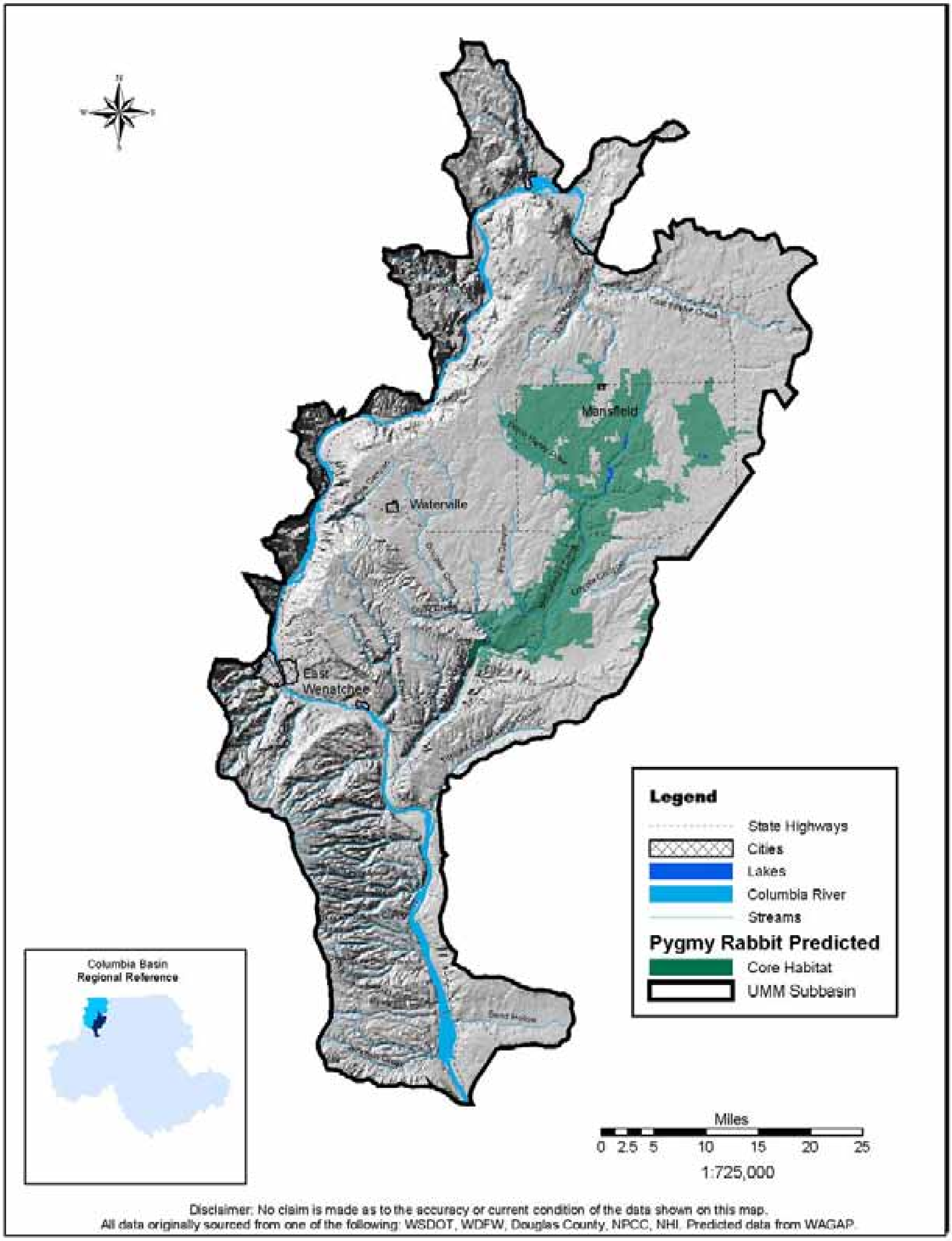

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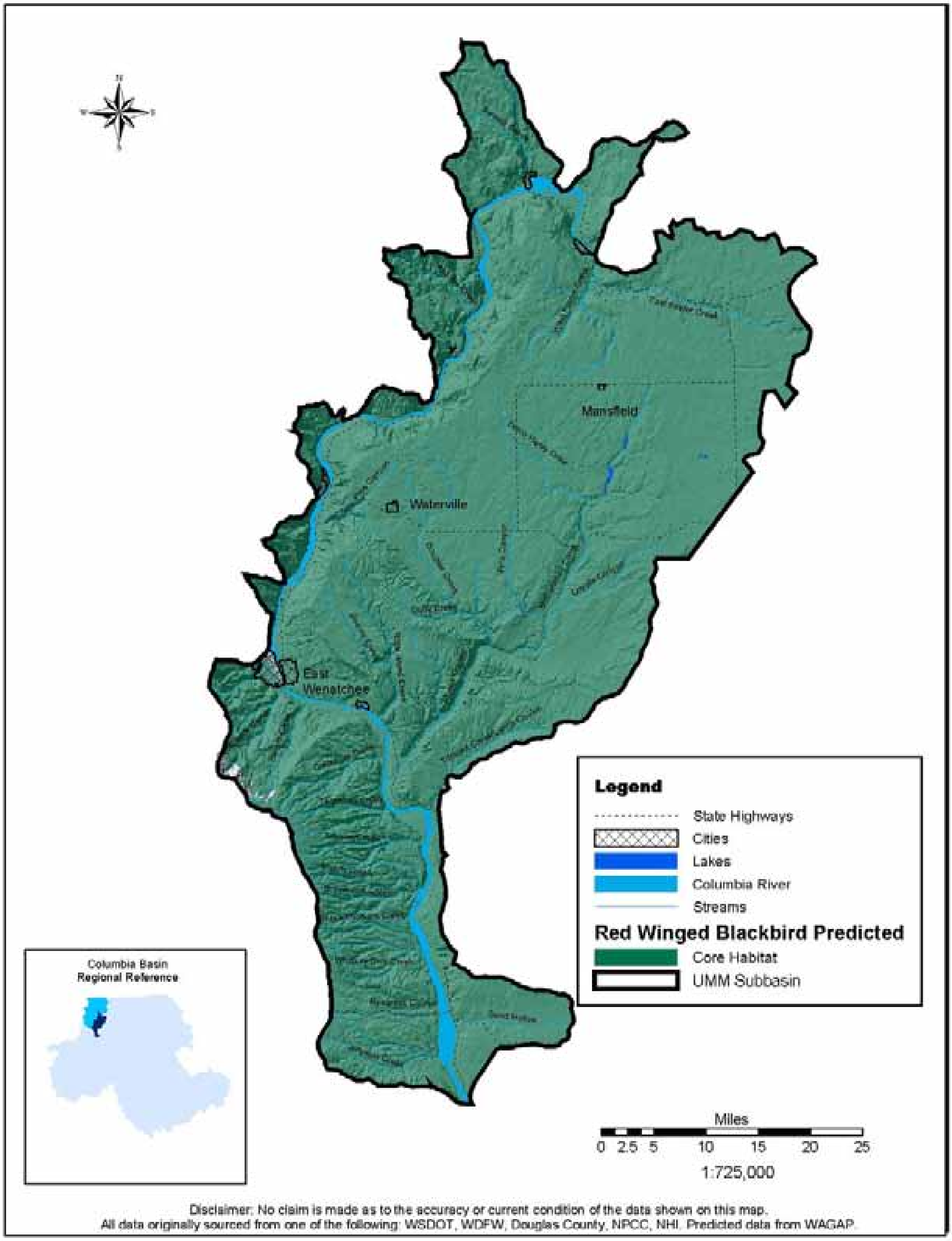
Figure 12 Pygmy rabbit predicted distribution in the UMM Subbasin, WA.



(DCTLS 2004)

Figure 13 Red-winged blackbird predicted distribution in the UMM Subbasin, WA.

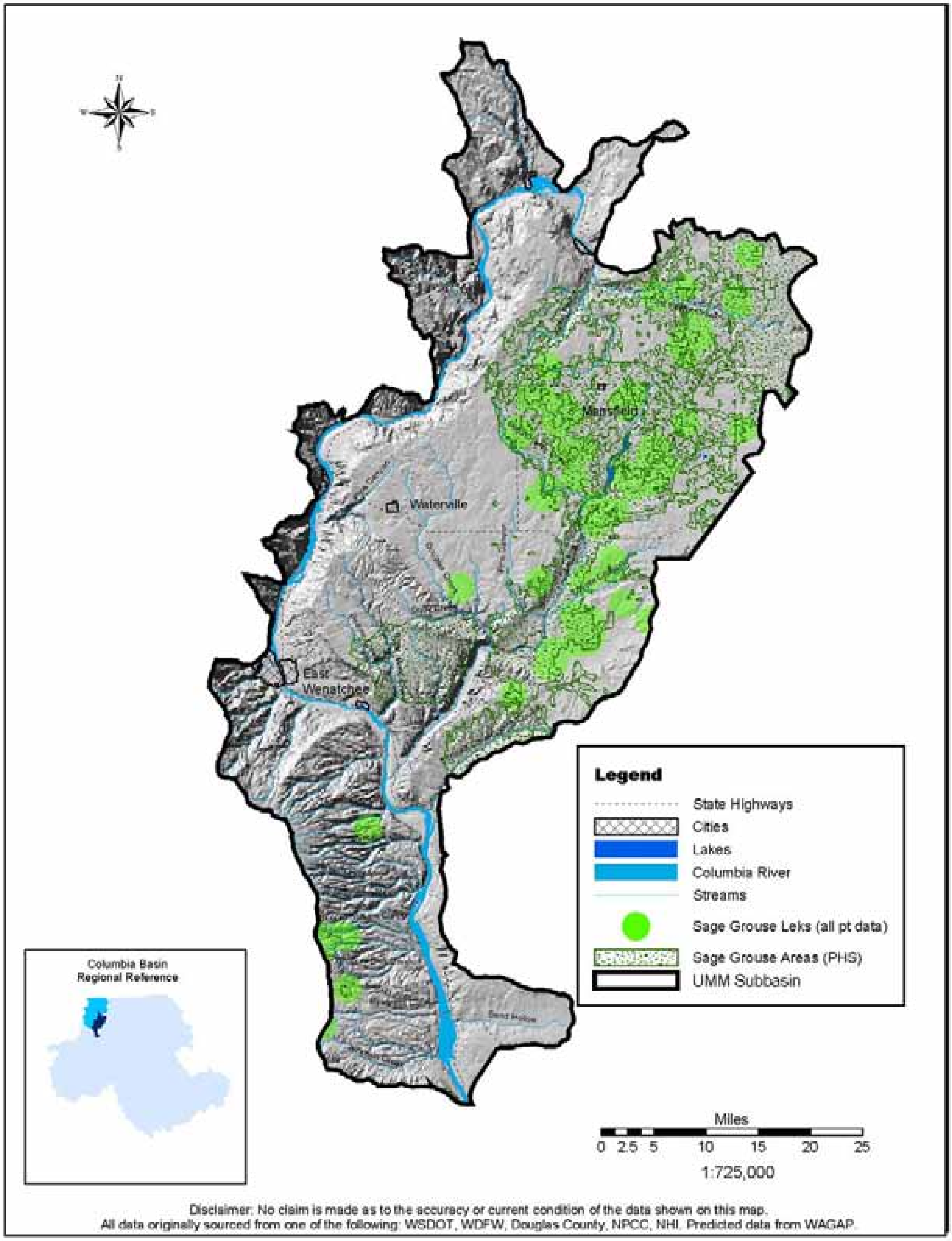


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Figure 14 Sage grouse known distribution in the UMM Subbasin, WA.

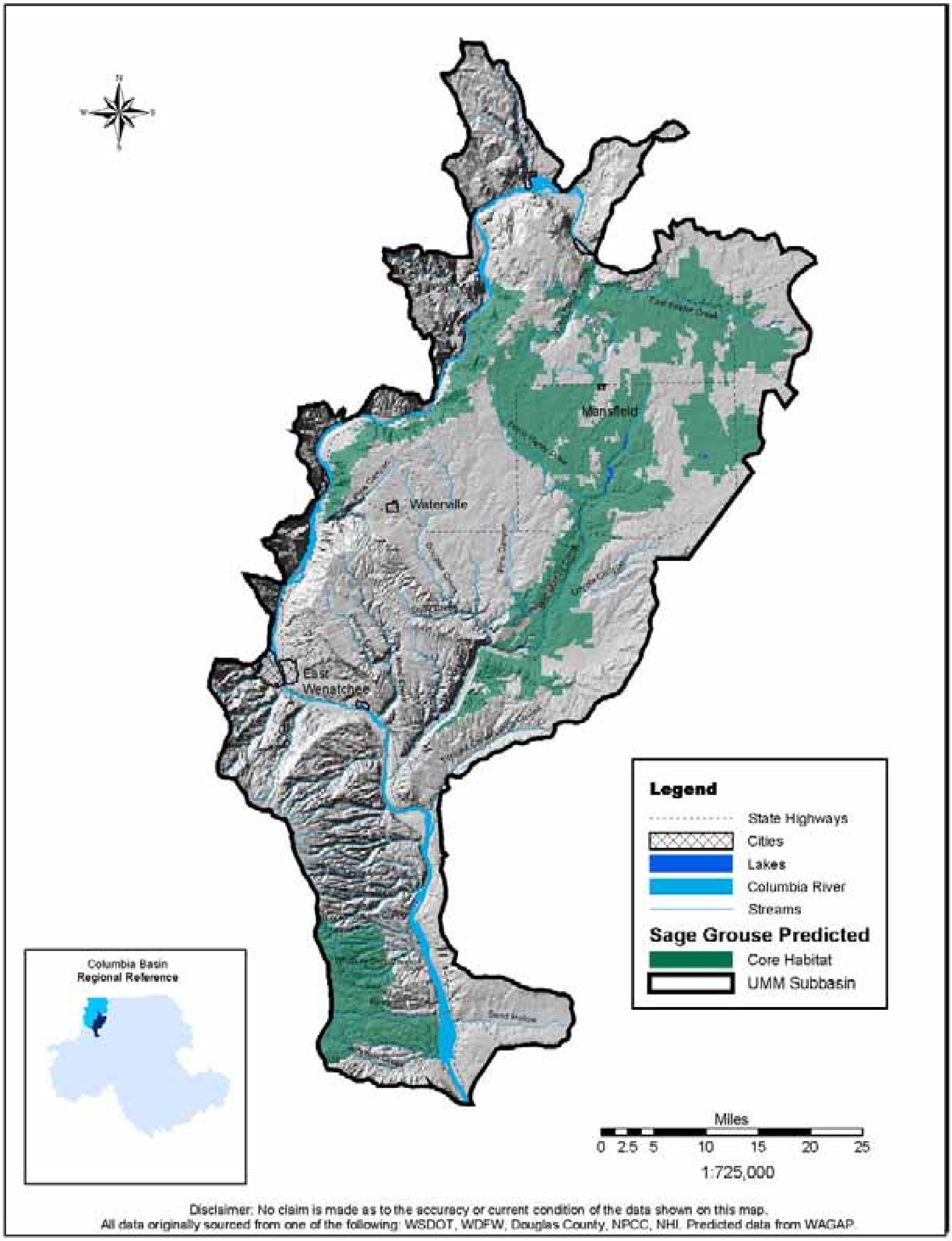

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Figure 15 Sage grouse predicted distribution in the UMM Subbasin, WA.

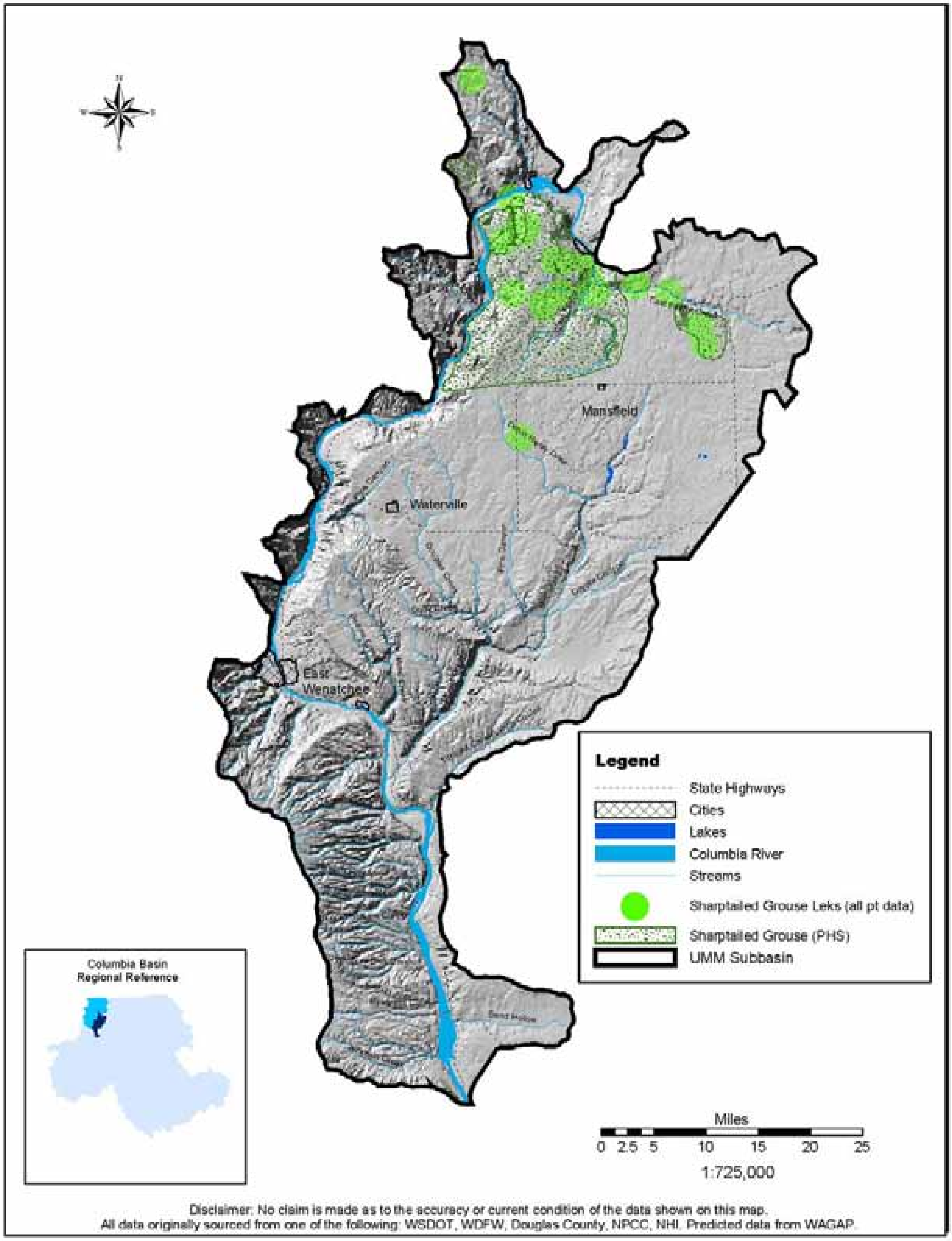

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Figure 16 Sharp-tailed grouse known distribution in the UMM Subbasin, WA.

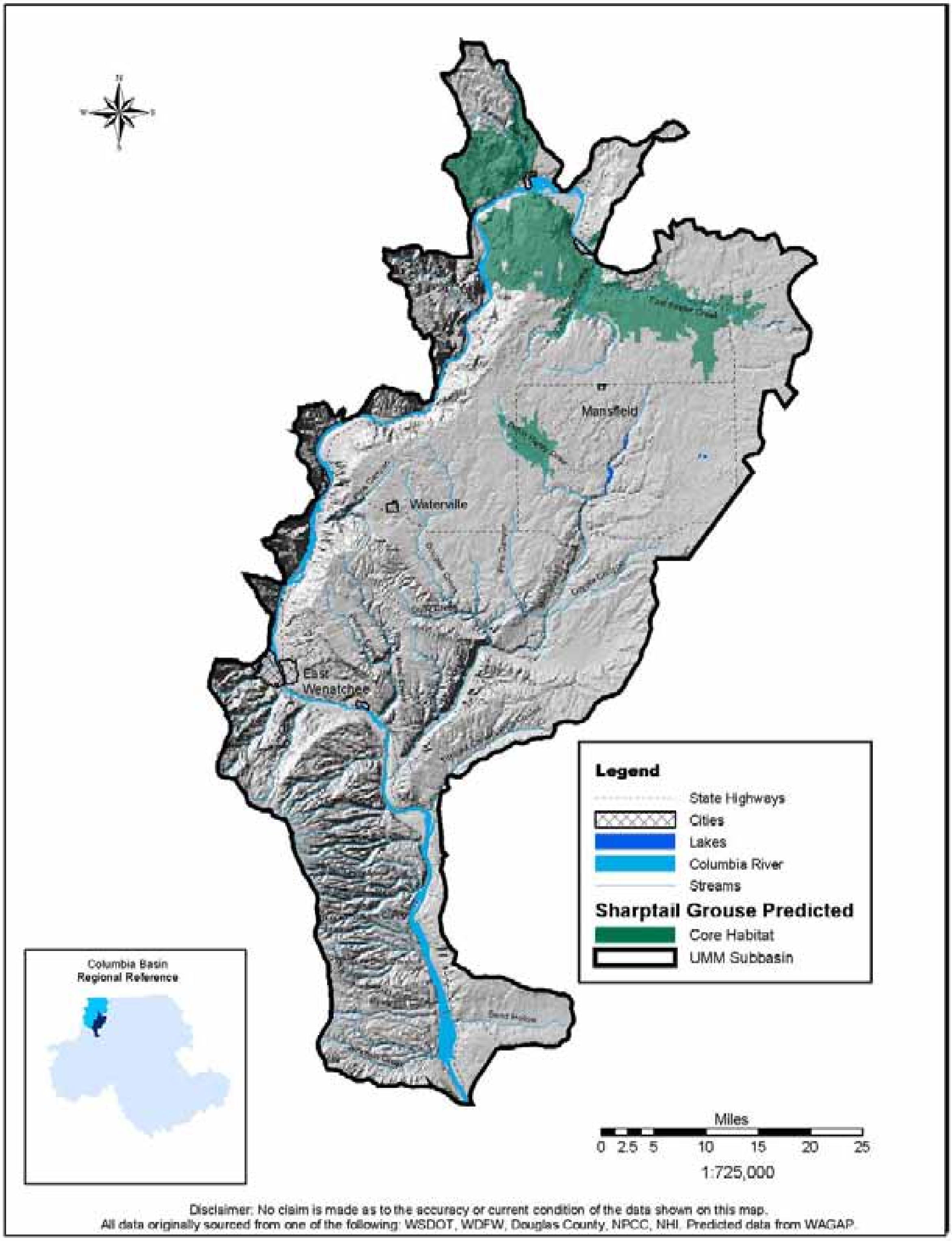

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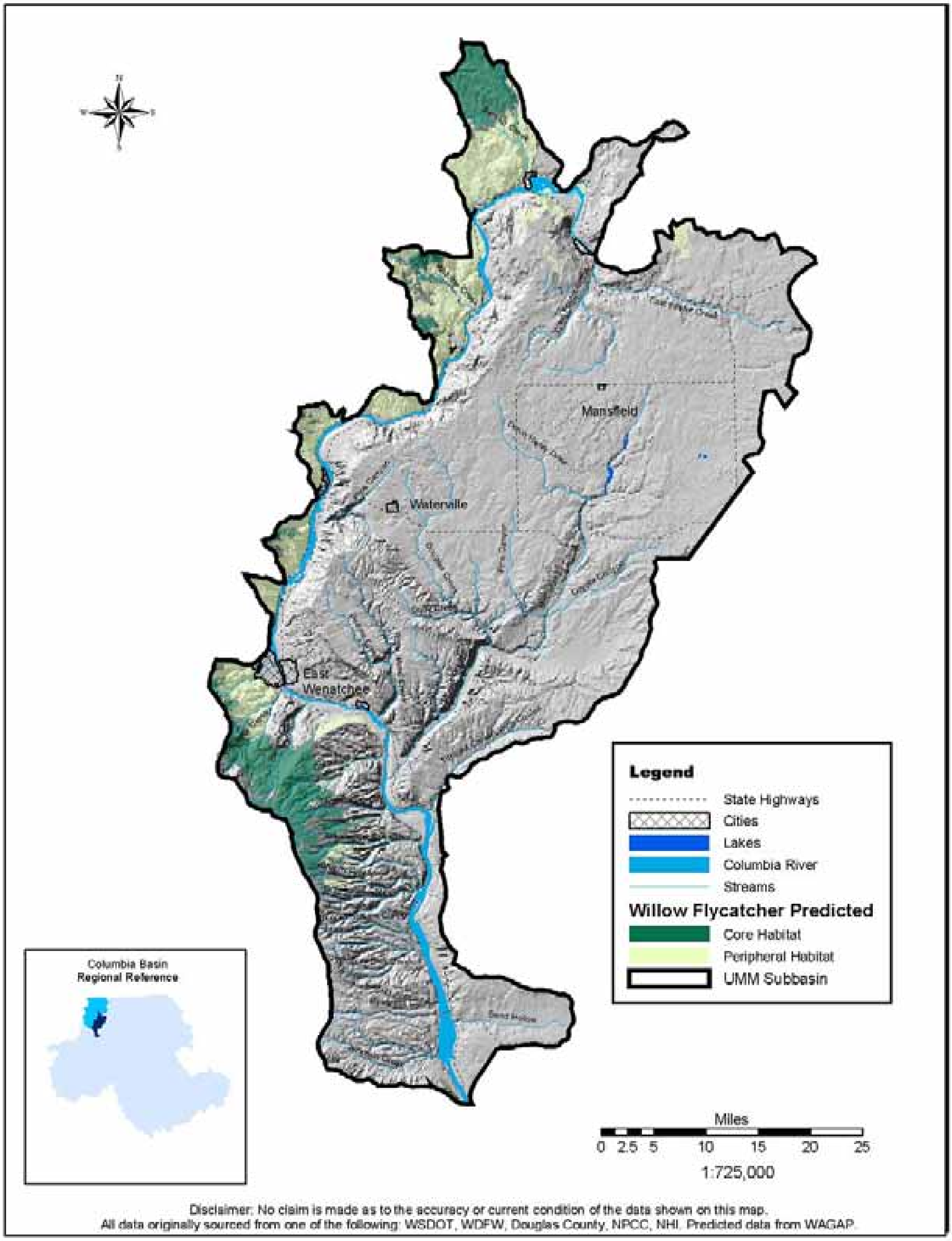
Figure 17 Sharp-tailed grouse predicted distribution in the UMM Subbasin, WA.



(DCTLS 2004)

Figure 18 Willow flycatcher predicted distribution in the UMM Subbasin, WA.

4.1.3 Aquatic/Fish

The UMM Subbasin supports at least 42 species of indigenous and introduced fish (Table 4, Appendix B). At least five anadromous fish species are found in the UMM Subbasin, including spring, summer/fall Chinook (*Oncorhynchus tshawytscha*), summer steelhead (*O. mykiss*), sockeye salmon *(O. nerka*), coho salmon (*O. kisutch)*, and pacific lamprey (*Lampetra tridentata*). The Columbia River serves as a spawning, rearing and migration corridor to and from the Pacific Ocean each year for adult and juvenile salmon, steelhead, and pacific lamprey. Most fish species however, spawn and rear in tributary streams away from the Columbia River. Fall Chinook salmon spawning has been observed in limited areas in the Columbia River and in the mouth of the Chelan River. Fish distribution and production facilities in the UMM Subbasin are illustrated in Figure 19.

Whitefish, sturgeon, trout, and char were the dominant resident species in the reach before reservoir inundation. Bull trout, rainbow, white fish and white sturgeon are currently present in the reservoir along with numerous non-native species. Rainbow trout are present in the mid-Columbia reservoirs, however they are likely the result of hatchery steelhead and resident rainbow trout production programs in nearby tributaries. Resident rainbow trout do not appear to be self-sustaining in the reservoirs, though self-sustaining populations of rainbow, cutthroat, and brook trout are maintained in the tributaries (Chelan County PUD 1998; Zook 1983). It is believed that white sturgeon also spawn in the UMM Subbasin (Chelan PUD, unpublished data, 2001; Todd West, pers. comm., 2001 in Kaputa & Woodward 2002).

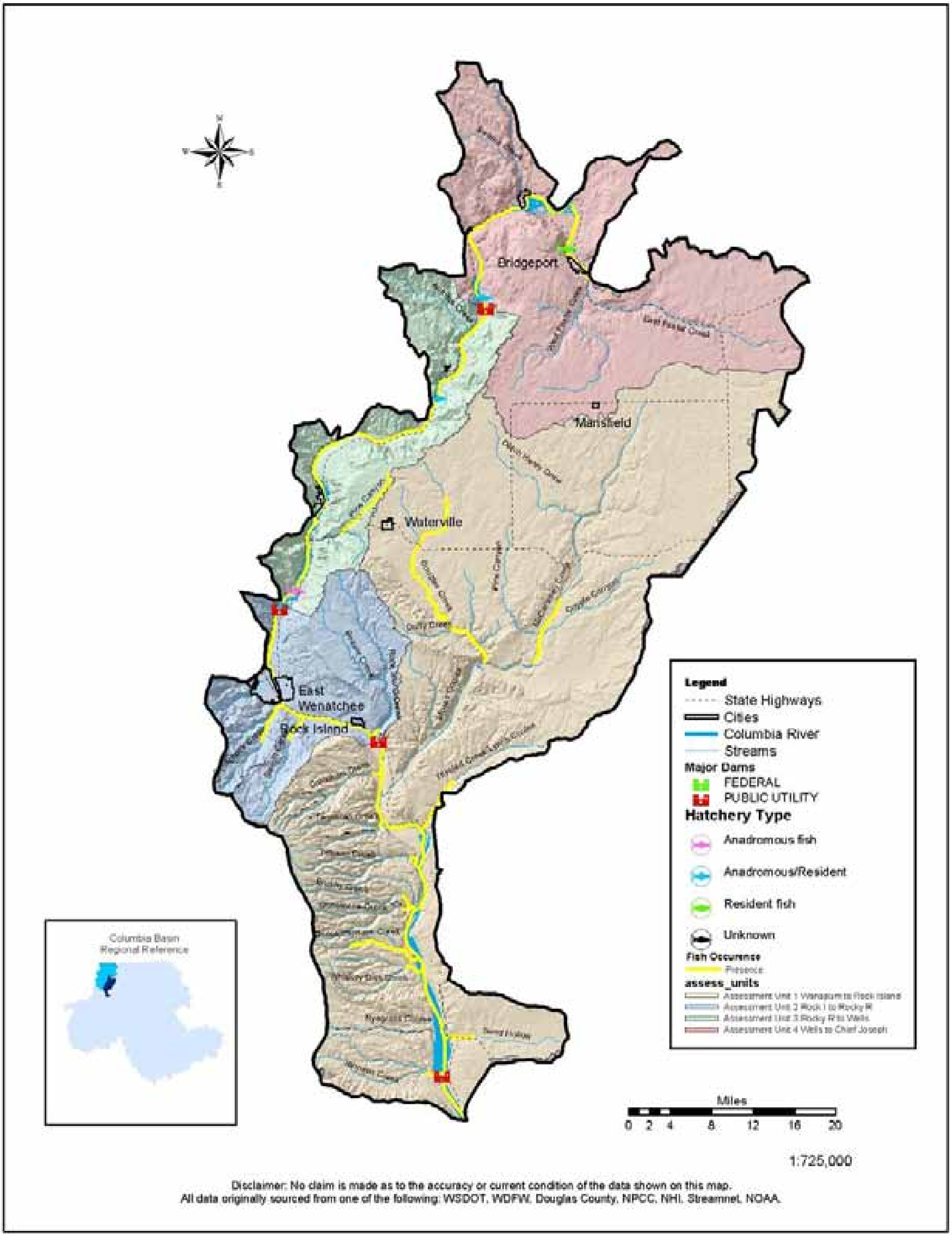
Hydropower development and production in the mid-Columbia created a subsequent shift in resident species composition toward dominance by cool water non-game species such as sucker, chub, northern pikeminnow, and shiners. Walleye peamouth, chiselmouth, carp, and perch are also found in the UMM Subbasin.

Focal Species Selection and Rationale

Of the 49 species of anadromous and resident fish found in the UMM Subbasin, two were chosen as aquatic focal species (Figure 19 Fish distribution and production facilities in the UMM Subbasin, WA.

Table 10): steelhead / rainbow trout (*O. mykiss*) and Chinook salmon (*Oncorhynchus tshawytscha*). These focal species were chosen because 1) they have one form or race that is on the Endangered Species List, 2) the small tributaries assessed have one or more of the life forms occurrence documented, and 3) their forms represent stream characteristics that historically occurred and are linked to wildlife species habitat requirements. All forms of *Oncorhynchus mykiss* and Chinook salmon, rather than one form, were used to model the streams as the occurrence and use within these tributaries is highly variable.

Species of interest include, sockeye salmon (*O. nerka)*, coho (*O. kisutch*), Pacific lamprey (*Lampetra tridentata*), sturgeon (*Acipenser transmontanus*), and bull trout (*Salvelinus confluentus*). These species were also considered for focal species status, but only occur in the Columbia River, which was not modeled as a part of this process. These species will be discussed, along with others, but only in the context of existing documents and in reference to the other five subbasins in the CCP where more life histories stages occur. Each of the focal species for the UMM Subbasin is described below.



(DCTLS 2004)

Figure 19 Fish distribution and production facilities in the UMM Subbasin, WA.

Table 10 Fish focal species and their distribution within the UMM Subbasin, WA.

Fish Focal Species	Habitat Attributes
Chinook Salmon	Columbia River and various 2nd/3rd order tributaries - Sensitive to water quality / temperatures.
Steelhead / Rainbow Trout	Columbia River and lakes - Found throughout the watershed, indicative of many habitat types.

4.1.4 Descriptions of Fish Focal Species and Species of Interest

(Information for this section taken from Peven 2003 except where noted)

Large runs of Chinook and sockeye, and lesser runs of coho, steelhead and chum historically returned to the Columbia River (Chapman 1986). By the 1880s, the expanding salmon canning industry and the rapid growth of the commercial fisheries in the lower Columbia River had heavily depleted the mid and upper Columbia River spring and summer/fall Chinook runs (McDonald 1895), and eventually steelhead, sockeye and coho (Mullan 1987, 1986, 1984; Mullan et al. 1992). The full extent of depletion in upper Columbia River salmonid runs is difficult to quantify because of limited historical records, but the runs had been decimated by the 1930s (Craig and Suomela 1941). Many factors including construction of impassable mill and power dams, un-screened irrigation intakes, poor logging and mining practices, overgrazing (Chapman et al. 1982; Bryant and Parkhurst 1950; Fish and Hanavan 1948), and private development of the subbasins, in combination with intensive fishing, all contributed to the decline in abundance of Upper Columbia basin salmonids.

Steelhead, Spring Chinook, Sockeye and Sturgeon Population Management

Steelhead, spring Chinook, sockeye and sturgeon populations in the UMM and its associated subbasins are managed by WDFW through: 1) the control of harvest with sport fishing regulations, 2) aquatic and riparian habitat protection and restoration and 3) the addition of hatchery-reared fish to naturally reproducing populations (supplementation). Hatchery steelhead and salmon rearing and release strategies have been developed to maintain as much genetic similarity as possible between supplemented and naturally produced fish and to minimize negative interactions among them. Funding for these efforts comes from WDFW and other agencies. WDFW receives funding for supplementation primarily from the Columbia River Hydroelectric projects. The USFWS also rears and releases steelhead and salmon into one of the UMM tributaries.

Fish Focal Species: Steelhead / Rainbow Trout

Steelhead is classified into two distinct races, or runs (Chilcote et al. 1980, Withler 1966, Smith 1960). Winter-run fish ascend streams between November and April, while summer-run fish enter rivers between May and October. In Washington state, winter-run fish are found primarily west of the Cascade Mountains, although both summer- and winter-run fish inhabit certain west side streams (Pauley et al. 1986, Kendra 1985). Winter-run steelhead is not found above of the Deschutes River in the Columbia River Basin (Pauley et al. 1986). In Washington, the Klickitat River is the uppermost tributary where winter-run fish are found (Kendra 1985). Steelhead runs on the Columbia River above the Deschutes River, and the entire Snake River are made up of exclusively summer-run fish. There are two groups of summer-run steelhead that ascend the

Columbia River. An early segment known as the "A" group, which enters the Columbia River in June and July, is the only native race of steelhead in the Upper Columbia. The "B" group enters the Columbia River during August and September and is made up of larger fish that are produced primarily in the Clearwater and Salmon rivers drainages (Chrisp and Bjornn 1978). Steelhead and rainbow trout distribution in the UMM subbasin are illustrated in Figure 20 and Figure 21.

Anadromy is not obligatory in steelhead/rainbow trout (*O. mykiss)* (Mullan et al. 1992a, Rounsefell 1958). Progeny of steelhead can spend their entire life in freshwater and progeny of rainbow trout can migrate seaward. It is difficult to summarize the life history strategy of anadromy without due recognition of the life history strategy of residency. The two strategies co-mingle on a continuum with certain residency at one end, and certain anadromy on the other. Anadromy, although genetically linked (Thorpe 1987), is influenced by environmental conditions (Mullan et al. 1992a, Thorpe 1987, Shapovalov and Taft 1954). The upstream distribution of steelhead/rainbow trout in headwater tributaries is limited by low heat budgets (about 1,600 temperature units) (Mullan et al. 1992b). The response of steelhead/rainbow trout in these cold temperatures is residency, presumably because growth is too slow within the time window for smoltification. However, these headwater steelhead/rainbow trout contribute to anadromy via emigration and displacement to lower reaches, where warmer water improves growth rate and subsequent opportunity for smoltification.

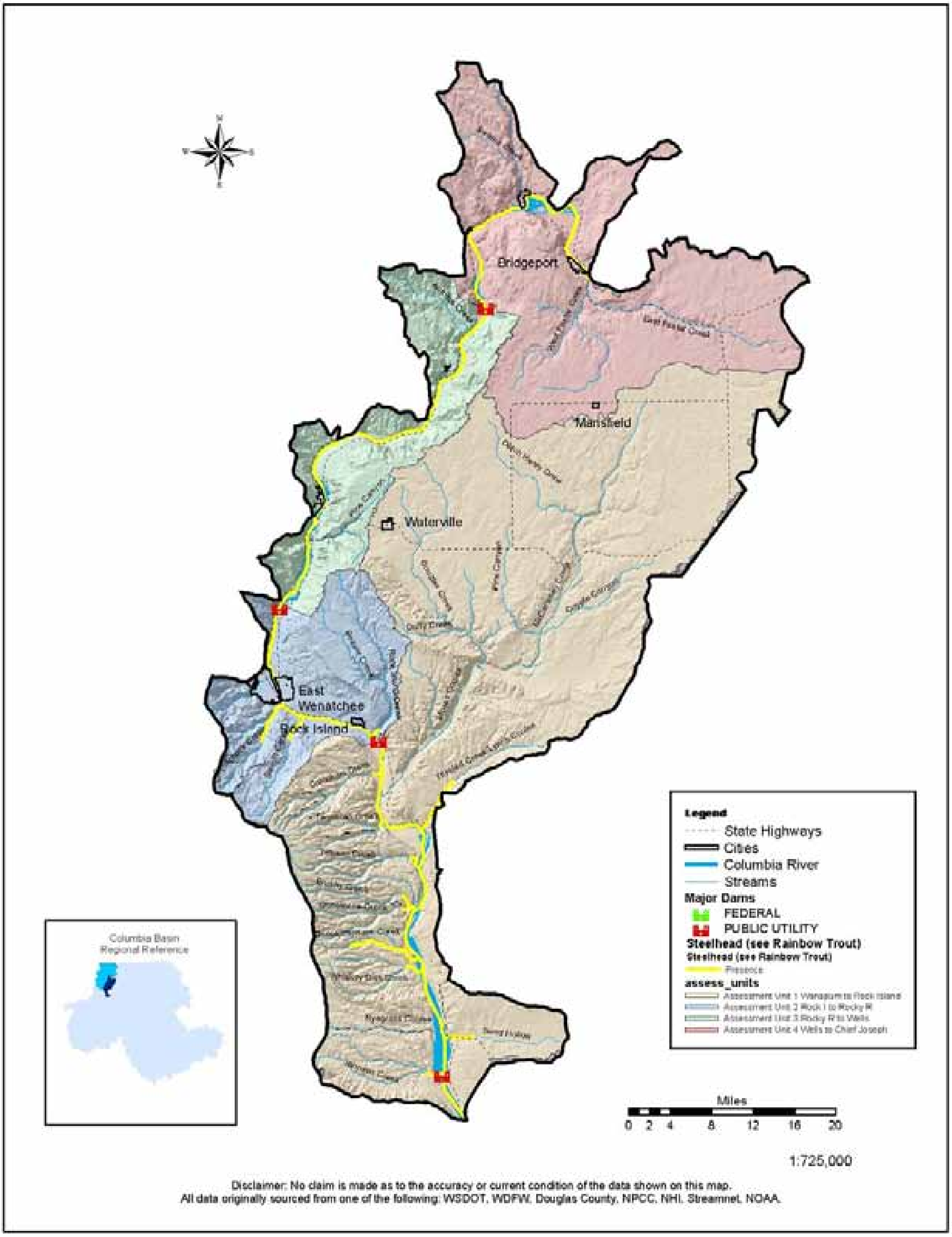


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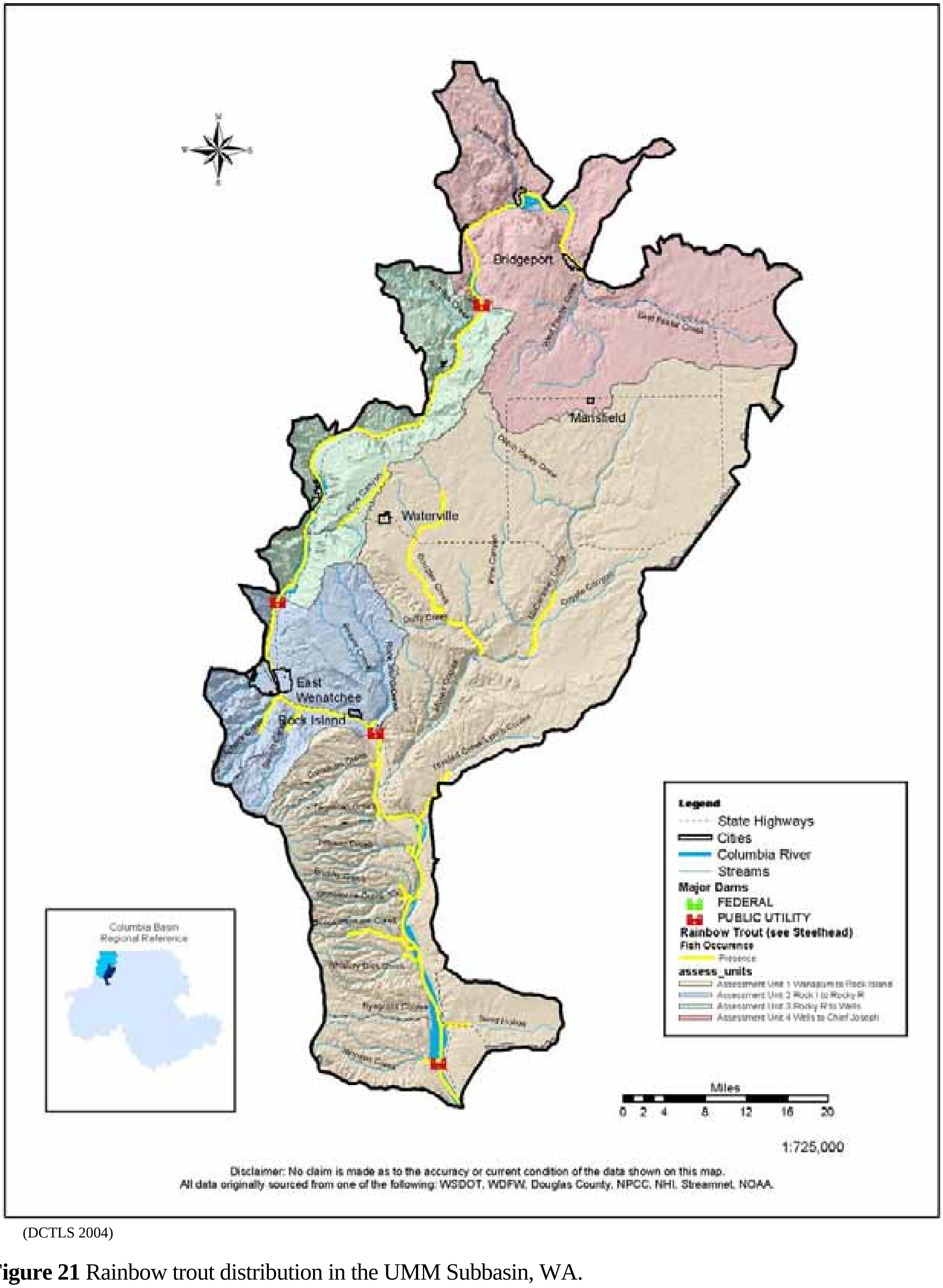
Figure 20 Steelhead distribution in the UMM Subbasin, WA.



(DCTLS 2004)

Figure 21 Rainbow trout distribution in the UMM Subbasin, WA.

Population Characterization and Habitat Relationships

Steelhead in the Mid-Columbia Region are considered to be at high risk of extinction (Busby et al. 1996). Juvenile and adult summer steelhead use the Columbia River as a migration corridor and many tributary streams provide spawning and rearing habitat (Chapman et al. 1994b, Peven 1992b). Adult steelhead generally arrive in the UMM Subbasin from June through late September, though some adults arrive much later at the upstream dams. Steelhead generally spawn in the tributaries from March through July of the following year. No steelhead spawning has been observed in this reach of the Columbia River, but some could potentially occur, particularly in areas of substantial groundwater upwelling (CCPUD 1998). Wild steelhead juveniles emigrate during the spring, passing mid-Columbia dams from April through June. The outmigration generally peaks in late April and early May. No information is available about the feeding habitats of steelhead juveniles in the upper middle Columbia reach (CCPUD 1998).

Population Status

Adult steelhead returns declined substantially in the mid-1990s, remained low for several years, and then increased substantially in 2000 and 2001 (CCPUD, unpub. data, 2001; Mosey and Murphy 2000). Although 2001 adult steelhead counts were still in progress at Rock Island Dam at the time the Subbasin Summary was written, 18,012 steelhead had been counted as of September 17, 2001, the largest return since 1986 (Figure 22).

In a study of the resident fish community in 11 tributaries of the Priest Rapids Project Area (PRPA) during 1999, (Pfiefer et al. 2001) juvenile rainbow trout were the most abundantly sampled species. The highest abundance of juvenile rainbow trout was found in Whiskey Dick Creek, followed by Colockum, Johnson, and Tarpiscan creeks. The study also included a genetic analysis for steelhead, rainbow, and redband trout. Objectives of the research were: to provide baseline information concerning the genetic diversity, variation, and genetic population structure of redband/rainbow trout and to determine whether genetic structuring observed in rainbow trout populations in the PRPA is indicative of pure, native trout populations or indicative of populations that have undergone introgression with hatchery rainbow trout or steelhead.

Genetic analysis was performed on tissue from a sub-sample of trout collected during the 1999 surveys (Dresser, pers. comm., 2003). Genetic analysis was also performed on fifty hatchery rainbow trout, fifty hatchery steelhead and twenty-three wild steelhead tissue samples (Wells Hatchery) for comparison purposes. Results of the analysis indicate four genetic “categories”: 1) resident redband/rainbow trout (this includes all stream sample locations except Johnson Creek), 2) a unique stream population in Johnson Creek, 3) a hatchery rainbow trout component, and 4) steelhead populations.

Grant PUD also assessed the upstream and downstream migration of adult steelhead through the mid-Columbia River using radio-telemetry techniques during October 1999 and June 2000 (English et al. 2001). During aerial tracking efforts, no adult steelhead was found in the tributaries of the PRPA. Further details on adult steelhead movements/migration in the mid-Columbia River can be reviewed in English et al. (2001).

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Figure 22 Adult Steelhead Counts at Rock Island Dam 1980- September 17, 2001

Population Management

Hatchery

The Federal Energy Regulatory Commission (FERC) requires that each hydroelectric project located on the Columbia River between Wanapum and the Chief Joseph dams mitigate for steelhead killed while migrating through project dams. To comply with this requirement the hydroelectric projects have funded the construction of hatcheries at four hydroelectric projects. The projects also fund WDFW to run the hatcheries and rear and release steelhead into Columbia River tributaries. Four of the six hydroelectric dams between Wanapum and Chief Joseph Dam include hatcheries these are: Wells, Eastbank, Chelan and Ringold hatcheries. The Winthrop National Fish Hatcheries also rears steelhead and releases them into a tributary to the UMM Subbasin.

Current WDFW management for steelhead emphasizes separation of above Wells Dam and below Wells Dam populations. Two separate hatchery broodstocks have been created. Adult steelhead is trapped in the Wenatchee River and in the Columbia River at Wells Dam. Only the progeny from fish trapped in the Wenatchee River are stocked in waters below Wells Dam. Only the progeny from fish trapped at Wells Dam are stocked in waters above Wells Dam.

Below Wells Dam

About 360,000 juvenile steelhead from the Eastbank and Chelan Hatchery Complex are released into the Wenatchee River. About 175,000 juvenile steelhead are released directly into the mainstem Columbia River from Ringold Springs Hatchery.

Steelhead supplementation was ceased in the Entiat River in 2001. Changes in steelhead population abundance in the Entiat River will be compared to other supplemented rivers to learn how effective supplementation is at increasing numbers of naturally produced steelhead.

Above Wells Dam

About 400,000 juvenile steelhead from the Wells Hatchery Complex are distributed among the Chewuch, Twisp, Methow, Okanogan and Similkameen rivers; the Winthrop National Fish Hatchery stocks 100,000 juvenile steelhead into the Methow River. A more detailed description of hatchery operations and supplementation efforts can be found in the WDFW Steelhead Management and Conservation Plan 2001.

Fish Focal Species: Chinook Salmon

Adult Chinook that spawn in the upper reaches of the ESU watersheds, generally return past Columbia River dams in the spring and are known as spring Chinook. Natural spring Chinook production is not known to occur in the UMM Subbasin, although migration and rearing in the mainstem and some of the small tributaries does.

Brannon et al. (2002) identified two populations of summer/fall Chinook salmon in the mid- and upper- Columbia region. Mainstem spawners downstream of Rock Island Dam (which includes the Hanford Reach) were designated as part of a metapopulation belonging to the mid-Columbia and Snake River populations, which includes the Klickitat, Deschutes, John Day, lower portions of the Grande Ronde, and Clearwater rivers. Upstream of Rock Island Dam (the lower Wenatchee, Okanogan, Similkameen, and mainstem Columbia River), spawners are characterized as one metapopulation. Spring Chinook and summer/fall/Chinook distribution in the UMM are illustrated in Figure 23 and Figure 24.

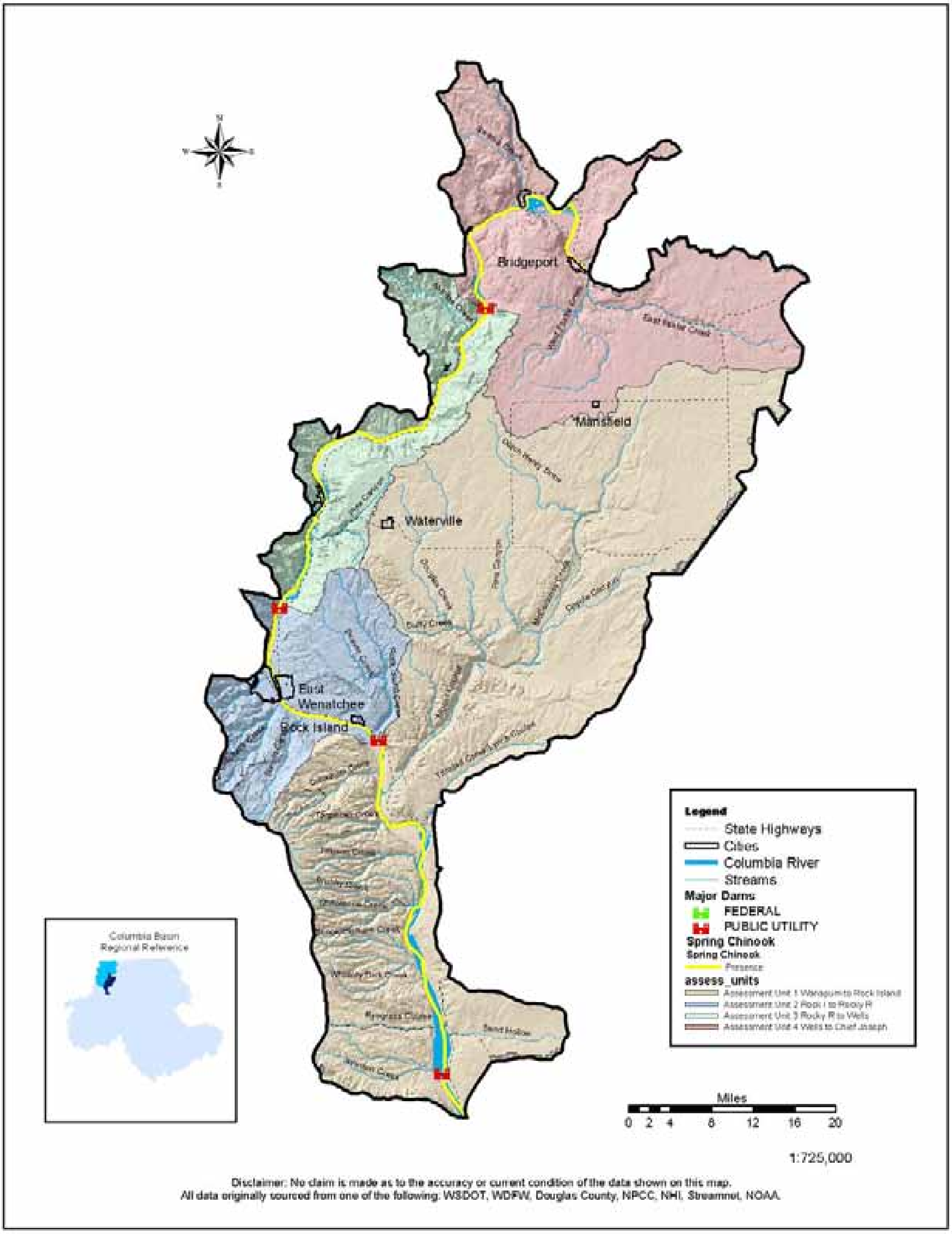

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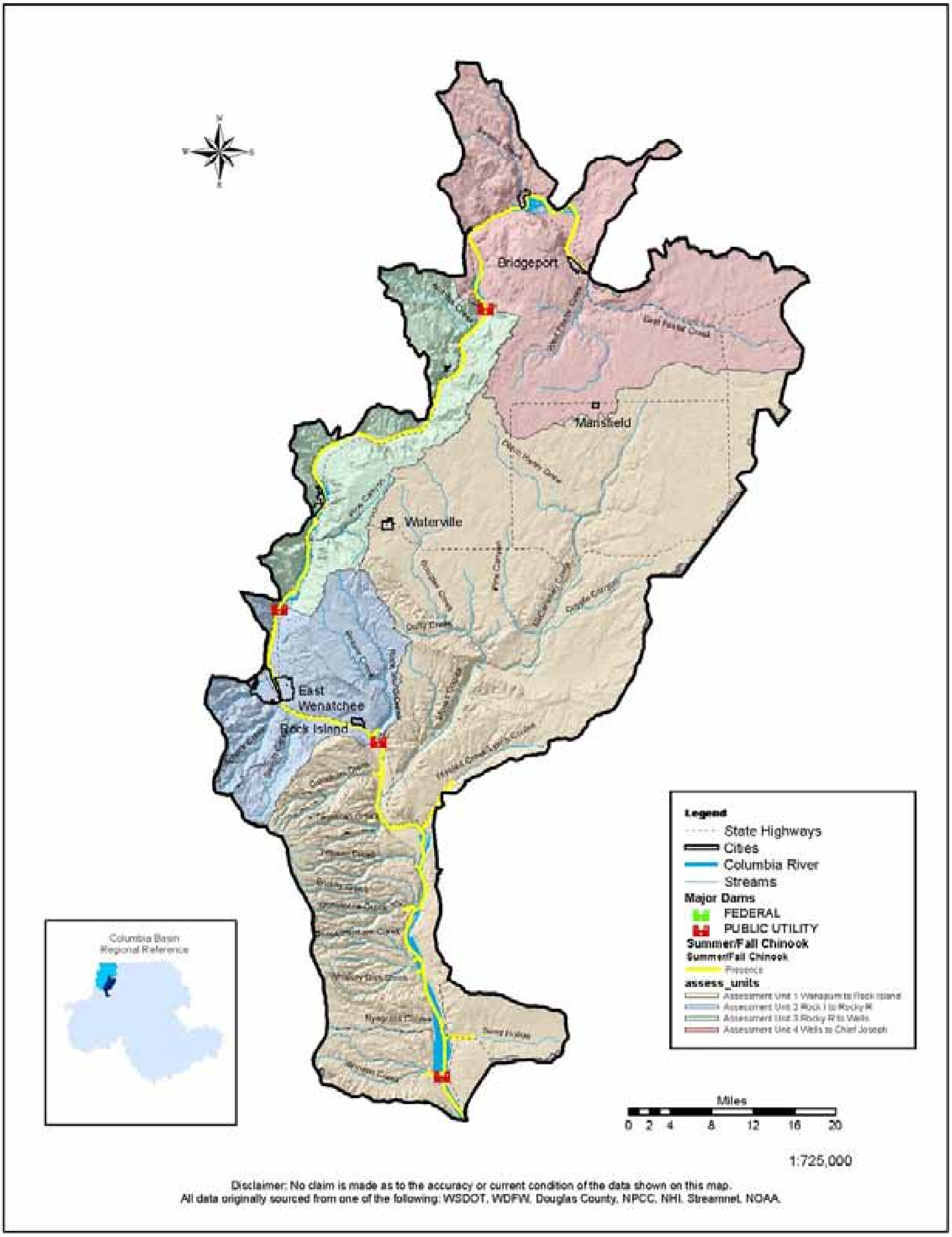
Figure 23 Spring Chinook distribution in the UMM Subbasin



(DCTLS 2004)

Figure 24 Summer/Fall Chinook distribution in the UMM Subbasin, WA.

Population Characterization and Habitat Relationships

Spring Chinook

Upriver migrations of adult spring Chinook salmon through Rock Island Dam are generally observed in early April through the third week of June (Mosey and Murphy 2000). Spawning occurs in the upper reaches of tributary streams, including the Wenatchee, Entiat, and Methow river systems, from early August through most of September, though the timing of spawning varies among tributaries. After spawning, adult spring Chinook remain near their redds until death.

Eggs hatch in late winter and early spring and the fry emerge from the gravel in April and May (Peven 1992a). Shortly after emergence, juveniles may migrate to rearing areas farther upstream or downstream. Most juvenile spring Chinook salmon rear in tributary streams to the Columbia River for approximately one year and then migrate downstream to the ocean (age 1+) when smoltification occurs. Smolts pass through the mid-Columbia dams from mid-April through mid-June. A small percentage migrate as sub-yearlings (age 0+) into lower reaches of their watersheds for overwintering before migrating to the ocean (Chapman et al. 1995a).

In 1993, the average length of yearling Chinook collected at Rock Island Dam (mixture of naturally and hatchery produced individuals) was 138 mm (Chapman et al. 1995a). In general, hatchery smolts are larger than wild smolts at the time of migration. Juvenile spring Chinook in the mid-Columbia migrate actively (averaging about 21.5 km/day from Rock Island to McNary Dam), thus the reservoir residence time is relatively short (Giorgi et al. 1997).

Summer/Fall Chinook

Summer/fall Chinook salmon have similar life history strategies and are combined in much of the discussion in this Plan. Summer/fall Chinook spawn in the mid-Columbia River and its tributaries, where suitable habitat prevails. Juveniles spend several weeks to months in Columbia River reservoirs before outmigrating through the UMM, between June and August (Chapman et al. 1994a, Peven 1992a), to the ocean where they spend 2-4 years (Peven 1992a). Apparently, some juveniles use the mainstem Columbia River to overwinter before entering the ocean in their second year of life. Adults usually spend two years in the ocean, but in some years a significant proportion of the run is composed of fish that spend 1 or 3 years in the ocean. Summer/fall Chinook show similar life histories and cannot be distinguished on the spawning grounds. Summer/fall Chinook return to the Columbia River between late May and early July and begin entering the UMM in mid- to late June through mid November. Some migrate up tributaries and spawn in late September through November, while others spawn in the mainstem between October and November. After spawning is complete, the adults die near their redds.

Summer/fall Chinook are known to spawn in the Wells and Chief Joseph dam tailraces as well as the confluence of the Chelan River (Chapman et al. 1994a). Spawning in the Chelan River is limited to the short segment below the Chelan powerhouse. In 1990 and 1991, Giorgi (1992) found Chinook redds in the Chelan River between the boat ramp and about 150 feet downstream from the railroad bridge.

Chapman et al. (1994a) suggested Columbia River spawning was continuing in the Brewster Bar area following inundation by the Wells reservoir. Other surveyors have indicated potential deep water spawning near Bridgeport Bar, Washburn Island, and downstream of Wanapum Dam

(Bickford 1994, Chapman et al. 1994a, Hillman and Miller 1994, Swan et al. 1994, GCPUD 2003a). They probably also spawn below other mid-Columbia River dams (Dauble et al. 1994), and perhaps in other Columbia River reservoir segments where suitable water velocities and substrate conditions exist.

Population Status

Spring Chinook

Spring Chinook were relatively abundant in upper Columbia River tributary streams prior to the 1860s. Based on the peak commercial catch of fish in the lower Columbia River and other factors, such as habitat capacity, Chapman (1986) estimated that approximately 588,000-spring Chinook was the best estimate of pre-development run sizes. Spring Chinook counting at Rock Island Dam began in 1935. Numbers (adults and jacks) in the period 1935-39 averaged just over 2,000 fish. Average counts fluctuated on a decadal average from the 1940s to 1990s from just over 3,200 (1940s) to over 14,400 (1980s). Within the past 10 years, counts of spring Chinook declined to near record lows and remained low for four consecutive years from 1995-1999 (Mosey and Murphy 2000). In 2000 and 2001, adult returns increased dramatically, with 41,262 adult spring Chinook counted at Rock Island Dam in 2001, marking the highest recorded return. Ten-year average counts (1991-2000) for anadromous adult salmonids migrating through Rock Island Dam, Rocky Reach and Wells Dams are presented in **Table 11**. The long-term average of spring Chinook passing Rock Island Dam is just over 8,900.

Table 11 Ten year average (1991-2000) counts of adult salmon and steelhead migrating upstream through UMM hydroelectric projects (Mosey and Murphy 2000)

Location	Chinook (jacks included)	Steelhead	Sockeye	Coho
Rock Island Dam	25,597	7,129	36,080	42
Rocky Reach Dam	11,241	4,934	18,714	24
Wells Dam	5,814	3,894	17,095	32

Since 1970, hatchery production of spring Chinook juveniles has increased, and the run is now comprised of at least 60 to 70 percent hatchery adults (CCPUD 1998, BPA et al. 1994, Palmisano et al. 1993). In 1993, stream-type Chinook salmon hatchery juvenile releases to the mid-Columbia reach totaled 4,171,000 (CCPUD 1998, BPA et al. 1994). Hatchery produced stream-type Chinook smolts migrating through the mid-Columbia originate from Winthrop, Methow, Entiat, Eastbank, Leavenworth and WDFW operated hatcheries (CCPUD 1998).

Summer/Fall Chinook

At Rock Island Dam, counts of adult summer/fall Chinook ranged from 6,874 to 48,844 between 1980 and 2001 and fall Chinook ranged from 1,706 to 6,846 fish between 1980 and 2000. The estimated number of adult fall Chinook salmon in the Priest Rapids Project (downstream of Wanapum Dam) was 10,971, 8,336, and 9,202 for 2000, 2001, and 2002, respectively (GCPUD 2003). Summer/fall Chinook populations in the UMM exhibited large increases in 2000 and 2001, similar to the increases observed for most other anadromous species (CCPUD unpublished data 2001, Mosey and Murphy 2000).

Population Management

Hatchery

Spring Chinook

To comply with FERC mitigation requirements, the Columbia River Hydroelectric projects fund Wells, Eastbank, and Methow hatcheries to rear and release juvenile spring Chinook into the tributaries of the UMM Subbasin. In addition, the Entiat and Winthrop National Fish Hatcheries rear and release juvenile spring Chinook. Table 12 provides an example of annual spring Chinook stocking into the UMM Subbasin and its tributaries.

Table 12 Annual Spring Chinook Stocking in the UMM Subbasin and its tributaries

Hatchery	Release Site	Approximate Number Released	Stock
Entiat NFH	Entiat River	375,000	Carson River
East Bank Hatchery	Wenatchee	400,000	Upper Columbia
Leavenworth NFH	Icicle Creek	1,289,000	Carson River
Methow Hatchery	Methow River	450,000	Methow River
Wells Hatchery	Main Stem Col. River	313,000	Upper Columbia
Winthrop NFH	Methow River	500,000	Methow River

Summer/Fall Chinook

Hatchery production of summer/fall Chinook in the region has been continuous since implementation of the Grand Coulee Fish Maintenance Project (GCFMP). Management practices have not changed since the implementation of the GCFMP.

Summer Chinook broodstock are collected randomly throughout the July-August migration to ensure proportional representation of age and size. Trap sites include Dryden and Tumwater dams on the WenatcheeRiver, the Wells Dam east ladder, and the Wells Hatchery outfall on the Columbia River.

The fish collected from Wenatchee River and Okanogan/Methow summer Chinook populations are natural or hatchery origin and are indigenous to those systems. Summer Chinook program protocols allow for annual collection of 492 adults for the Wenatchee, 556 for the Wells east ladder, and 1,210 for the Methow/Okanogan programs. The only broodstock program that uses selection criteria for a particular trait or parental origin is the Wells and Rocky Reach/Turtle Rock mitigation programs. These programs use fish collected at Wells Dam east ladder that are a mix of hatchery and natural fish.

Summer Chinook collected from the Wenatchee River and at Wells Dam are maintained separately at Eastbank Hatchery and spawned at a 1 male to 1 female ratio to help maintain genetic diversity. The program survival standard from fertilization to ponding is 90.0 %. The survival objective from fertilization to release is 65.0 %.

The rearing conditions at Wells and Eastbank hatcheries, including acclimation ponds, are based on loading densities recommended by Piper et al. (1982; 6 lb/gpm and 0.75 lb/ft^3) and Banks

(1994; 0.125 lb/ft^3/in) (BAMP 1998). Fry are transferred from Heath incubation trays to fiberglass rearing tanks (flow through water circulation), and then to raceways for continued rearing. Summer Chinook are transferred as fingerlings or sub-yearlings to acclimation ponds in the Wenatchee, Methow, and Similkameen drainages in the fall (September or October) or late winter (February or March) to acclimate and imprint the fish to the desired up-river return locations. Summer Chinook yearlings and sub-yearlings produced at Wells Hatchery are reared entirely at the hatchery and fully acclimated to the release site, while those released from Turtle Rock Hatchery are transferred from Rocky Reach Hatchery in November (yearlings) for six months of acclimation (April release), and in April-May (sub-yearlings) for three months of acclimation (June-July release).

Ocean-type Chinook salmon are released from hatcheries at both the yearling and sub-yearling stages. The current annual production goal for the combined programs is 2.36 million yearling smolts and 2.104 million sub-yearling smolts. Assuming a fertilization to release percent survival standard of 65.0 %, 6.87 million summer Chinook eggs are needed each year for the program. All summer Chinook smolts, except the Rocky Reach/Turtle Rock sub-yearlings (200K index group), produced through the programs are marked with an adipose clip/coded wire tag combination.

Chapman et al. (1994b) proposed an escapement objective to basin tributaries above Wells Dam of 3,500; a level carried forth in the “Mid-Columbia Hatchery Plan” as a natural escapement goal (BAMP 1998). A baseline adult production objective for the summer Chinook salmon population reaching Rocky Reach Dam is 30,293 (BAMP 1998).

Currently, summer/fall Chinook salmon have a low risk of extinction in the UMM; more are artificially propagated in the region than any other species. Most hatcheries rear them to a yearling stage because survival is up to 15 times higher than subyearlings. In addition, fewer yearlings need to be propagated to meet required compensation levels. In the short-term, this strategy appears to have few ecological impacts on natural fish; however, some indicators are inconclusive. This strategy, in combination with relatively high numbers of naturally spawning hatchery fish, may have deleterious long-term genetic effects to natural fish and may be impossible to detect in a timely manner. Given these constraints, the chosen strategy is to continue to propagate yearlings to compensate for dam mortalities; evaluate the genetic, ecologic, and demographic characteristics of the natural populations throughout the hatchery program; and recognize the risk that potential impacts may not be detected in sufficient time to correct them (DCPUD 2002).

Hatchery production of summer Chinook occurs at the Wells, Eastbank and Rocky Reach/Turtle Rock hatcheries in the mid-Columbia. Fall Chinook above McNary Dam are reared at Priest Rapids and Rocky Reach hatcheries (BPA et al. 1994).

WDFW operates and manages the Upper Columbia Summer Chinook Salmon Mitigation and Supplementation Program at the Eastbank (Rocky Reach and Rock Island Settlement Agreements) and Wells (Wells Settlement Agreement) Fish Hatchery Complexes. These “integrated harvest” programs pertain to Upper Columbia River Summer and Fall run ESU Chinook salmon (i.e., summer run component upstream of Priest Rapids Dam). Hatchery operations include broodstock capture and holding, fish spawning, incubation, rearing, and rearing to release (DCPUD 2002).

Current Hatchery Production and additional production to compensate for hydropower losses are detailed in Table 13. Current hatchery production totals 2,360,000 yearlings and 7,104,000 subyearlings, while additional production totals 1,470,000 yearlings and 1,000,000 subyearlings.

Table 13 Current and additional summer/fall Chinook hatchery production to compensate for hydropower losses in UMM Subbasin, WA.

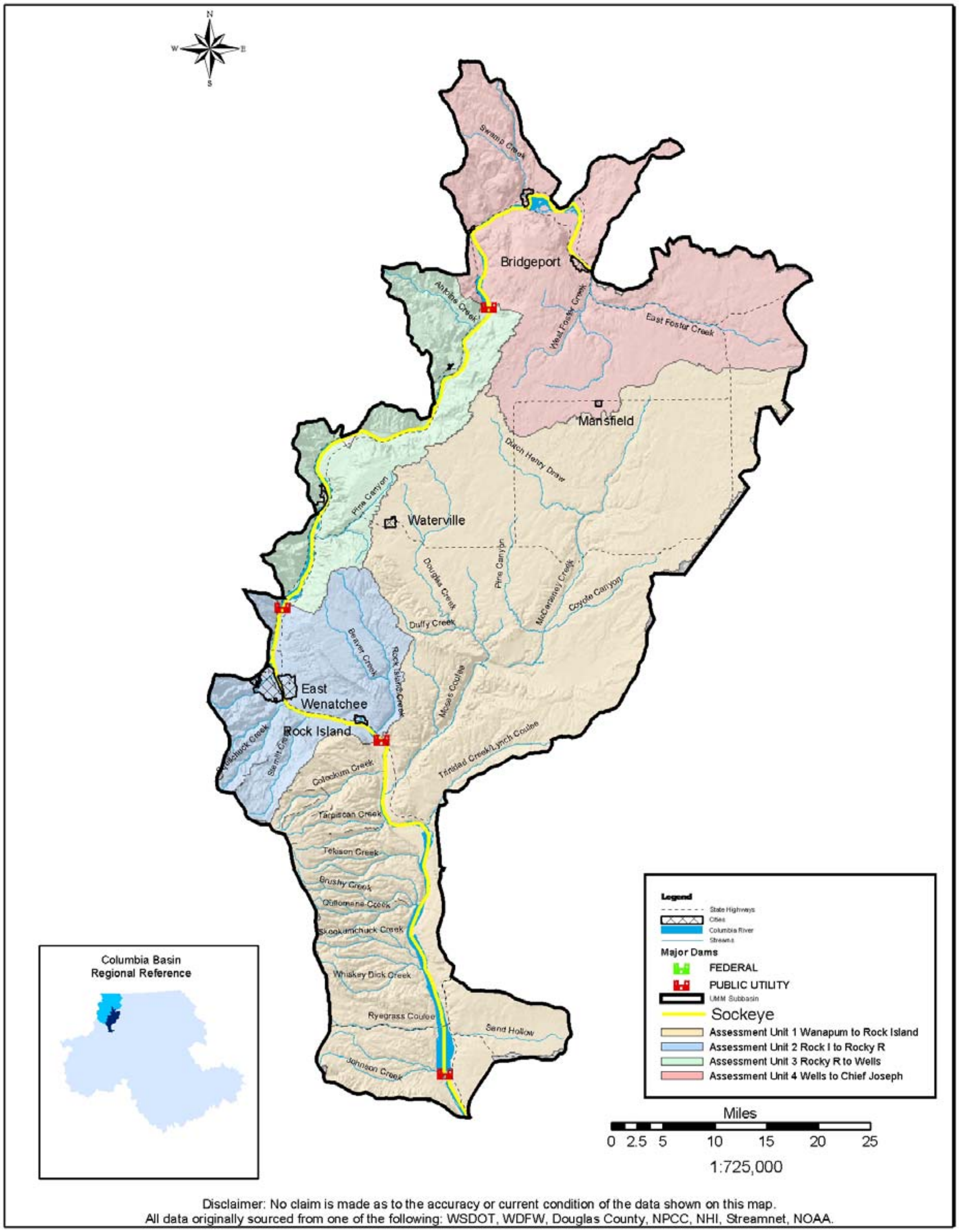
Hatchery	Size	Number
Wenatchee	Yearlings	864,000 plus 750,000 HP*
Methow	Yearlings	400,000 plus 120,000 HP*
Okanogan	Yearlings	576,000
Columbia River at Wells Fish Hatchery	Yearlings	320,000
Columbia River at Wells Fish Hatchery	Subyearlings	484,000
Rocky Reach Fish Hatchery	Yearlings	200,000
Rocky Reach Fish Hatchery	Subyearlings	1,620,000
Priest Rapids Fish Hatchery	Subyearlings	5,000,000 plus 1,000,000 HP
Entiat	Yearlings	150,000 HP*
Chelan River	Yearlings	150,000 HP*
Chief Joseph Dam area	Yearlings	300,000*

*HP- additional mitigation for losses at hydropower projects.

(Chuck Peven, pers. comm., 2004)

Fish Species of Interest: Sockeye

Sockeye salmon populations spawn and rear in the Wenatchee and Okanogan Rivers and use the Columbia River within the UMM Subbasin as a migration corridor (Figure 25). Sockeye are not listed under the ESA.



(DCTLS 2004)

Figure 25 Sockeye distribution in the UMM Subbasin, WA.

Population Characterization and Habitat Relationships

Sockeye salmon populations from the Wenatchee and Okanogan Rivers use the Columbia River within the UMM for migrations as adults and juveniles (Peven 1987). Adult sockeye migrate up the Columbia River between June and August with the peak generally occurring at Rock Island Dam in mid-July. Juvenile sockeye migrate downstream in April and May with Lake Wenatchee fish arriving at Rock Island Dam before Osoyoos Lake fish (Peven 1987).

Sockeye spawn and rear in the upper Wenatchee basin and Okanogan River / Osoyoos Lake area at the US / Canadian border. The two stocks are separable by caudal fork length frequency distributions. The tail fork length of Osoyoos Lake stock is generally larger than 100 mm and the Wenatchee stock is less than 100 mm (Peven 1987b).

Population Status

Since 1980, adult counts at Rock Island Dam have ranged from 9,334 to 109,074 (Mosey and Murphy 2000). In 2001, 104,842 adult sockeye passed Rock Island Dam making it the largest return since 1984.

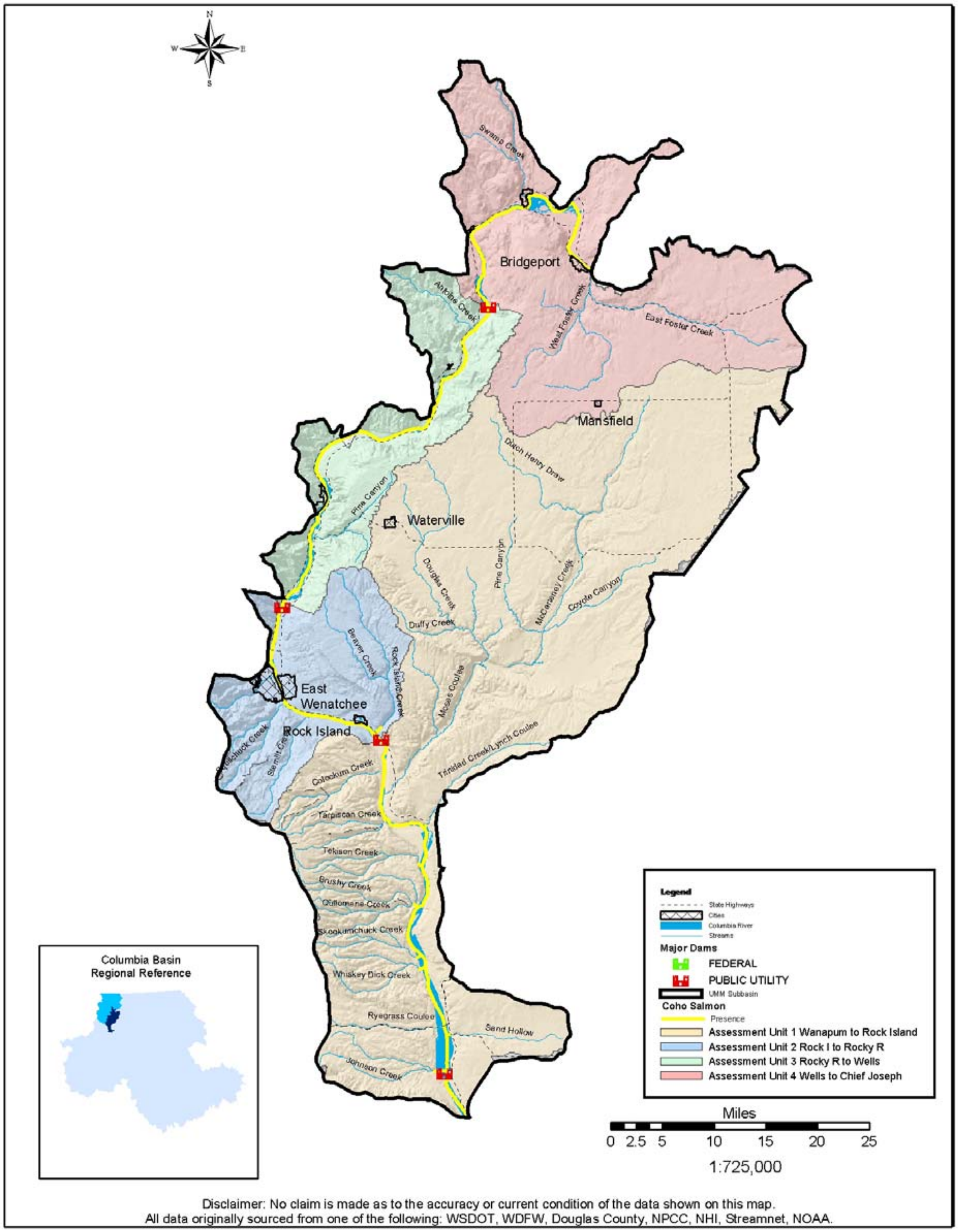
Population Management

Hatchery

Currently the only sockeye supplementation program conducted in the UMM occurs in Lake Wenatchee in the Wenatchee River drainage. Eggs are taken from naturally reproducing fish in the White River, a tributary to the Lake Wenatchee. The eggs are reared at Eastbank Hatchery to fingerling size and then transferred to net pens in Lake Wenatchee and released in the early summer or fall. Approximately, 209,000 juvenile sockeye have been stocked annually.

Fish Species of Interest: Coho

An endemic stock of coho salmon once spawned in several tributaries to the UMM Subbasin, but has been extirpated from this region since the 1930s. Current distribution of hatchery coho in the UMM Subbasin, released as part of the Yakama Nation/WDFW Reintroduction Feasibility Study (BPA et al. 2002), is illustrated in Figure 26.



(DCTLS 2004)

Figure 26 Coho distribution in the UMM Subbasin, WA.

Population Characterization and Habitat Relationships

Historically, coho salmon migrated through Wells reservoir to spawning areas in several tributaries to the UMM Subbasin (DCPUD 2002). The endemic stock has been considered extinct in the mid- and upper-Columbia River regions, including upstream of the Wells Project, since the 1930s (CBFWA 1990, Mullan 1984), despite plantings of 46 million fry, fingerlings, and smolts from fish hatcheries between 1943 and 1975 (Andonaegui 1999). The State of Washington does not currently recognize any natural coho stock in the UMM Subbasin (WDF/ WDW 1993). The Wells HCP includes mitigation and off site compensatory measures for coho salmon (DCPUD 2002).

Population Management

In the early 1900s, a fish hatchery in the Methow Basin raised primarily coho salmon. Between 1904 and 1914, an average of 360 females were used for broodstock from this hatchery annually. Between 1915 and 1920, an average of only 194 females were taken, suggesting a 50% decline in the run between this and the previous period. After 1920, no coho were taken from this hatchery and it was closed in 1931 (Mullan 1984).

No further releases of coho into the Methow River occurred until the GCFMP in 1945. The Winthrop National Fish Hatchery released coho in 17 of the 24 years between 1945 and 1969. In only four of those years did the broodstock originate from the Methow River, which were admixtures of various stocks originally captured at Rock Island Dam. Most of the coho released at Winthrop originated from Lower Columbia River stocks from the Eagle, Lewis, and Little White Salmon hatcheries (Mullan 1984). No further releases of coho occurred into the Methow River until the late 1990s.

The first hatchery opened in the Wenatchee Basin in 1899 near Chiwaukum Creek. It closed 5 years later (Craig and Suomela 1941). Besides logistical problems (e.g., heavy snow, extreme cold, etc.), the hatchery was unable to obtain eggs of Chinook, which were evidently its prime target. Mullan (1984) quotes from the 14^{th} and 15^{th} annual report of the State Fish Commissioners of Washington: "… if it [the hatchery] had been below the Tumwater Canyon, the early Chinook could have been secured; as it is, it takes only an inferior run of coho."

In 1913, a new hatchery was built, below Tumwater Canyon, near the town of Leavenworth. Very few spring Chinook, the target species, were collected there. Subsequently, the hatchery closed in 1931. Mullan (1984) reports that there were, at most, two plants of coho from this hatchery, utilizing lower Columbia River source fish.

No further releases of coho occurred in the Wenatchee River until the GCFMP, with the first release in 1942. Between 1942 and 1975, most of the coho released at Leavenworth originated from Lower Columbia River stocks from the Cascade, Quilcene, Eagle, Lewis, and Little White Salmon hatcheries (Mullan 1984).

Hatchery

The Yakama Nation and WDFW are currently implementing a Reintroduction Feasibility Study funded by the BPA (BPA et al. 2002). The project is designed to gather data and develop and implement plans for coho restoration in the Wenatchee, Entiat, and Methow river sub-basins. The Yakima Subbasin has sufficient productivity to sustain a meaningful in-basin fishery in most years. The study focuses on the development of a localized broodstock while minimizing potential negative interaction among coho and listed and sensitive species. As the study transitions from the exclusive use of lower Columbia River hatchery coho to the exclusive use of in-basin returning broodstock, a locally adapted broodstock will develop and it is expected that positive trends in smolt-to-adult survival will be observed. The first phase evaluates the initial feasibility and risks associated with coho restoration through intensive experimental monitoring and evaluation.

Monitoring and evaluation activities in the Wenatchee subbasin have focused on evaluating the success of broodstock development, associated survival rates, and examining interactions between coho and listed species, particularly spring Chinooksalmon, steelhead, sockeye salmon, and bull trout. The program relies on the transfer of non-basin specific information from the Methow and Yakima river basins where concurrent releases of coho and associated studies are occurring. Studies have been conducted to determine the impact of hatchery coho predation on salmonid fry in the Wenatchee and Yakima subbasins, the abundance of residual hatchery coho following volitional releases in the Methow, Wenatchee, and Yakima subbasins, the potential for Chinook redd superimposition by later spawning coho salmon, coho micro-habitat use and overlap by naturally spawned coho salmon, and carrying capacity. In addition, all juvenile coho salmon, to be released in the Wenatchee and Methow subbasins in 2002, have been successfully marked, enabling identification and quantification of future smolt and adult natural production. Project performance is evaluated annually through the Mid-Columbia Technical Workgroup to coordinate, expand, or adapt studies as data indicate is necessary. The scope, magnitude, and biological approach of the second phase will be determined by the results of the risk/feasibility phase.

Fish Species of Interest: Pacific Lamprey

(This section taken from Nass et al. 2002 in GCPUD 2003a)

Population Characterization and Habitat Relationships

The Pacific lamprey is an anadromous fish and is one of three species of lamprey found in the Columbia River. The other two are river lamprey (*L. ayresii*) and brook lamprey (*L. richardsoni*) (Wydoski and Whitney 1979). Lamprey are native to many of the tributaries of the lower Columbia (Jackson et al. 1997, Jackson et al. 1996) and the Snake River (Close and Bronson 2001, Close et al. 1995), but their distribution between Priest Rapids and Chief Joseph Dam is less certain. Pacific lamprey do not appear to have genetically different stocks (at least between some lower and mid-Columbia basins) (Powell and Faler 2001) or to have homing tendencies, but will stray to other locations (Hatch et al. 2001).

Pacific lamprey are long and snake-like in form and are poor swimmers utilizing an anguilliform swimming motion (Mesa et al. 2001). Burst swimming speed was calculated to be approximately 2.1 m/sec for lamprey (Bell 1990). On the Fraser River in British Columbia, lamprey were estimated to migrate 8 km/day (Beamish and Levings 1991). In the Columbia River, the lamprey were estimated to migrate 4.5 km/day (Kan 1975).

They have a disk-shaped funnel for a mouth, which juveniles use to filter feed on detritus and algae (Close et al. 2002) in backwaters and eddies. Adults are opportunistic feeders and prey on a variety of fish species in the ocean. They have a series of teeth at the center of the mouth disk to tear the skin of their prey. This mouth disk is also used during migration to conserve energy and move upstream against the flow; the lamprey swims in bursts, and then uses its mouth as a suction cup to attach to a surface and rest.

Distribution

Historical distribution of Pacific lamprey in the Columbia and Snake rivers was coincident wherever salmon occurred (Simpson and Wallace 1978). It is likely that Pacific lamprey occurred historically throughout the Wenatchee, Entiat, Methow, and Okanogan basins. Within the Wenatchee River basin, Pacific lamprey would have occurred in the Wenatchee River, Chiwawa River, Nason Creek, Little Wenatchee River, White River, Icicle Creek, Peshastin Creek, and Mission Creek. In 1937, WDF (1938) collected several juvenile lamprey that were bypassed from irrigation ditches in Icicle and Peshastin creeks, and the lower Wenatchee River. Pacific lamprey would have used the Entiat and Mad rivers in the Entiat Basin and the Methow, Twisp, Chewuch, and Lost rivers, and Wolf and Early Winters creeks in the Methow Basin. In the Okanogan Basin, lamprey may have used the Okanogan River, Similkameen River, Salmon Creek, and Omak Creek.

Because Grand Coulee Dam was built without fish passage facilities, the Fish and Wildlife Service developed the Grand Coulee Fish Maintenance Project (GCFMP) (Fish and Hanavan 1948. Fish and Hanavan (1948) do not mention the capture of lamprey. Apparently these fish were allowed to pass Rock Island Dam.

The current distribution of Pacific lamprey in the Columbia River and tributaries extends to Chief Joseph Dam on the Columbia River and to Hells Canyon Dam on the Snake River (Close et al. 1995). Both dams lack fishways and exclude lamprey from large areas where they were assumed historically present Landlocked populations have been found (Wallace and Ball 1978), but they have not persisted. Beamish and Northcote (1989) concluded that metamorphosed landlocked lamprey were unableto survive to maturity. Within the CCP, the distribution of lamprey is not well known. They still exist in the Wenatchee, Entiat, and Methow systems, but the distributions within those systems are mostly unknown.

Migration

Pacific Lamprey spend 5 to 7 years in fresh water before they migrate to the ocean and transform from the larvae (ammocoete) stage to adults (Wydoski and Whitney 1979, Hart 1973). After metamorphosis in October and November, young adults migrate to the ocean between late fall and late spring (Close et al. 1995). Fyke net sampling at Wells Dam indicates that lamprey pass the dam during most months that sampling occurs, but the greatest numbers usually pass during April through July (BioAnalysts 2000a). Most pass Rocky Reach Dam in late May and June (CCPUD 1991).

Adult Pacific Lamprey spend 1.5 to 3.5 years in the Pacific Ocean (Beamish 1980 as cited in Close et al. 2002, Kan 1975) before returning to freshwater streams to spawn. At Bonneville Dam, the adult run begins in May and generally goes through October, peaking towards the end of June-mid July (Columbia River DART webpage). Beamish (1980) suggested lamprey enter fresh water between April and June, and complete migration into streams by September. It is not clear how flow impacts freshwater immigration.

Spawning

Pacific lamprey that migrate inland in the Columbia River spawn later than those in coastal streams (Close et al. 1995). Lamprey along the Oregon coast generally spawn in May at temperatures between 10° and 15°C. In the Columbia River basin, lamprey typically spawn during June and July (Wydoski and Whitney 1979; 2003). Kan (1975) collected both spawning and pre-spawning fish in the John Day River system in July. Mattson (1949) described lamprey spawning in the Willamette River during June and July. They probably spawn in the UMM Subbasin in June and July.

No one has documented the spawning sites selected by Pacific lamprey in the UMM Subbasin (BioAnalysts 2000a). They likely spawn in the lower reaches of the Wenatchee, Entiat, and Methow rivers. Lamprey may spawn in the Wenatchee River near Leavenworth (RM 23.9-26.4), because both adults and ammocoetes occur there. This area consists of well-sorted gravels and cobbles. Lamprey may also spawn in the Gunn Ditch near Monitor (K. Petersen, NOAA Fisheries, pers. comm., in Nass et al. 2002). Females lay between 35,000 and 100,000 eggs per nest and the adult lamprey die after spawning (Wydoski and Whitney 1979).

Population Status

Fish counts at Columbia River dams began in the 1930s, and lamprey were counted along with salmonids as they ascended to spawning grounds. In the first few years of counts at Bonneville Dam, lamprey counts were above 150,000. In the 1940s, counts ranged from approximately 50,000 to just under 150,000 (Close et al. 1995). In the late 1950s, counts rose dramatically to over 350,000 and then dropped to less than 50,000 in the mid 1990s.

There is little information on the abundance of Pacific lamprey in the upper Columbia region except counts of adults and juvinilles at dams and juvenile salmon traps. There are no estimates of redd counts or juvenile and adult counts in tributaries.

In the upper Columbia, large declines of adults occurred at most mainstem dams during the late 1960s and early 1970s (Close et al. 1995). During the period between about 1974 and 1993, adult lamprey counted at Rock Island Dam was quite low. Counts of adults have increased since that time; however, this increase corresponds with the start of both day and night counts (see below), which may have some effect on the comparison. Recent increases are greater than those in the last 10 (years, days, months, decacades?), suggesting that a true increase in abundance occurred.

In summary, while it is difficult to determine the historical abundance of lamprey in the Columbia Basin, and in the CCP, circumstantial evidence suggests that they have declined. Counts of juvenile and adult lamprey fluctuate widely. It is unknown whether these fluctuations represent inconsistent counting procedures, actual population fluctuations, or both. Although these factors may make actual comparisons difficult, it appears that lamprey in the upper Columbia are currently increasing.

Population Management

Hydroelectric

As part of the relicensing process, GCPUD began a multi-year research program to evaluate adult Pacific Lamprey passage at Priest Rapids and Wanapum dams using radiotelemetry techniques. Study results included (or will include?) evaluation of passage success, identification of factors that impede lamprey passage, and identification of passage improvements. A total of 51 and 74 fish were radio-tagged and released in the Priest Rapids Dam area in 2001 and 2002, respectively.

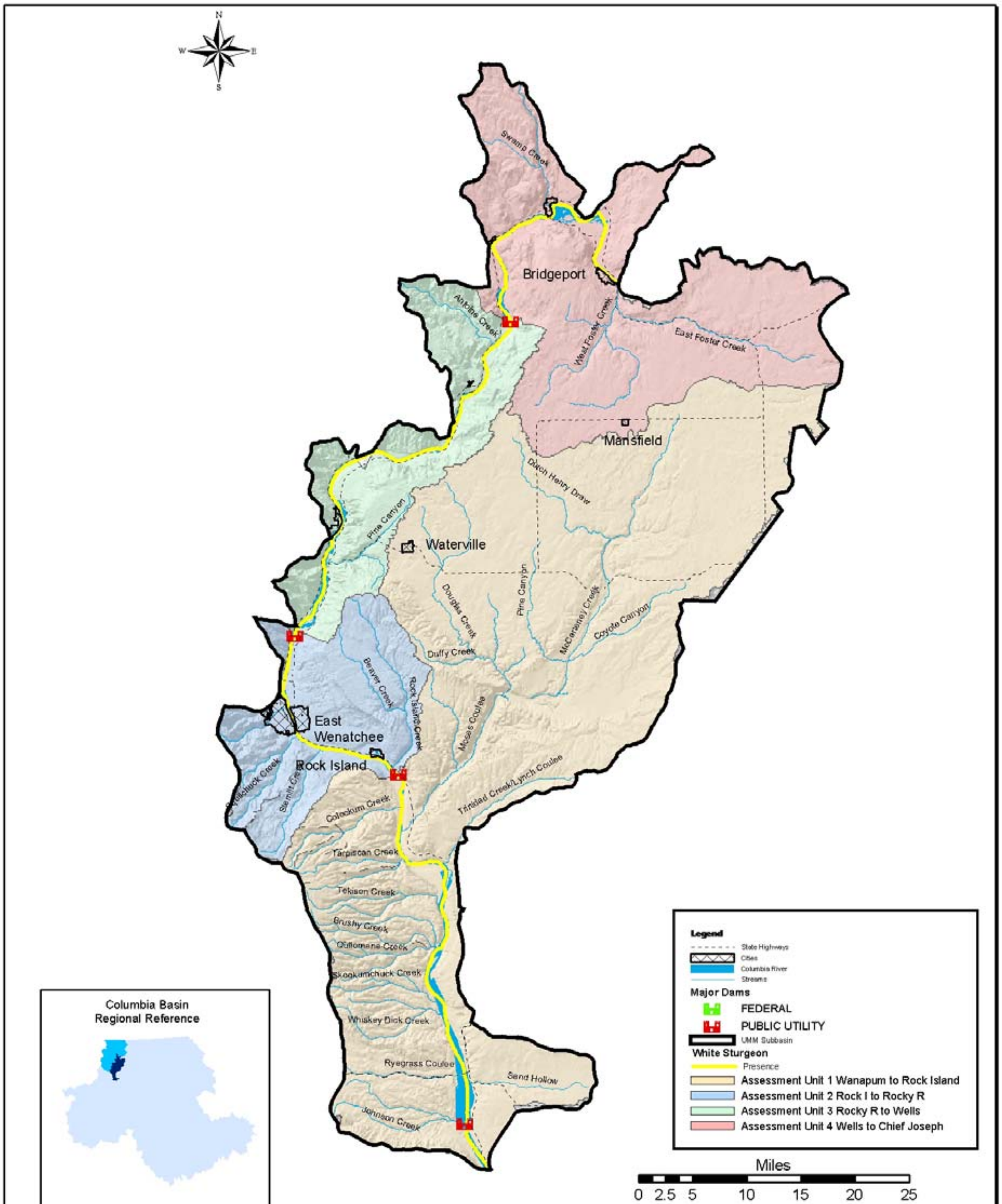
Harvest

The Pacific lamprey is reported to be an important fish of cultural, utilitarian, and ecological significance (Close et al. 2002). Close et al. (1995) reported that Native American tribes of the Pacific Coast and interior Columbia Basin harvested lamprey for subsistence, ceremonial, and medicinal purposes. In addition, a commercial fishery for lamprey also occurred during the 1940s, and was used as food for livestock and cultured fish.

Fish Species of Interest : White Sturgeon

Historically, white sturgeon moved throughout the mainstem Columbia River from the estuary to the headwaters, although passage was probably limited at times by large rapids and falls (Brannon and Setter 1992). Beginning in the 1930s, with construction of Rock Island, Grand Coulee, and Bonneville dams, migration was disrupted because sturgeon will apparently only pass downstream through fish ladders designed for salmon (S. Hays, pers. comm., in Peven 2003). Current populations in the Columbia River Basin can be divided into three groups: fish below the lowest dam, with access to the ocean; fish isolated (functionally but not genetically) between dams; and fish in several large tributaries. In the CCP, construction of Wells, Rocky Reach, Rock Island, and Wanapum Dam have disrupted upstream movement of sturgeon. Current White Sturgeon distribution is illustrated in Figure 27.

Construction of Columbia River dams may have created “isolated” populations of white sturgeon. However, the population dynamics and factors regulating production of white sturgeon within these “isolated” populations are poorly understood. Because of this lack of understanding, Douglas, Chelan, and Grant PUDs have instigated studies for white sturgeon through the re-licensing processes (Bickford, pers. comm., in Peven 2003; Golder Assoc. 2003 a, b). A better understanding of basic life history information, distribution and population sizes that currently exist within the CCP will result.



(DCTLS 2004)

Figure 27 White sturgeon distribution in the UMM Subbasin, WA.

Population Characterization and Habitat Relationships

Age structure and Sex Ratios

Sturgeon are known to live in excess of 100 years (Beamesderfer and Nigro 1995). The median age of maturity of lower Columbia River sturgeon is 24 years and 95% were mature between the ages of 16 and 35 years (Wydoski and Whitney 2003). This supports the data collected on fish in the Wanapum and Rocky Reach reservoirs of the CCP (Golder Assoc. 2003a, 2003b in GCPUD 2003a).

In recent studies by Golder Assoc. (2003a, b in GCPUD 2003a), ages of sturgeon sampled were estimated between 3-50 years. The younger age classes are indications of successful spawning in the CCP and emigration from upstream. For fish captured in the Wanapum and Rocky Reach reservoirs, the overall sex ratio was 1:1 (Golder Assoc. 2003a, b in GCPUD 2003a). Because of relatively small sample sizes, especially in the Rocky Reach reservoir, this may or may not be representative of the total population.

Length at age

Sturgeon can attain lengths of greater than 381 cm (12.5 feet; Wydoski and Whitney 2003). White sturgeon can reach sexual maturity at about 120 cm (4 feet) for males and 180 cm (6 feet) for females; however, most fish mature at a larger size (Wydoski and Whitney 2003).

In the CCP, sturgeon caught in the Wanapum and Rocky Reach reservoirs appeared to have two length modes; one roughly between 45-100 cm (1.5-3.3 feet) and the other from about 150-250 cm (5-8 feet; Golder Assoc. 2003a, 2003b in GCPUD 2003a). This supports the information presented in Wydoski and Whitney (2003), where white sturgeon throughout the west coast ranged from 48-81 cm (1.5-27 ft) for 5-year-old fish to 160-241 cm (5.3-8 ft) for 30 year old fish.

Migration

Sonic tagging studies show that white sturgeon are mostly inactive from late fall to spring (Golder Assoc. 2003a, 2003b in GCPUD 2003a). Spawning migration in the Wanapum Reservoir occurred between April and June. Since movement is limited by the dams, no large movements are believed to occur in the reservoirs of the CCP. Juvenile white sturgeon appear to migrate downstream during winter and early spring, and the movements are thought to be primarily to increase (Golder Assoc. 2003a in GCPUD 2003a).

Spawning

In the lower Columbia River, the spawning period extended from late April or early May through late June or early July of each year (McCabe and Tracy 1993). Spawning occurred primarily in the fast-flowing section of the river downstream from Bonneville Dam, at water temperatures ranging from 10 to 19 °C. Freshly fertilized white sturgeon eggs were collected at turbidities ranging from 2.2 to 11.5 NTU, near-bottom velocities ranging from 0.6 to 2.4 m/s, mean water column velocities ranging from 1.0 to 2.8 m/s, and depths ranging from 3 to 23 m. Bottom substrate in the spawning area sampled was primarily cobble and boulder. White sturgeon deposit their eggs by “broadcast” spawning. Mature white sturgeon commonly produce between 100 and 300 thousand eggs, although larger fish may produce up to 3 million eggs (Wydoski and Whitney 2003). Only a small percentage of white sturgeon spawn in a given year; spawning intervals are estimated at 3 to 11 years (Wydoski and Whitney 2003). No data has been collected in the CCP for fecundity of white sturgeon.

Spawning has been documented in the CCP only in the tailrace of Rock Island Dam (Golder Assoc. 2003a in GCPUD 2003a)., Indirect evidence of spawning in the Rocky Reach reservoir includes presence of the 1997 brood (Golder Assoc. 2003b in GCPUD 2003a), capture of juvenile sturgeon (84 cm in length and less then 3 kg in weight) (Chelan PUD, unpublished data, 2001), and a sturgeon less then 90 cm was observed during pikeminnow removal programs (Todd West, pers. comm., 2001). The sturgeon spawning migration begins in May in the Wanapum Dam reservoir when water temperatures are between 8-13 °C (Golder Assoc. 2003CPa), which is similar to spawning activities documented in the lower Columbia River (Wydoski and Whitney 2003).

Grant County PUD Project Area Study

White sturgeon populations in Priest Rapids and Wanapum reservoirs, on the middle Columbia River, were investigated from 2000 to 2002 as part of the Public Utility District No. 2 of Grant County's (GCPUD) hydroelectric project relicensing process (FERC No. 2114). Below is a summary of a comprehensive study that has been conducted on white sturgeon in the GCPUD Project area (Golder 2003b in GCPUD 2003a).

The population of white sturgeon (estimated between 398 and 881 individuals) in Wanapum Reservoir contained a relatively equal distribution of young and mature individuals. Approximately 20% of the total catch was composed of juvenile fish, which suggests that this population experiences natural recruitment or that the reservoir receives an influx of juveniles from upstream. Based on set line capture and sonic tag movement information, white sturgeon were distributed throughout the free-flowing portion of the reservoir upstream of Vantage Bridge (RM 421) to Rock Island Dam tailrace (RM 452). Wanapum Reservoir contained areas for feeding, spawning, and rearing; these areas were similar to habitats observed in reservoirs throughout the Columbia River and on the Snake River. Spawning velocities were found to be slightly lower than those observed in Priest Rapids Reservoir below Wanapum Dam, and were within optimal spawning velocities established for white sturgeon during wet water years as calculated by a habitat model (Batelle, unpublished data, 2001 in Golder 2003b).

During set line capture programs conducted in 2000 and 2001 in Wanapum Reservoir, white sturgeon ranged from 50 to 231 cm in fork length (FL), and 1 to 118 kg in weight. Juvenile/sub-adult fish were present in the sampled population. Length-frequency distributions of white sturgeon did not vary between study years. Surgical examination of captured individuals indicated that an equal proportion of males and females, was present in Wanapum Reservoir. These fish were of varying sex and maturation stages. Captured white sturgeon in Wanapum Reservoir ranged from age-4 to age-37, however intermediate aged fish were not well represented in the sampled population. Six fish were recaptured during the present study, and exhibited an increase in growth of approximately 6.8 cm per year.

In Wanapum Reservoir, 31 white sturgeon, 19 females, 11 males, one juvenile/subadult, and one of unknown sex and age, were implanted with sonic transmitters during capture sessions conducted in the spring and fall of each year. Movement information collected by boat-based surveys and remote telemetry stations indicated that sonic tagged white sturgeon were relatively inactive from September to May, and usually remained in one of four overwinter areas identified during the present study. Columbia Cliffs (RM 442) was identified as a very important overwinter area during the present study, since a large proportion of sonic tagged fish at-large resided at this location during this period.

Some fish were observed to move between overwinter areas throughout the duration of the overwinter period. In October and November, a few white sturgeon were also observed to move from the main overwinter area to the feeding area located near Whiskey Dick Creek (RM 426), likely to take advantage of the fall Chinook salmon that migrate during this time. One mature female that was implanted with a temperature and depth sensor (i.e., CHAT tag), moved into both deep and shallow habitats during the overwinter period, but these movements were not diurnal in nature.

During the spawning period, mature white sturgeon were observed to move upstream to the tailrace of Rock Island Dam in Wanapum Reservoir in early June, and most remained until late July. Short-term observations made on white sturgeon implanted with temperature and depth sensors indicated that one mature female moved into deep and shallow areas during the spawning period. These variations in depth were diurnal in nature and were more variable during the spawning season compared to the end of the overwinter period. Observations from another mature female also indicated that this fish was located in depths that were, on average, 10m shallower during the early spawning season compared to the overwinter period.

Spawning was detected in Wanapum Reservoir, below Rock Island Dam, during all three years of study. Newly spawned white sturgeon eggs were collected when water temperatures below Rock Island Dam were within suitable ranges for optimal development. Preliminary information indicated that larvae incubated *in situ* also hatched within the time required for normal embryo development. Spawning habitats below Rock Island Dam were similar to other white sturgeon habitats throughout the Columbia River, with the exception of slightly lower water velocity during dry and normal water years as calculated by the habitat model (Batelle, unpublished data, 2001 in Golder 2003b). The number of spawning events and egg catch-rates was highest in 2002 (i.e., seven events; 1.78 eggs/mat-day), followed by 2000 (i.e., five events; 0.06 eggs/mat-day), and 2001 (i.e., one event; 0.02 eggs/mat-day). The variability in the number of spawning events and egg catch-rates may be related to differences in discharge between years; 2001 was the second lowest discharge event recorded since the early 1960's.

Population Status

Historic abundance of white sturgeon within the CCP is not known. Grant, Chelan, and Douglas PUDs are currently gathering information on white sturgeon in the Columbia River, within the CCP, as required by existing licenses and re-licensing for their hydroelectric facilities.

In Wanapum Reservoir, Golder Assoc. (2003a in GCPUD 2003a) estimated the population at 351 (95% CI: 314-1,460) based on mark and recapture studies between 1999 and 2001. In the Rocky Reach Reservoir, Golder Assoc. (2003 b in GCPUD 2003a) estimated the population at 47 (95% CI: 23-237). There are no estimates for Rock Island Reservoir, and Douglas PUD is still collecting information for Wells Reservoir (S. Bickford, pers. comm.,).

While estimates of abundance have been obtained within the last few years in various sections of the Columbia River, baseline information is not available to determine if the population(s) are stable, increasing, or decreasing. However, it is reasonable to assume that the construction of the hydroprojects on the mainstem Columbia has significantly altered the population structure, and potentially the productivity of the white sturgeon population.

Population Management

Hatchery

Currently WDFW manages sturgeon solely through sport fishing regulations. No supplementation programs are present in the UMM. Sturgeon abundance has declined substantially since the Hydroelectric Dams were constructed. This decline is attributed to changes in fluvial characteristics of the river habitat and because the dams physically prevent movement up and down the river, precluding anadromy.

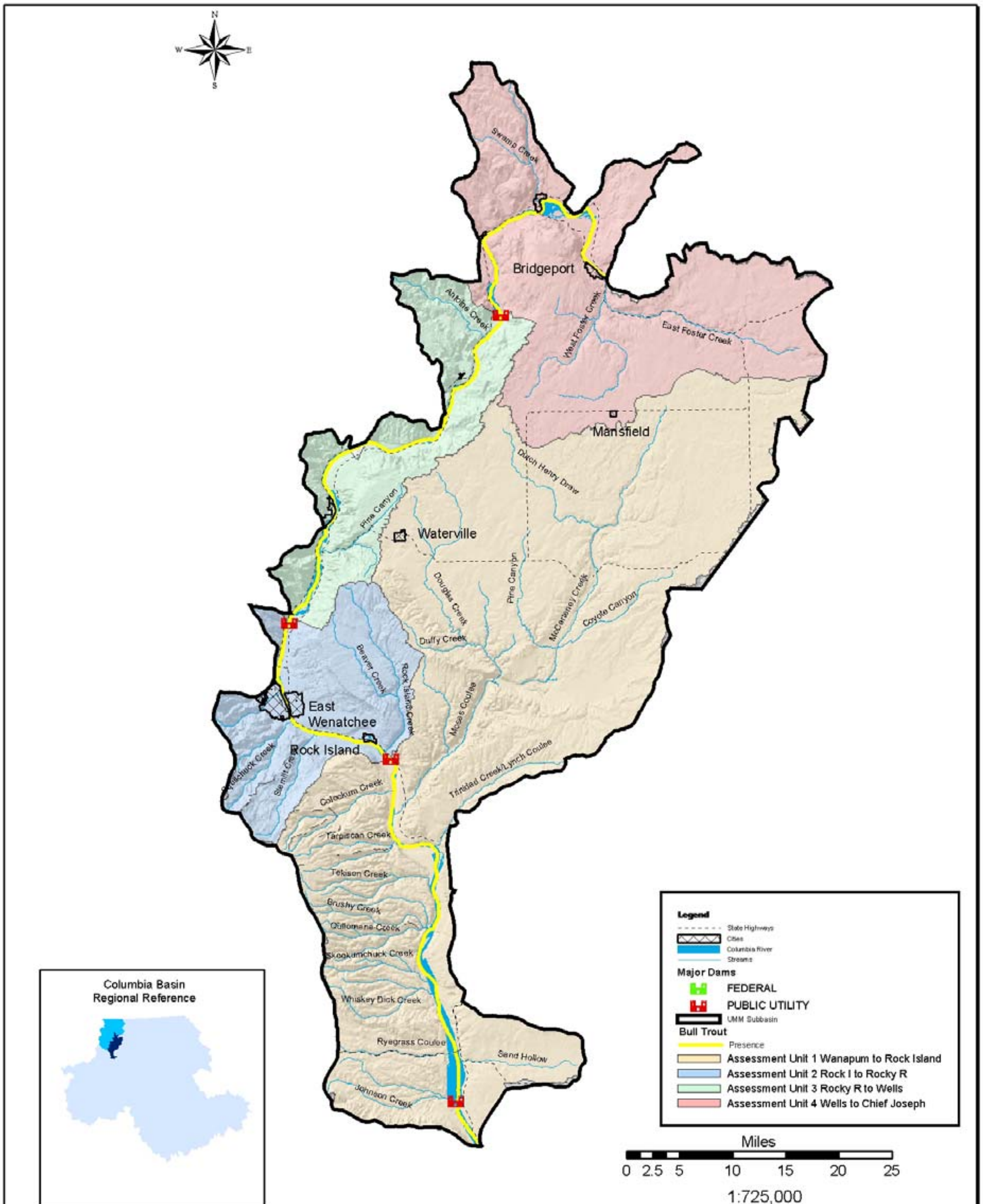
Sonic tagging studies shows that white sturgeon is mostly inactive from late fall to spring (Golder Associates 2003a, 2003b). Spawning migration in the Wanapum Reservoir occurred between April and June. Since the dams limit movement, no large movements are believed to occur between reservoirs of the UMM. Juvenile white sturgeon appears to migrate downstream during winter and early spring, the movements are thought to be primarily an attempt to migrate down river to the ocean (Golder Associates 2003CPa).

Hydroelectric

White sturgeon distribution has been affected by construction of Columbia River dams. What was believed to be a relatively continuous population, traveling throughout the Columbia River below barriers, is now a number of potentially disjunct populations between hydroelectric projects with only downstream movement of individuals. The biggest influence on the white sturgeon population(s) in the UMM Subbasin is the apparent upstream migratory blockage caused by the hydropower dams. As previously mentioned, this may be limiting the normal migratory ecotype and potentially affecting the productivity of the independent population(s) that occur in the UMM Subbasin.

Fish Species of Interest: Bull Trout

The Columbia River, from the Pacific Ocean at river kilometer (Rkm) 0 [river mile (Rm) 0] to Chief Joseph Dam at Rkm 877 (Rm545.1), has been proposed as critical habitat for the Columbia River Distinct Population Segment (DPS) of bull trout. Bull trout occur in greatest numbers in the upper Columbia River section of the proposed critical habitat reach where populations are larger and suitable conditions for foraging, overwintering, and migration occur (Figure 28).



(DCTLS 2004)

Figure 28 Bull trout distribution in the UMM Subbasin, WA.

Population Characterization and Habitat Relationships

Historically, there were most likely three life histories (or ecotypes) of bull trout within the CCP (adfluvial, fluvial, and non-migratory), with distribution and population levels dictated by temperature and gradient (Mullan et al. 1992a).

Distribution

Bull trout once filled most every cold-water niche in the tributaries of the CCP, except were the presence of natural barriers such as waterfalls or small stream size blocked access to headwater streams. While historic distribution in the CCP is difficult to determine (Rieman et al. 1997), The Columbia River, between Wanapum and Grand Coulee dams was likely a migration corridor, overwintering habitat, and foraging area for fluvial bull trout that spawned in the major tributary systems (BioAnalysts 2002a, b; FWS 2002; Brown 1992). Bull trout are believed to have been present in the, Methow, Lake Chelan, Entiat, Wenatchee, and possibly Okanogan river basins (Mongillo 1993, Brown 1992).

The FWS's Upper Columbia Recovery Unit Team (UCRUT) identified three independent populations of bull trout currently in the CCP. These core populations include the Wenatchee, Entiat, and Methow Rivers and their tributaries (FWS 2002). Based on survey data and professional judgment, the UCRUT also identified subpopulations of bull trout within each core area: six subpopulations in the Wenatchee, two in the Entiat, and eight in the Methow.

There is considerable evidence that bull trout use the UMM for foraging, overwintering, and migration. In recent years, a large number of migratory adults have been observed moving through the fish ladders at Rock Island, Rocky Reach, and Wells dams. Current radiotelemetry and radiotagging studies show that bull trout use the Columbia River during fall, winter, and spring and move to and from the Columbia River and tributaries, upstream and downstream within the Columbia River, and overwinter throughout the Columbia River from an area upsteam of Wells Dam (Bioanalyst 2002) to an area near Wanapum Dam (T. Dresser, pers. comm., 2001 in FWS 2004).

Age Structure

Bull trout normally reach sexual maturity in 4 to 7 years (reviewed in Platts et al. 1993) and feed on macroinvertebrates, crayfish, and juvenile salmon (FWS 2004). The size and age of bull trout at maturity depends upon life-history strategy (Platts et al. 1993). Non-migratory fish are usually smaller than migratory populations and may live up to 20 years (, Brown 1992, Mullan et al. 1992a).

Within the CCP, Mullan et al. 1992 report some populations that did not mature until 9 years of age in the Methow Basin. They found that headwater male bull trout (potentially non-migratory ecotype) in the Methow River began to mature at age 5, and were all mature by age 6. Females from the same area began to mature at age 7 and were all mature by age 9. Brown (1992) found that most migratory bull trout within the Wenatchee River basin were between 5 and 7 years old. The bull trout that Mullan et al. (2002b) found that did not mature until 9 years of age are the oldest (at first maturity) reported within the literature. The oldest bull trout sampled in the Methow River was 12 years (Mullan et al. 1992b).

Migration

Studies show patterns of long distance migrations (>225 km or 140 miles round trip), and extended over-wintering use (>6 months) of the Columbia River. Migrations of bull trout between the Columbia River and the Wenatchee, Entiat, and Methow rivers have been documented (FWS 2001, 2002, CCPUD 2002, BioAnalysts 2001). Bull trout have also been collected in the juvenile fish passage facilities at Rocky Reach and Rock Island dams (Fish Passage Center, *in litt.*).

A 3-year radio telemetry study was initiated in 2001 (BioAnalysts 2002a, b, 2003) to track bull trout movement within the CCP. A total of 79 bull trout were tagged in 2001 and 2002 (15, 45, and 19 fish at Rock Island, Rocky Reach, and Wells dams, respectively) during May and June. All of the tagged fish, despite their release location, migrated into the Wenatchee, Entiat, or Methow rivers, by the beginning of August, although most entered in June and July. Only one fish entered the Okanogan River; where it stayed briefly, then swam back downstream and entered the Methow River.

After entering tributaries, most bull trout remained there until October-November, when they migrated back to the Columbia River (BioAnalysts 2002a, b, 2003). This time period overlapped with spawning timing (see below) and most fish were presumed to have spawned within the tributary areas that they were in during August through October.

Once fish exited the tributaries, they migrated various distances both up- and downstream of the tributary confluences. Some bull trout held near the hatchery outfall at Wells Hatchery. Since temperatures were not greatly different from ambient Columbia River temperatures, it is assumed that fish were occupying this area for feeding opportunities, instead of seeking thermal refugia (BioAnalysts 2003, 2002).

As previously indicated, most bull trout pass counting windows at dams on the Columbia River during May and June (CCPUD, unpublished data, 2001). Diel timing of migration at the dams indicates that fish pass primarily during day light hours.

Migratory juveniles usually rear in natal streams for 1-4 years before emigration (Pratt 1992, Fraley and Shepard 1989, Goetz 1989). Methow Subbasin juvenile bull trout rear in the coldest headwater locations until they reach a size that allows them to compete with other fish (75-100 mm; Mullan et al. 1992b). Non-migratory forms above barrier falls probably contribute a limited amount of recruitment downstream, nevertheless, this recruitment contributes to fluvial and adfluvial productivity. The fluvial forms (e.g., Twisp River, Wolf Creek) migrate to the warmer Methow and Columbia rivers, while the adfluvial populations (e.g., Lake Creek, Cougar Lake) migrate to nearby lakes.

McPhail and Murray (1979) suggested two migration periods for juvenile bull trout: a spring migration of newly emerged fry, and a fall migration of larger age 1+ and 2+ fish. These fish may be migrating because of high flows (in the spring), or survival (thermal refugia) in the fall, which may be different than the “smolt” behavior of migratory fluvial or adfluvial fish. At Columbia River dams within the CCP, very low numbers of juvenile bull trout pass between April and August, primarily in June (CCPUD, unpublished data, 2001).

Spawning

Bull trout spawn between August and November in streams with cold, unpolluted water, clean gravel, cobble substrate, gentle stream slopes, and water temperatures ranging from 5-9 °C (Reiman and McIntyre 1993). Spawning areas are commonly associated with cold-water streams or areas where stream flow is influenced by groundwater. All bull trout life stages are associated with complex forms of cover including large woody debris, undercut banks, boulders, and pools.

Population Status

In the state of Washington, reductions of bull trout have primarily occurred in the eastern part of the state. It is unclear how many bull trout used the Columbia and Snake rivers, but fish are still observed in counting windows of dams, primarily in the Columbia, upstream of the confluence of the Snake (Rieman et al. 1997).

Rieman et al. (1997) listed 144 watersheds within the "Northern Cascades" that had bull trout present. Their classification of Northern Cascades includes watersheds south of the CCP, including the Yakima, White Salmon, and Kickitat basins. This is almost 50% of potential historic range, using their criteria. While this complicates their assessment of the streams within the CCP, they state that within the Northern Cascades, 10 populations are "strong," 22 are depressed, 90 were of unknown status, and 22 were transient (i.e., the watershed was used mostly as a migratory corridor; Rieman et al. 1997).

Estimates of abundance specific to the CCP were not available until recent years through redd counts (begun in the 1980s in the Wenatchee and Entiat basins, and the 1990s in the Methow Basin), and Columbia River dam counts. Since non-migratory fish are difficult to enumerate, all estimates of current abundance should be considered underestimates of the true population size of bull trout within the CCP. This is based on the belief that "non-migratory" fish are most likely contributing to the "migratory" populations, and potentially vice versa, although there may not be very many non-migratory bull trout populations within the CCP (MacDonald, pers. comm., in Peven 2003, Archibald and Johnson 2002).

Prior to 1998, fish counts at Rock Island and Rocky Reach dams did not differentiate bull trout from other resident trout. Since then, bull trout counts at Rock Island Dam have averaged 126, while at Rocky Reach and Wells dams, the fishway counts have averaged 250 and 120 bull trout, respectively. Bull trout counts have been lower at Rock Island Dam than at Rocky Reach Dam in all years from 1998 through 2002. This may be occurring because the major spawning areas are upstream of Rocky Reach Dam (Entiat and Methow basins), and only one between Rock Island and Rocky Reach (Wenatchee River).

Recent comprehensive redd surveys, coupled with preliminary radio telemetry work suggest that remaining spawning populations are not complete "genetic isolates" of one another, but rather co-mingle to some degree (Foster et al. 2002). Recent telemetry studies suggest that fluvial bull trout migrate between subbasins within the CCP (FWS 2002b, 2001). It is possible that there are separate, local spawning aggregates, but more monitoring and DNA analysis is necessary to be able to empirically determine this. Any independent subpopulations would most likely be found in headwater areas, upstream of barriers, within each subbasin. The barriers prevent immigration from downstream recruits, but not necessarily emigration to downstream areas during occasional high water events.

Population Management

Hydroelectric

While there are no physical barriers between each of the major tributaries and the Columbia River, the nine Columbia River dams may inhibit upstream migration and downstream passage of bull trout. These structures are equipped with passage facilities designed and operated primarily for upsteam and downstream passage of anadromous salmonids and not specifically for bull trout; therefore their degree of impact is uncertain. In the Upper Columbia, it appears bull trout move upstream and downstream between dams and tributaries without affecting the ability of the bull trout to reach spawning grounds (BioAnalysts 2002a, b, 2003). Bull trout have been observed in the fish ladders at Bonneville (Sprague, *in litt*.) and The Dalles dams (R. Cordie, pers. comm., in FWS 2004). Bull trout have never been officially recorded on Corps fish ladder counts even though fish counters may have observed them. Past records at the Lower Columbia River dams may not accurately represent bull trout passage because adult fish counts and juvenile fish monitoring ceased after October 31 and fish counters have not been instructed to record bull trout sightings. Bull trout have been observed passing the fish ladders at Wanapum, Rock Island, Rocky Reach, and Wells dams. These bull trout have been observed passing at similar or lower rates compared to salmon and steelhead through the ladders (Chuck Peven, pers. comm., in FWS 2004).

Downstream passage for juvenile anadromous fish is provided by fish passage facilities, by spilling water over dam spillways, or traveling through the powerhouse. Bonneville, John Day and McNary dams have fish screen and bypass facilities for juvenile anadromous salmonids. The Dalles Dam turbines are not screened and fish pass the dam through an ice-trash sluiceway. Fish pass the Upper Columbia projects via the spillways or similar passage devices. Wells Dam uses a hydrocombine which incorporates a spillway above the powerhouse. During the summer, fish that are collected at juvenile fish facilities at McNary Dam are transported by barge or truck and released at a site downstream from Bonneville Dam. It is uncertain if the juvenile fish facilities are effectively passing bull trout because these structures were designed for juvenile anadromous salmon and steelhead (FWS 2004). Only one bull trout has been officially recorded at the juvenile fish facilities at the Lower Columbia River dams. The fish was captured at the John Day Dam Smolt Monitoring Facility in May 2002 (R. Cordie, pers. comm., in FWS 2004). There is also a possibility that bull trout have not been recorded properly in the past at some of the smolt monitoring projects on the mainstem Snake and Columbia Rivers. Small numbers of juvenile and adult bull trout have been collected at the Rock Island Dam Smolt Monitoring Facility and at the Rocky Reach Dam surface collector (Fish Passage Center, *in litt.*).

While juvenile fish passage facilities were not specifically developed for the downstream passage of larger fish such as migrating steelhead kelts or adult bull trout, most systems have not shown injury or mortality to these life stages. However, a 40 to 50% injury rate has been measured in some years to adult salmonids passing through the juvenile fish bypass system at McNary Dam (Wagner and Hilson 1993, Wagner 1991). The overall efficiency of adult salmonids, including bull trout, passing through juvenile bypass facilities and spill has not been thoroughly examined (FWS 2004).

On December 20, 2000, the FWS issued a biological opinion to the Corps, BPA, and BOR (Action Agencies) on the effects of the Federal Columbia River Power System (FCRPS) on threatened and endangered species and their critical habitat. The four federal Lower Columbia

River dams are presently operating under this opinion, which includes four reasonable and prudent measures (RPM) to reduce the take of bull trout associated with operation of these projects. The RPMs are directed at determining the presence of and extent of bull trout use of the lower Columbia River within the FCRPS area, ensuring that bull trout passage is not impeded at FCPRS dams, preventing adverse impacts caused by FCPRS operations such as fish stranding, and reducing total dissolved gas caused by spilling at FCRPS dams to state standards. To implement the RPM's, the Action Agencies are required to do the following: 1) Count and record bull trout observed at the FCRPS lower Columbia River dams and those captured in field studies funded by the Action Agencies; 2) Cooperate in studies to determine the movements of bull trout from the Hood River and other tributaries into Bonneville Reservoir, to evaluate fluvial bull trout in the Klickitat River and potential habitat use in the White Salmon River following removal of Condit Dam; 3) Begin studies of the effect of flow fluctuations caused by FCRPS operations on bull trout or their prey 4) Initiate studies to determine the use and suitability of bull trout habitat in the lower Columbia River; 5) Investigate and implement, if appropriate, ways to reduce total dissolved gas production at FCRPS dams. These terms and conditions are directed to impacts on bull trout at the Lower Columbia River dams and do not specifically address habitat needs of bull trout in the Columbia River.

Conservation Actions

A number of federal, state, local, and tribal agencies and organizations are currently working on various programs, plans, and projects to protect and restore bull trout populations in the Columbia River Basin. Federal conservation actions include: (1) the development of the draft Bull Trout Recovery Plan (FWS 2002); (2) ongoing implementation of the Interim Strategy for Managing Anadromous Fish-producing Watersheds in Eastern Oregon and Washington, Idaho, and Portions of California (USFS and BLM [PACFISH] 1994b) and the Interim Strategy for Managing Fish-producing Watersheds in Eastern Oregon and Washington, Idaho, Western Montana and Portions of Nevada (INFISH 1995); (3) ongoing implementation of the Northwest Forest Plan (USFS and BLM 1994a); (4) ongoing implementation of the Northwest Power and Conservation Council, Fish and Wildlife Program targeting subbasin planning; (5) ongoing implementation of the Federal Caucus Fish and Wildlife Plan; and, (6) ongoing implementation of Department of Agriculture Conservation Reserve Programs.

Conservation actions by the State of Washington include: (1) establishment of the Salmon Recovery Act (ESHB 2496) and Watershed Management Act (ESHB 2514) by the Washington State legislature to assist in funding and planning salmon recovery efforts; (2) abolition of a brook trout stocking in streams or lakes connected to bull trout-occupied waters; (3) changing angling regulations in Washington prohibit the harvest of bull trout, except for a few areas where stocks are considered "healthy"; (4) collecting and mapping updated information on bull trout distribution, spawning and rearing areas, and potential habitat; and, (5) adopting new emergency forest practice rules based on the "Forest and Fish Report" process. These rules address riparian areas, roads, steep slopes, and other elements of forest practices on non-federal lands.

Many Tribes throughout the range of the bull trout are participating on bull trout conservation working groups or recovery teams in their geographic areas of interest. Some tribes are also implementing projects that focus on bull trout or that address anadromous fish but benefit bull trout (e.g., habitat surveys, passage at dams and diversions, habitat improvement, and movement studies).

Three of the Mid-Columbia River hydroelectric projects, Wells, Rocky Reach, and Rock Island, have requested FERC to include in their licenses HCPs under Section 10 of the ESA. Parties to these HCPs include the Chelan and Douglas county PUDs, the NMFS, FWS, WDFW and the Colville Tribes. This HCP includes operations and measures to address all anadromous fish that occur upstream of Rock Island Dam (not just ESA listed species). Bull trout will likely benefit from these HCPs, even though dam protection measures and habitat improvements are directed toward anadromous fish.

Ecologic Effects/Relationships (at subbasin scale)- Limiting Factors

The Upper Columbia DPS of bull trout was listed as threatened under ESA on June 10, 1998 (63 FR 31647). In the draft recovery plan (FWS 2002a), bull trout were grouped into DPSs, recovery units, core areas or local populations (see above). They defined core areas as composed of one or more local populations, recovery units are composed of one or more core areas, and a distinct population segment is composed of one or more recovery units. The manner in which bull trout were grouped in the recovery plan represents an adaptive comparison of genetic population structure and management considerations.

4.1.5 Limiting Factors

Five Dams are located within the UMM Subbasin: Wanapum, Rock Island, Rocky Reach, Wells, and Chief Joseph. These dams are run-of-the-river hydroelectric facilities and have no significant water storage capacity (CCPUD 2003). All of the projects except Chief Joseph Dam incorporate features to assist fish in their upstream and downstream passage. Three ladders assist adult fish on their return upriver to spawning grounds in the Columbia River tributaries.

At Rock Island, testing of conventional turbine intake screens at the First Powerhouse occurred between 1992 and 1995. Testing was suspended after researchers concluded that high intake velocities were trapping some juvenile fish against the screens, causing injuries and death. Now, shallow spills are being used to meet the survival standards of the HCP. Openings or notches have been installed in nine spillgates (CCPUD 2003).

Extensive monitoring occurred in 1999 for total dissolved gases in the tailrace at Rock Island. Waterways Experimental Station, a division of the U.S. Army Corps of Engineers, placed monitors in the water in numerous locations to take readings on total dissolved gases. This was designed to help biologists and engineers determine whether operational changes for spill can reduce total dissolved gas levels or if the placement of abatement structures, such as concrete deflectors that reduce the depth that spill plunges to in the tailrace, are required (CCPUD 2003).

A combination of factors have negatively impacted the viability of focal species and species of interest within the UMM Subbasin. These include, residential development and urbanization, road construction and maintenance, mining, grazing, hydropower development and water diversions, forest management, fish management (hatcheries and harvest regulations); entrainment (process by which aquatic organisms are pulled through a diversion or other device) into diversion channels, and exotic species. The affects of these actions is to degrade and fragment fish and wildlife habitat, and block fish passage.

Hatchery

General

The only direct Columbia River releases of hatchery fish between the Wanapum Dam forebay and the Chief Joseph Tailrace occur from the Turtle Rock Ponds near Rocky Reach Dam and at Wells Hatchery immediately downstream of Wells Dam. Competition between hatchery and wild juveniles may occur where food and space requirements overlap. Impacts may be highest at hatchery release sites where large concentrations of hatchery fish can overwhelm the capacity of the immediate environment (CCPUD 1998). Impacts are assumed to diminish downstream as the hatchery fish disperse. The impact from large releases of hatchery fish on wild fish may be exacerbated by hatchery fish deficiencies in foraging and habitat selection behaviors. Thus, competition may drop as the hatchery fish disperse, adapt to their environment and learn to forage for natural food. Little data exists for evaluating adverse behavior effects of hatchery fish on wild fish in the Columbia basin, however one study presents evidence that larger hatchery juvenile Chinook pulled smaller wild Chinook with them as they migrated downstream (CCPUD 1998, BPA et al. 1994) and resulted in excessive predation by other fish on the smaller wild Chinook.

Increased migration time caused by the reservoirs could increase competition for available food supply between emigrating juvenile hatchery and wild Chinook and expose Chinook to increased predation, particularly by northern pike minnow. Predation risks to hatchery Chinook juveniles posed by coho, steelhead, and other Chinook stocks are unknown (SIWG 1984). Large concentrations of migrating hatchery fish may attract predators (e.g., birds, fish, and seals) and consequently contribute indirectly to predation of listed wild fish (Steward and Bjornn 1990). The presence of large numbers of hatchery fish may also alter wild salmonid behavioral patterns, potentially influencing their vulnerability and susceptibility to predation.

Differences in release timing for hatchery stocks could diminish competition (CCPUD 1998). Hatchery releases of summer/fall Chinook may also have positive ecologic impacts on other species. Increased numbers of Chinook and other salmonid species that escape to spawn in upper Columbia River tributaries may contribute nutrients to the system upon dying. In addition, releasing a mass of summer/fall Chinook juveniles from a WDFW hatchery may benefit co-occurring wild salmonid populations by overwhelming established predator populations.

Summer / Fall Chinook

Chapman et al. (1994a) estimated that only about 6 percent of the summer and fall run fish are of hatchery origin. There are no known genotypic, phenotypic, or behavioral differences between the hatchery stocks and natural stocks in the target area.

The ocean-type Chinook salmon in the UMM is one of the most electrophoretically homogenous populations in the state (BAMP 1998). Ocean-type Chinook in the region are genetically distinct from lower Columbia River ocean-type populations (Myers et al. 1998). Hatchery manipulations, post-GCFMP and in recent years, have lead to the mixing of summer/fall Chinook from various parts within the upper Columbia River region (Chapman et al. 1994b). This mixing, and/or homogenization that occurred through the GCFMP, may be responsible for the inability of electrophoretic analysis to differentiate among components of the Upper Columbia River summer/fall Chinook ESU (Chapman et al. 1994b).

The collection of summer/fall Chinook from the Wenatchee and Methow/Okanogan natural runs for use as broodstock is not expected to adversely affect the population status of the natural population relative to critical and viable thresholds. The effects of the broodstock collection program on the timing of spawning and on the composition of the spawning population (e.g., hatchery versus wild origin, age class distribution, sex ratios) are presently unknown, but are being determined through monitoring and evaluation projects underway. The percentage of non-indigenous stocks incorporated into the hatchery programs has been low (about 3 % of the over 200 million ocean-type Chinook propagated since 1941), and does not appear to have had a significant impact on the genetic integrity of the ESU (Chapman et al. 1994b, Myers et al. 1998).

There are, however, some uncertainties in the incubation and rearing protocols. Subbasin planners are unsure whether the release of ocean-type Chinook salmon into the tributaries impose deleterious ecological effects upon natural fish and whether the increasing incidence of "reservoir-reared" juveniles (Petersen and Murdoch 1998) is related to or simply because of changes in river hydrology from hydroelectric development.

Hydroelectric

Salmon and Steelhead

Salmon and steelhead migrating through the UMM are affected by mid-Columbia PUD project operations. The projects are operated as run-of-the-river facilities, with reservoirs that have rapid flushing rates and no thermal stratification during summer. Rapid water exchange and steep, sparsely vegetated shorelines limit juvenile steelhead rearing habitat. Transformation of the Columbia River into a series of reservoirs also altered the food webs that support juvenile salmonids and steelhead. Food available in the UMM reservoirs typically provides lower amounts of energy levels than that found in free-flowing areas such as the Hanford Reach (MCMCP 1995). Reduced productivity in the reservoir may affect feeding efficiency of fishes (Rondorf and Gray 1987).

Migrating juvenile salmonids and steelhead are also exposed to predation as they migrate through the UMM. Changes in physical habitat, water quality, and downstream passage conditions because of construction and operation of hydropower facilities have combined to increase the abundance of predators and the risk of juvenile outmigrant mortality because of predation (Chapman et al. 1994a). Studies of upriver migration confirm that hydro projects do not delay the return trip of adult salmon to their spawning grounds (CCPUD 2003).

Summer/Fall Chinook

Grant County PUD, through a contract with Battelle examined how summer/fall Chinook salmon and their habitat are influenced by the operation of the Priest Rapids Project (PRP) on the mid-Columbia River over a 3-year period (GCPUD 2003b). The research encompassed all aspects of the freshwater life stages of summer/fall Chinook salmon that take place within the PRP area (i.e., Columbia River from Priest Rapids Dam upstream to the tailrace of Rock Island Dam).

Specific research efforts related to the juvenile life stages included abundance, distribution, growth, and production, microhabitat use and availability, and survival studies. Adult life stage efforts included escapement and spawning in 2000, 2001, and 2002, spawning activity versus daylight and flow below Wanapum Dam, spawning habitat suitability in the Wanapum Dam tailrace and Priest Rapids Pool, and feasibility of monitoring fallback at Priest Rapids Dam using an acoustic camera.

The findings of the study show that juvenile sub-yearling Chinook salmon are produced in, rear in, and pass through the PRP, primarily rearing in the Wanapum Pool. The abundance of sub-yearling Chinook salmon, typically increased from mid-March through late May and then declined in June as the fish grew larger and moved offshore.

Chinook salmon in the PRP tend to use relatively shallow, warm, slow areas along the river/reservoir margins (e.g., island and bar areas, and sloughs) for early rearing habitat. The total area of the PRP that was suitable for early rearing habitat for sub-yearling Chinook was between 352 and 472 ha., and decreased with increasing discharge. At median discharge (Q50 = 154 kcfs), 2.93 percent of the area in Wanapum Pool was classified as suitable habitat for early rearing sub-yearling Chinook salmon.

Survival of sub-yearling Chinook salmon was determined for Wanapum and Priest Rapids dams by releasing paired replicates of PIT-tagged hatchery-origin sub-yearling Chinook salmon in 2001 and 2002.The survival of PIT-tagged sub-yearling Chinook salmon passing Wanapum Dam was 90 percent in 2001 and 93% in 2002 (GCPUD 2003a). In 2001 and 2002, PIT tags from this study were recovered from a tern colony on Solstice Island in Potholes Reservoir, 56 (64% from Wanapum Dam forebay releases) and 22 (no obvious trend relative to release location) respectively. Sixty-four percent of the 2001 tags were from releases made in the Wanapum Dam forebay.

Thirty-five redds were estimated to be constructed by fall Chinook salmon in a deepwater (9 to 11m) spawning area in the center of the river channel downstream of the railroad trestle (rkm 663) in 2001 and an estimated 66 redds were located in two deep water spawning areas in 2002. No redds were observed in 2000 or 2001 in the Rock Island Dam tailrace area. The use of side channels by spawning adult fall Chinook salmon was higher in 2000 and 2002, when mean daily discharge and escapement were higher than in 2001.

Pacific Lamprey

The study of adult lamprey migration patterns past dams and through reservoirs in the lower Columbia River have provided the first data sets on lamprey passage timing, travel times, and passage success at hydroelectric projects (Moser et al. 2002a, Moser et al. 2002b, Ocker et al. 2001, Vella et al. 2001). These studies have shown that approximately 90% of the radio-tagged lamprey released, migrate upstream and get detected at Bonneville Dam; however, less than 50% of the lamprey which encounter an entrance actually pass the dam. The primary reasons for relatively poor passage success are thought to be the lack of appropriate attachment sites in the high velocity areas and the high intensity lighting used at counting stations. Other factors that may affect passage include degree of sexual maturity in migrants, water flow velocities over 2 m/s, and fishway channel configuration and structure.

In the studies conducted at Priest Rapids Dam, radio-tagged lamprey passage success rates of 30% and 70% occurred in 2001 and 2002, respectively. At Wanapum Dam, radio-tagged lamprey passage success rates of 100% and 51% occurred in 2001 and 2002, respectively. A large proportion of lamprey never entered the fishway (Nass et al. 2002 in GCPUD 2003a).

Bull Trout

The nine Columbia River dams may inhibit upstream and downstream movement of bull trout in the Columbia River. However, the extent to which some of these structures inhibit bull trout migrations is unknown. Recent data suggests that bull trout move upstream at similar rates as anadromous salmonids (Chuck Peven, pers. comm., in FWS 2004).

Harvest

Estimation of recent, past harvest rates for summer/fall Chinook originating in the region is complicated by changes in timing of the adult return of the Wells Hatchery group. As a consequence, Chapman et al. (1994b) used only one brood year (1977) as the base for estimating preterminal exploitation rates for all subsequent brood years. The recent past (1975-87) mean exploitation rate for Wells Hatchery-origin summer/fall Chinook was estimated by Chapman et al. (1994b) to be about 40 %. The 1982-89 brood year average ocean fisheries exploitation rate is 39 %, with a total exploitation rate of 68 % estimated for the same years (Myers et al. 1998). Given fishery protection measures implemented in the preterminal area, Columbia River, and upper river tributaries to protect ESA-listed and depressed salmonid populations, future harvest rates on fish propagated by the program and on natural populations in the target area are expected to be lower than the mean level (40 %) estimated for the 1975-87 period. Ceremonial and subsistence fisheries by the Colville Tribe in waters upstream of Rock Island Dam (mainly at the base of Chief Joseph Dam) harvest an average of 800 summer/ fall Chinook adults each year (1987-92 data from Chapman and al. 1994b).

4.2 Environmental Conditions

4.2.1 Introduction

The process used to develop fish and wildlife assessments and management plan objectives and strategies is based on the need for a landscape level holistic approach to protecting the full range of biological diversity at the Ecoregion scale with attention to size and condition of core areas (subbasin scale), physical connections between core areas, and buffer zones surrounding core areas to ameliorate impacts from incompatible land uses. As most fish and wildlife populations extend beyond subbasin or other political boundaries, this “conservation network” must contain habitat of sufficient extent, quality, and connectivity to ensure long-term viability of obligate/focal fish and wildlife species. Subbasin planners recognized the need for large-scale planning that would lead to effective and efficient conservation of fish and wildlife resources.

In response to this need, Ecoregion planners approached subbasin planning at two scales. The landscape scale emphasizes focal habitats and associated species assemblages that are important to Ecoregion wildlife managers while specific focal habitat and/or species needs are identified at the subbasin level.

Ecoregion and subbasin planners agreed with Lambeck (1997) who proposed that species requirements (umbrella species concept) could be used to guide ecosystem management. The main premise is that the requirements of a demanding species assemblage encapsulate those of many co-occurring less demanding species. By directing management efforts toward the requirements of the most exigent species, the requirements of many cohabitants that use the same habitat type are met. Therefore, managing habitat conditions for a species assemblage should provide life requisite needs for most other focal habitat obligate species.

Ecoregion/subbasin planners also assumed that by focusing resources on selected terrestrial (riparian wetland, herbaceous wetland, shrub-steppe) and aquatic (Columbia River and small tributaries) habitats, the needs of most listed and managed fish and wildlife species dependent on these habitats would be addressed during this planning period.

4.2.2 Terrestrial/Wildlife Habitat

Wildlife Habitat Assessment Methods

The wildlife assessment was developed from a variety of "tools" including subbasin summaries, the Interactive Biodiversity Information System (IBIS), WDFW Priority Habitats and Species (PHS) database, Washington GAP Analysis database, Partners in Flight (PIF) information, National Wetland Inventory maps, Ecoregion Conservation Assessment (ECA) analyses, and input from local state, federal, and tribal wildlife managers. Specific information about these data sources is located in Appendix A of Ashley and Stovall (2004).

Interactive Biodiversity Information System (IBIS)

IBIS is an informational resource developed by the Northwest Habitat Institute (NHI) to promote the conservation of Northwest fish, wildlife, and their habitats through education and the distribution of timely, peer-reviewed scientific data.

IBIS contains extensive information about Pacific Northwest fish, wildlife, and their habitats, but more noteworthy, IBIS attempts to reveal and analyze the relationships among these species and their habitats. NHI hopes to make the IBIS web site a place where students, scientists, resource managers or any other interested user can discover and analyze these relationships without having to purchase special software (e.g. geographic information systems) or hassle with the integration of disparate data sets. IBIS will, however, provide downloadable data for users who desire to perform more advanced analyses or to integrate their own data sets with IBIS data. Finally, NHI sees IBIS not only as a fish, wildlife, and habitat information distribution system but also as a peer-review system for species data. NHI acknowledges that in a system as extensive as IBIS, there are going to be errors as well as disagreement among scientists regarding the attributes of species and their relationships. NHI encourages IBIS users to provide feedback in order to correct errors and resolve discrepancies.

The IBIS web site is in the early stages of development, however, NHI staff, with the support of many project partners, has been developing the data for over five years. The IBIS database was initially developed by NHI for Oregon and Washington during the Wildlife-Habitat Types in Oregon and Washington project. IBIS data is currently being refined and extended to include all of Idaho, Oregon, Washington, and the Columbia River Basin portions of Montana, Nevada, Utah and Wyoming. IBIS will eventually include species range maps, wildlife-habitat maps, extensive species-habitat data queries, and interactive wildlife-habitat mapping applications allowing dynamic spatial queries for the entire Pacific Northwest as previously defined.

Although IBIS is a useful assessment tool for some purposes, the current IBIS wildlife habitat maps have a minimum polygon size of 250 acres (O'Neil, pers. comm., 2003 in Ashley and Stovall, unpub. rpt., 2004). This polygon size results in under representation of linear aquatic, riparian, wetland, subalpine, alpine habitats and small patchy habitats that occur at or near the canopy edge of forested habitats. It is also likely that microhabitats located in small patches (e.g., herbaceous wetlands) or narrow corridors were not mapped at all. However, relatively continuous habitat types or fragmented habitats that occur in large blocks are better represented (e.g., shrubsteppe, agriculture). The historic IBIS wildlife habitat maps with a minimum polygon size of 1 km^2 are even more limited in accurately representing habitats that are located in small patches or narrow corridors. Habitat types that may be substantially underrepresented on these maps include herbaceous wetlands, montane coniferous wetlands, interior riparian wetlands, upland aspen forest, alpine and subalpine habitats, and small aquatic habitats such as lakes, rivers, and ponds (O'Neil, pers. comm., 2003 in Ashley and Stovall, unpub. rpt., 2003).

Another limitation of IBIS data is that they do not reflect habitat quality nor do they associate habitat elements (key ecological correlates [KECs]) with specific areas. As a result, a given habitat type may be accurately depicted on IBIS map products, but may be lacking quality and functionality. For example, IBIS data do not distinguish between shrubsteppe habitat dominated by introduced weed species and pristine shrubsteppe habitat.

Planners recognized the assumptions and limitations of the IBIS analysis. For those habitat types that are well represented, the data provide a good indication of the trends in habitat abundance and distribution from the historic to current condition (e.g., shrubsteppe) and IBIS data was used in the Assessment. Where IBIS data was most suspect of under representing habitat types, habitat quantifications were describes as "unknown" or alternate sources of data were used.

Washington State GAP

Washington State GAP data were 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.

Ecoregion Conservation Assessment (ECA)

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

Vegetation Zones

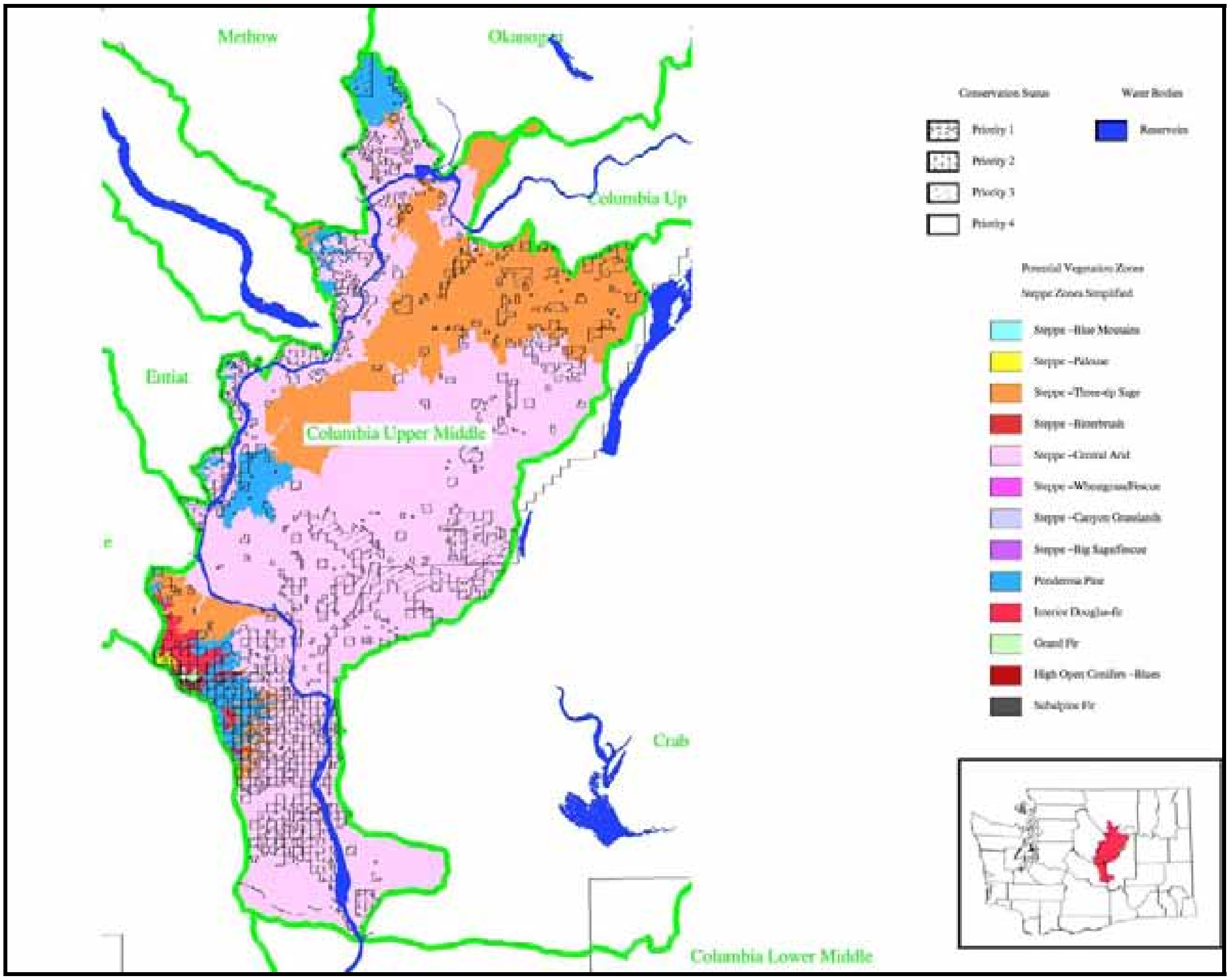
Cassidy (1997) identified seven historic (potential) vegetation zones that occur within the Subbasin (**Table 14**). The three-tip sage and central arid steppe vegetation zones are described in detail in Ashley and Stovall (unpub. rpt., 2004). These vegetation zones constitute focal habitat types. Alpine parkland, grand fir, ponderosa pine and Douglas fir are not focal habitat types, but occur in the far western portion of the Subbasin.

Vegetation zone status is summarized in Table 14. An estimated 18 percent of central arid steppe and 6 percent of three-tip sage has been lost to agriculture. Similarly, 2 percent of the ponderosa pine vegetation zone has been converted to agriculture.

Table 14 Historic and current extent of GAP vegetation zones in the UMM Subbasin, WA.

Status	GAP Vegetation Zone (acres)						
	Alpine Parkland	Subalpine Fir	Grand Fir	Douglas-fir	Ponderosa pine	Central Arid Steppe	Three-tip Sage
Historic (Potential)	1,629	2,203	1,580	21,214	89,116	1,111,686	380,155
Agriculture	0	0	0	0	523	366,762	186,254
CRP	0	0	0	0	0	22,348	48,048
Current	1,629	2,203	1,580	21,214	88,593	722,576	145,853

(Cassidy 1997)



(Cassidy 1997).

Figure 29 Protection status and vegetation zones of the UMM Subbasin, WA.

Noxious Weeds

Changes in biodiversity have been closely associated with changes in land use. Grazing, agriculture, and accidents have introduced a variety of exotic plants, many of which are vigorous enough to earn the title "noxious weed." Twenty-six species of noxious weeds occur in the Subbasin (Table 15).

Table 15 Noxious weeds in the UMM Subbasin and their origin

Common Name	Scientific Name	Origin
Field bindweed	*Convolvulus arvensis*	Eurasia
Buffalobur nightshade	*Solanum rostratum*	Native to the Great Plains of the U.S
Common crupina	*Crupina vulgaris*	Eastern Mediterranean region
Jointed goatgrass	*Aegilops cylindrica*	Southern Europe and western Asia
Poison hemlock	*Conium maculatum*	Europe
Johnsongrass	*Sorghum halepense*	Mediterranean
Diffuse knapweed	*Centaurea diffusa*	Eurasia
Russian knapweed	*Acroptilon repens*	Southern Russia and Asia
Spotted knapweed	*Centaurea bibersteinii*	Europe
Purple loosestrife	*Lythrum salicaria*	Europe
Silverleaf nightshade	*Solanum elaeagnifolium*	Central United States
Puncturevine	*Tribulus terrestris*	Europe
Tansy ragwort	*Senecio jacobaea*	Eurasia
Rush skeletonweed	*Chondrilla juncea*	Eurasia
Leafy spurge	*Euphorbia esula*	Eurasia
Yellow star thistle	*Centaurea solstitialis*	Mediterranean and Asia
Canadian thistle	*Cirsium arvense*	Eurasia
Musk thistle	*Carduus nutans*	Eurasia
Scotch cottonthistle	*Onopordum acanthium*	Europe
Dalmatian toadflax	*Linaria dalmatica*	Mediterranean
Yellow toadflax	*Linaria vulgaris*	Europe

(Callahan and Miller 1994)

Subbasin Habitat Types

The UMM Subbasin consists of 15 wildlife habitat types, which are briefly described in Table 16. Detailed descriptions of these habitat types can be found in Appendix B of Ashley and Stovall (unpub. rpt., 2004).

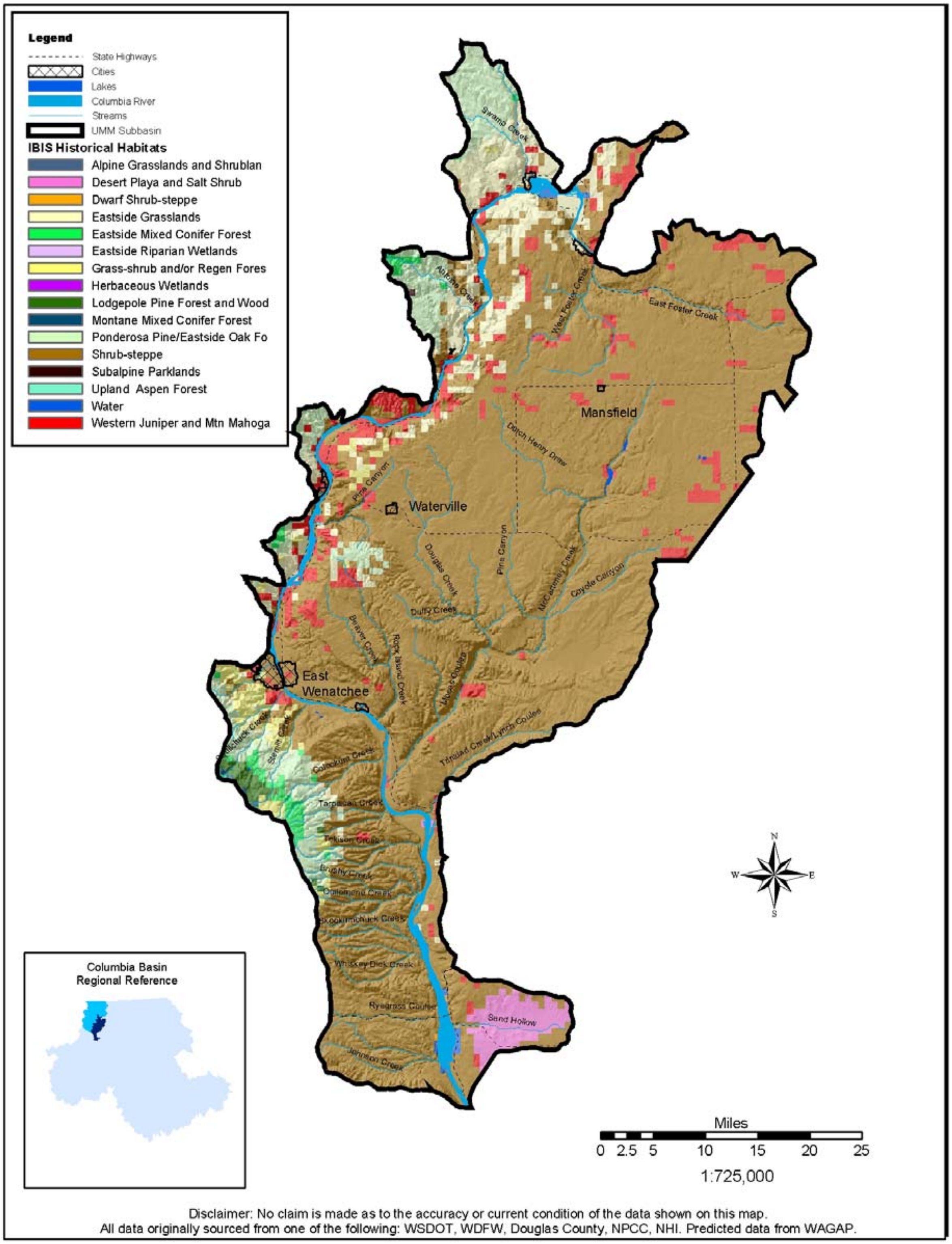
Dramatic changes in wildlife habitat have occurred throughout the Subbasin since pre-European settlement (circa 1850) (Figure 30 and Figure 31). The most significant habitat losses include the loss of 39 percent of shrubsteppe habitat. Quantitative changes in all Subbasin wildlife habitat types are compared in Figure 31 Current wildlife habitat types of the UMM Subbasin, WA.

Table 17.

Table 16 Current wildlife habitat types within the UMM Subbasin, WA.

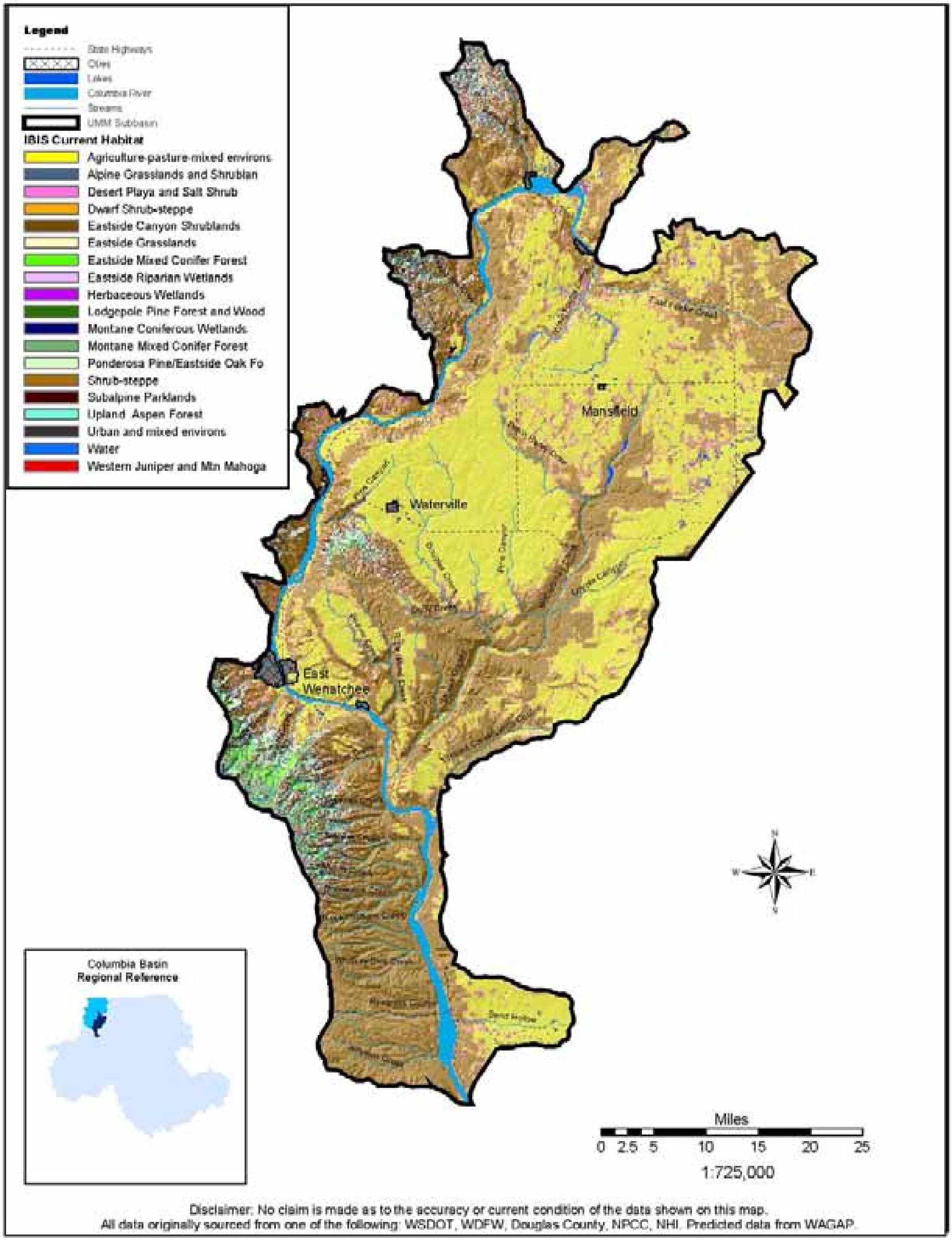
Habitat Type	Brief Description
Montane Mixed Conifer Forest	Coniferous forest of mid-to upper montane sites with persistent snowpack, several species of conifer, understory typically shrub-dominated.
Eastside (Interior) Mixed Conifer Forest	Coniferous forests and woodlands, Douglas-fir commonly present, up to 8 other conifer species present, understory shrub and grass/forb layers typical, mid-montane.
Lodgepole Pine Forest and Woodlands	Lodgepole pine dominated woodlands and forests, understory, various mid- to high elevations.
Ponderosa Pine and Interior White Oak Forest and Woodland	Ponderosa pine dominated woodland or savannah, often with Douglas-fir; shrub, forb, or grass understory; lower elevation forest above steppe, shrubsteppe.
Upland Aspen Forest	Quaking aspen (*Populus tremuloides*) is the characteristic and dominant tree in this habitat. Scattered ponderosa pine (Pinus ponderosa) or Douglas-fir (Pseudotsuga menziesii) may be present.
Subalpine Parkland	Coniferous forest of subalpine fir (*Abies lasiocarpa*), Engelmann spruce (*Picea engelmannii*) and lodgepole pine (Pinus contorta).
Alpine Grasslands and Shrublands	This habitat is dominated by grassland, dwarf-shrubland (mostly *Evergreen microphyllous*), or forbs.
Eastside (Interior) Grasslands	Dominated by short to medium height native bunchgrass with forbs, cryptogam crust.
Shrubsteppe	Sagebrush and/or bitterbrush dominated; bunchgrass understory with forbs, cryptogam crust.
Agriculture, Pasture, and Mixed Environs	Cropland, orchards, vineyards, nurseries, pastures, and grasslands modified by heavy grazing; associated structures.
Urban and Mixed Environs	High, medium, and low (10-29 percent impervious ground) density development.
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
Herbaceous Wetlands	Generally a mix of emergent herbaceous plants with a grass-like life form (graminoids). Various grasses or grass-like plants dominate or co-dominate these habitats.
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.
Eastside (Interior) Riparian Wetlands	Shrublands, woodlands and forest, less commonly grasslands, often multi-layered canopy with shrubs, graminoids, forbs below.

(IBIS 2003)



(DCTLS 2004)

Figure 30 Historic wildlife habitat types of the UMM Subbasin, WA.



(DCTLS 2004)

Figure 31 Current wildlife habitat types of the UMM Subbasin, WA.

Table 17 Changes in wildlife habitat types in the UMM Subbasin, Washington, from circa 1850 (historic) to 199 (current)

Habitat Types	Historic	Current	Changes (acres)	Changes (%)
Montane Mixed Conifer Forest	Unknown	10,500		
Eastside (Interior) Mixed Conifer Forest	Unknown	24,401		
Lodgepole Pine Forest and Woodlands	Unknown	1,045		
Ponderosa Pine Forest and Woodlands	100,329	50,843	-49,487	-49
Upland Aspen Forest	Unknown	292		
Alpine Grasslands and Shrublands	Unknown	421		
Subalpine Parkland	Unknown	1,179		
Eastside (Interior) Grasslands	117,133	14,396	-102,737	-88
Shrubsteppe	1,237,065	753,073	-483,992	-39
Agriculture, Pastures, and Mixed Environs	0	693,861	693,861	100
Urban and Mixed Environs	0	8,026	8,026	100
Montane Coniferous Wetlands	Unknown	407		
Eastside (Interior) Riparian-Wetlands	Unknown	3,898		
Herbaceous Wetlands	Unknown	3,514		
Open Water - Lakes, Rivers, and Stream	7,166	41,882	34,716	484

(IBIS 2003)

Rationale and Selection of Focal Habitats

A “coarse filter/fine filter” approach was used to select focal habitat (Haufler 2002). The coarse filter compares the current availability of focal species habitat against historic availability to evaluate the relative status of a given habitat and its suite of obligate species. To ensure that “nothing drops through the cracks,” the coarse filter habitat analysis was combined with a single species or “fine filter” analysis of one or more obligate species to further ensure that species viability for the suite of species is maintained. For a more detailed discussion of focal wildlife species selection and rationale, see section 4.1.3 in Ashley and Stovall (unpub. rpt., 2004).

The following four key principles/assumptions were used to guide selection of focal habitats: 1) Focal habitats were identified by WDFW at the CCP level and reviewed/modified at the subbasin level, 2) Focal habitats can be used to evaluate ecosystem health and establish management priorities at the CCP level (course filter), 3) Focal species/guilds can be used to represent focal habitats and to infer and/or measure response to changing habitat conditions at the subbasin level (fine filter), 4) Focal species/guilds were selected at the subbasin level.

To identify focal macro habitat types within the CCP, CCP planners used the assessment tools to develop a habitat selection matrix based on various criteria, including ecological, spatial, and cultural factors. As a result, subbasin planners selected four focal wildlife habitat types out of the seventeen that occur within the CCP (Table 18). Focal habitats selected for the UMM Subbasin include shrubsteppe, riparian wetlands, and herbaceous wetlands. Neither the IBIS nor the

Washington GAP Analysis data recognize the historic presence of herbaceous wetlands or riparian wetlands. Additionally, the current extent of these habitat types as reflected in these databases is suspect at best; however, NWI (FWS 1999-0518), hydric soils data (NRCS) and WDFW Priority Habitat and Species data were used to represent current riparian wetland and herbaceous wetland habitats. The amount of extant acres for each focal habitat type is illustrated by subbasin in Table 18.

Table 18 A comparison of the amount of current focal habitat types for each subbasin in the CCP, WA.

Subbasin	Focal Habitat			
	Ponderosa Pine (acres)	Shrubsteppe (acres)	Riparian Wetlands (acres)	Herbaceous Wetlands (acres)
Entiat	55,807	32,986	94	
Lake Chelan	45,480	45,018	5,079	
Wenatchee	51,912	24,248	141	
Methow	139,853	107,655	4,232	
Okanogan	140,738	562,763	9,920	
UMM	**50,843**	**753,073**	**3,898**	**6,032**
Crab	4,660	991,397	12,227	

(IBIS 2003, FWS 1999-0518)

Focal Habitat Changes

Changes in the extent of focal habitats within the Subbasin are summarized in Table 19. The UMM Subbasin shows a decrease in the extent of shrubsteppe habitat.

IBIS herbaceous wetland and riparian wetland historic habitat data are incomplete and not suitable for use in subbasin level analyses. As a result, riparian and herbaceous wetland analyses are incomplete. Accurate habitat type quantification, especially those detailing riparian and herbaceous wetland habitats, are needed to improve assessment quality and support management strategies. In spite of the lack of quantifiable historic habitat conditions, subbasin wildlife managers believe that significant physical and functional losses have occurred to these wetland habitats.

Table 19 Changes in focal wildlife habitat types in the UMM Subbasin, WA., from circa 1850 (historic) to 1999 (current)

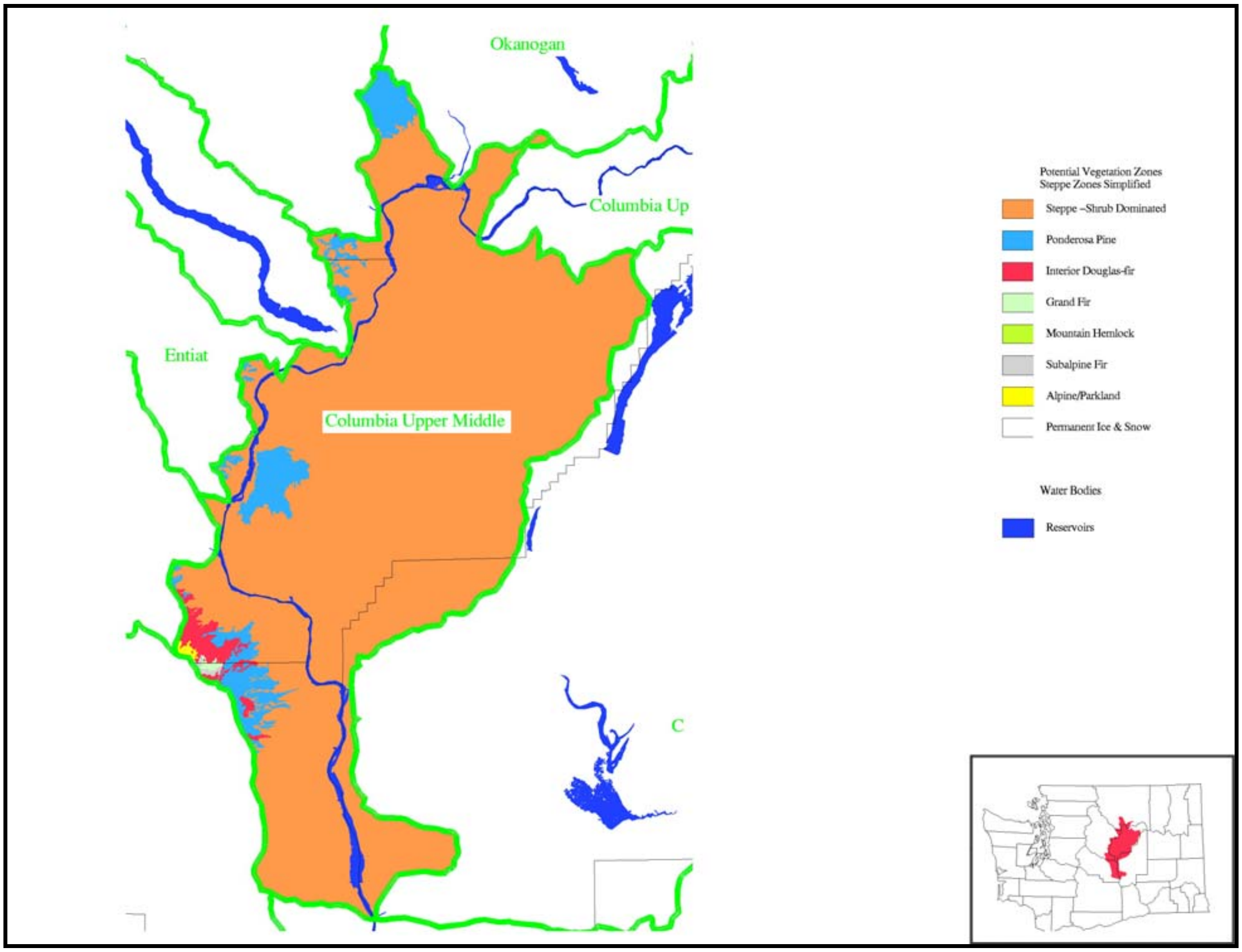
Focal Habitat Type	Historic Acres1	Current Acres	Acre Change	Percent Change
Shrubsteppe	1,237,065	753,073	-483,992	-39
Eastside (Interior) Riparian Wetlands	Unknown	3,898	Unknown	Unknown
Herbaceous Wetlands	Unknown	3,514	Unknown	Unknown
Agriculture	0	693,861	693,861	+100

Focal Habitat Type	Historic Acres1	Current Acres	Acre Change	Percent Change
[1] Historic GAP and IBIS riparian and herbaceous wetland data are not suitable for subbasin level analysis. See Wildlife Habitat Assessment Methods for explanation of data limitations.				

(IBIS 2003)

4.2.3 Shrubsteppe Assessment Unit

The shrubsteppe habitat type is described in section 4.1.7.2 of Ashley and Stovall (unpub. rpt., 2004). Shrubsteppe habitat in the UMM Subbasin is illustrated in Figure 32.



(Cassidy 1997)

Figure 32 Potential shrubsteppe habitat in the UMM Subbasin, WA.

Habitat Structure and Composition

Shrubsteppe was historically co-dominated by shrubs and perennial bunchgrasses with a micro biotic crust of lichens and mosses on the surface of the soil. Shrubsteppe that was located in areas of deep soil have largely been converted to agriculture leaving shrubsteppe intact on shallow lithosols soil. Floristic quality, however, has generally been impacted by decades of heavy grazing, introduced vegetation, wild fires, and other anthropogenic disturbances. In addition, habitat alterations from loss of native wildlife interactions/associations are largely unknown.

The greatest changes in the remaining shrubsteppe habitat from historic conditions are the reduction of bunchgrass cover in the understory and an increase in sagebrush cover. Soil compaction is also a significant factor in heavily grazed lands affecting water percolation, runoff, and soil nutrient content. A long history of grazing, fire, and invasion by exotic vegetation has altered the composition of the plant community within much of the extant shrubsteppe in this region (Knick 1999, Quigley and Arbelbide 1997), and it is difficult to find stands that are still in relatively natural condition.

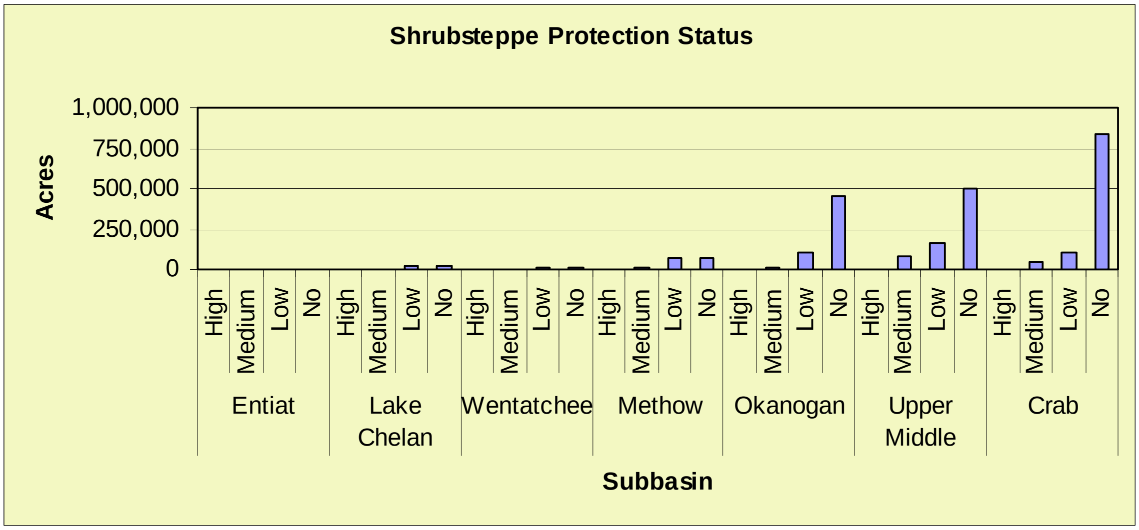
Fire has relatively little effect on native vegetation in the three-tip sagebrush zone, since three-tip sagebrush and the dominant graminoids resprout after burning. Three-tip sagebrush does not appear to be much affected by grazing, but the perennial graminoids decrease and are eventually replaced by cheatgrass (*Bromus tectorum*), thread-leaved sedge (*Carex filifolia*), and/or gray rabbitbrush (*Chrysothamnus nauseosus).* In recent years, diffuse knapweed (*Centaurea diffusa*) and Dalmation toadflax (*Linaria dalmatica*) have spread through this zone and threaten to replace other exotics as the chief increaser after grazing (Roche and Roche 1998).

In areas of central arid steppe with a history of heavy grazing and fire suppression, true shrublands are common and may even be the predominant cover on non-agricultural land. Most of the native grasses and forbs are poorly adapted to heavy grazing and trampling by livestock. Grazing eventually leads to replacement of the bunchgrasses with cheatgrass, small fescue (*Vulpia microstachys*), sixweeks fescue (*V. octofiora),* and Indian wheat (*Plantago patagonica*) (Harris and Chaney 1984). In recent years, several knapweeds (*Centaurea* spp.) have become increasingly widespread. Russian knapweed (*Centauries ripens)* is widespread, along and near major watercourses, streams, ponds, springs, seeps, or any disturbed site with suitable soil moisture (Roche and Roche 1988).

Status, Trends, and Limiting Factors

Protection Status

The protection status of shrubsteppe habitat for CCP subbasins is compared in Figure 33. The protection status of remaining shrubsteppe habitats in all subbasins is primarily within the “low” to “no protection” status categories. As a result, this habitat type will likely suffer further degradation, disturbance, and/or loss in all CCP subbasins. Protection status of shrubsteppe habitat within the UMM Subbasin is illustrated in Figure 33 and Table 20.



(IBIS 2003)

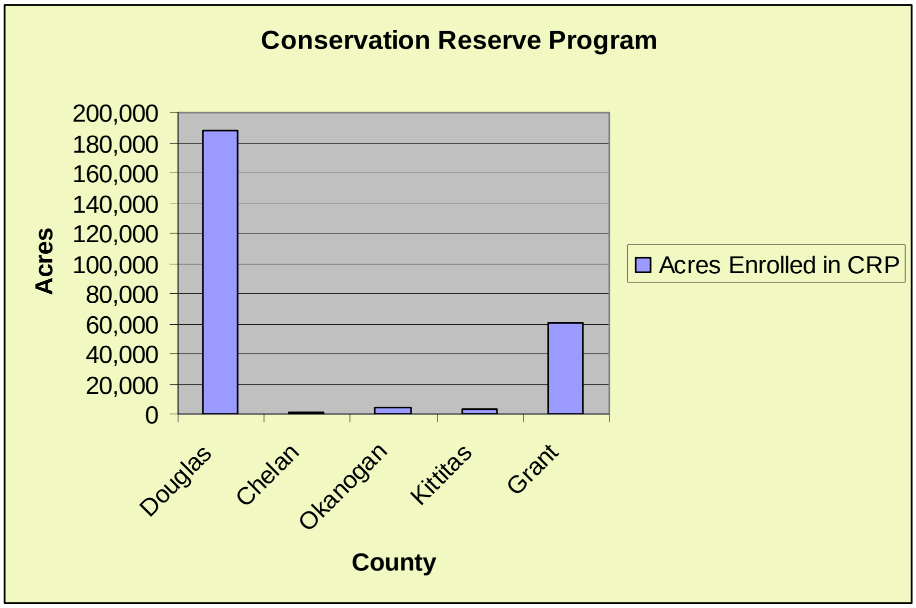
Figure 33 GAP protection status of shrubsteppe habitat in the CCP, Washington

Table 20 Shrubstepp habitat GAP protection status in the UMM Subbasin, WA.

GAP Protection Status	Acres
High Protection	0
Medium Protection	109,523
Low Protection	312,766
No Protection	1,185,451

(IBIS 2003)

Shrubsteppe-like habitat established through implementation of the Conservation Reserve Program receives short-term/high protection. The number of acres protected by CRP are compared by county in Figure 34 and listed in Appendix D.



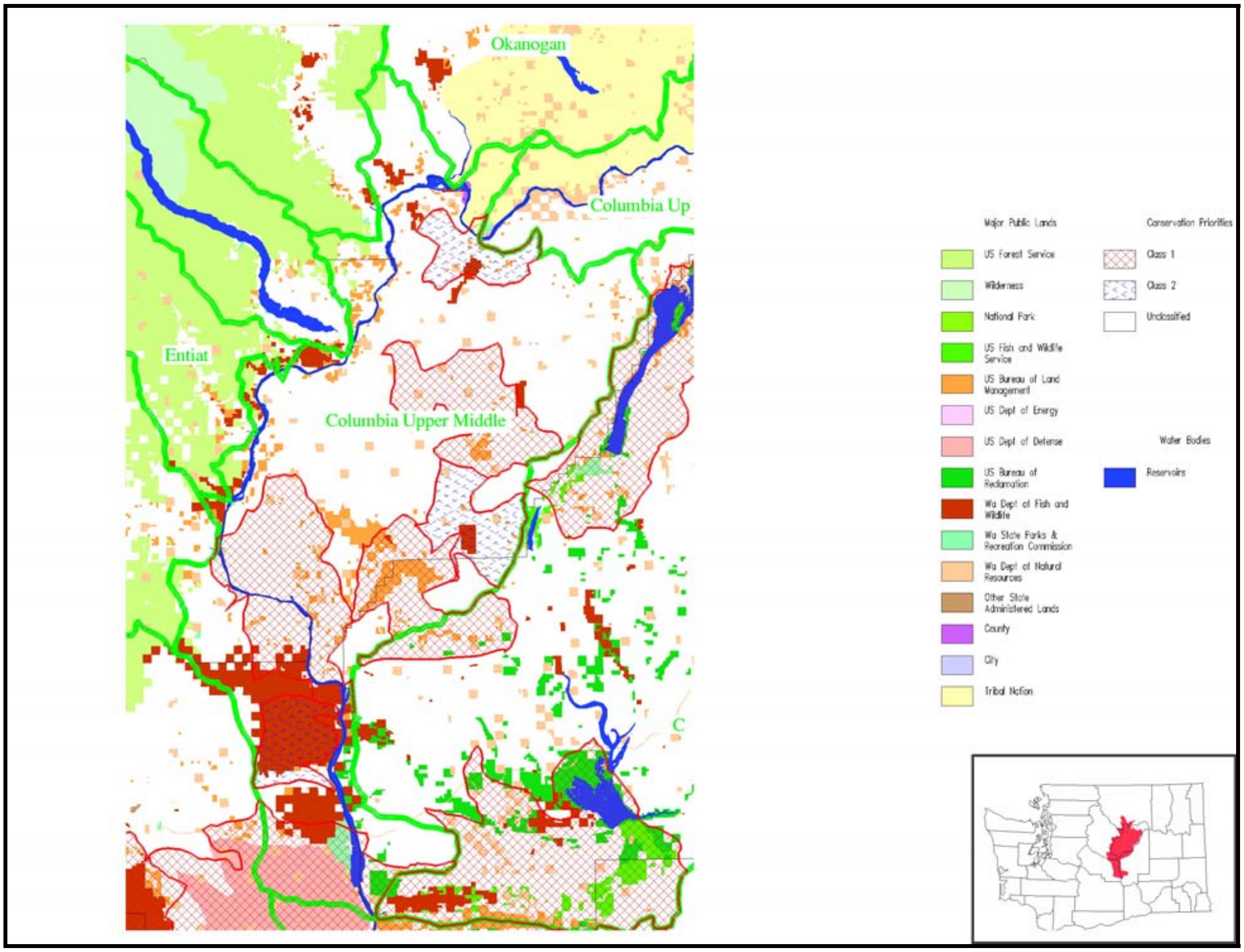
(FSA, unpublished data, 2003).

Figure 34 Acres protected through the CRP

Ecoregion Conservation Assessment Priorities

Subbasin ECA priorities and public land ownership are illustrated in Figure 35. The Ecoregion Conservation Assessment is further discussed in section 4.2 of Ashley and Stovall (unpub. rpt., 2004). An extensive area of shrubsteppe in the central portion of the Subbasin is comprised of ECA class 1 lands. Three areas in the Subbasin, comprised largely of shrubsteppe habitat owned and managed by WDFW, are designated ECA class 2. The majority of these class 2 lands are provided some threat protection primarily through public ownership. Washington Department of Fish and Wildlife ECA planners, with local input, may identify additional shrubsteppe habitats as ECA priority areas when ECA data are updated.

Subbasin planners can use ECA data, in conjunction with other tools such as IBIS and Streamnet, to identify areas in which to focus protection strategies and conservation efforts. Protection of critical habitats on private lands, located adjacent to existing public lands, within ECA designated areas is a high priority within the Subbasin and EcoCCP.



(ECA 2003)

Figure 35 ECA and publicly owned lands in the UMM Subbasin, WA.

Limiting Factors

Factors affecting shrubsteppe habitat are explained in detail in section 4.2.10.2 (Ashley and Stovall (unpub.rpt. 2004) and are summarized below:

- Shrubsteppe/grassland habitats are destroyed (e.g., approximately 60 percent of shrubsteppe in Washington [Dobler et al. 1996]) because of permanent conversions to agriculture and urban uses and remaining tracts of moderate to good quality shrubsteppe habitat are fragmented.
- Habitats are degraded by intensive grazing and invasion of exotic plant species, particularly annual grasses such as cheatgrass, diffuse knapweed, and Dalmatian toadflax.
- Urban and rural residential development/encroachment and conversion to agriculture degrade and destroy properly functioning shrubsteppe ecosystems. The best sites for healthy sagebrush communities have deep soil and relatively mesic conditions, but are also best for agricultural productivity, therefore past losses and potential future losses are great. Most of the remaining shrubsteppe in Washington is in private ownership with little long-term protection (57 percent).

- Big sagebrush communities are lost to brush control; however, this may not be detrimental relative to interior grassland habitats.
- CRP lands may be converted back to cropland or rangeland.
- Cryptogamic crusts, which help maintain the ecological integrity of shrubsteppe/grassland communities, are reduced and destroyed.
- High densities of nest parasites (e.g., brown-headed cowbird) and domestic predators, primarily cats, may be present in hostile/altered landscapes, particularly those in proximity to agricultural and rural development, and residential areas subject to high levels of human disturbance.
- Agricultural and grazing practices cause direct or indirect mortality and/or reduce wildlife productivity.

Recommended Future Conditions

Recommended future conditions are described in section 4.1.7.2.3 in Ashley and Stovall (unpub. rpt., 2004) and are summarized as follows:

Sagebrush-dominated Shrubsteppe:

Condition 1– Deep soil shrubsteppe: Pygmy rabbit was selected to represent species dependent on deep rock-free soil (greater than 20 inches deep) underlying shrubsteppe habitat with patches of dense tall sagebrush (average 32.7 percent shrub cover and shrub height of 32 inches) (Gahr 1993).

Condition 2 – Sagebrush dominated shrubsteppe habitat: The sage thrasher was selected to represent shrubsteppe obligate wildlife species that require sagebrush dominated shrubsteppe habitats and that are dependent upon areas of tall sagebrush within large tracts of shrubsteppe habitat (Knick and Rotenberry 1995; Paige and Ritter 1999; Vander Haegen et al. 2001). Suitable habitat includes 5 to 20 percent sagebrush cover greater than 2.5 feet in height, 5 to 20 percent native herbaceous cover, and less than 10 percent non-native herbaceous cover.

Steppe/Grassland-dominated Shrubsteppe:

Condition 1 – Sagebrush habitat with diverse native herbaceous understory: Sage grouse were selected to represent species that require/prefer diverse sagebrush habitat with medium to high shrub cover and residual grass. Sage grouse prefer slopes less than 30 percent, sagebrush/bunchgrass stands having medium to high canopy cover (10-30 percent), forb/grass cover at least 15 percent, and less than 10 percent non-native herbaceous cover.

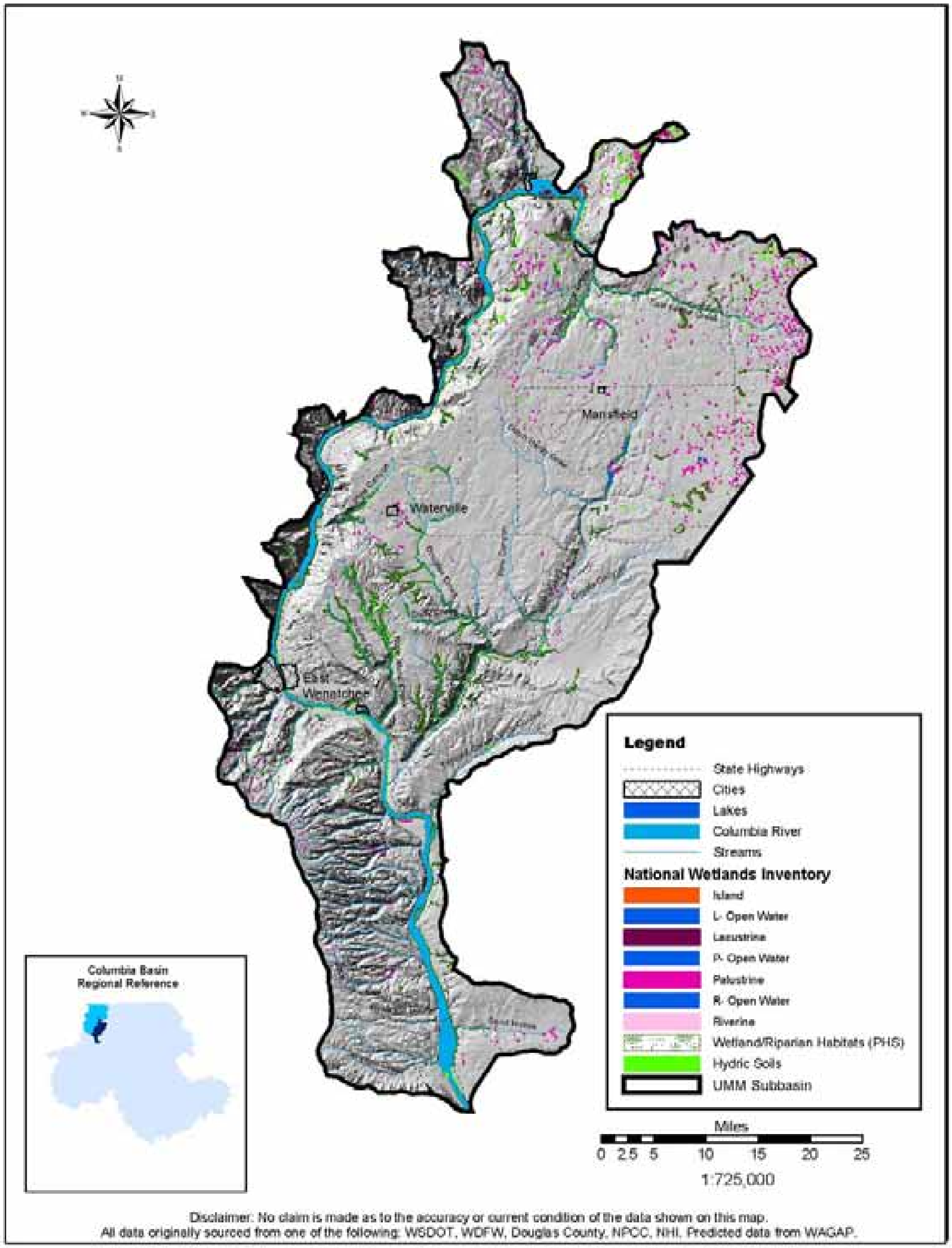
Condition 2 – Shrubsteppe habitat with multi-structured deciduous trees and shrubs: Sharp-tailed grouse were selected to represent species that require multi-structured, fruit/bud/catkin producing deciduous trees and shrubs dispersed throughout the landscape (10 to 40 percent of the total area). Other habitat conditions include:

- Native bunchgrass greater than 40 percent cover
- Native forbs with at least 30 percent cover
- Visual obstruction readings (VOR) of at least 6 inches

- At least 75 percent deciduous shrubs and trees cover
- Exotic vegetation/noxious weeds of less than 5 percent cover

4.2.4 Eastside (Interior) Riparian Wetlands Assessment Unit

The eastside (interior) riparian wetlands habitat type (Figure 36) refers only to riverine and adjacent wetland habitats in both the CCP and individual subbasins. According to the IBIS database (2003), there are an estimated 3,898 acres of riparian wetland habitat currently in the Subbasin, which is an underestimate (see Wildlife Habitat Assessement Methods). GAP analysis estimated 11,544 acres (Cassidy 1997). Subbasin planners relied on a combination of data sources to depict current riparian wetland distribution in the subbasin. Although there are no historic data to make comparisons, the actual number of acres or absolute magnitude of the change is less important than recognizing a loss of riparian habitat has occurred and the lack of permanent protection continues to place this habitat type at further risk.



(DCTLS 2004)

Figure 36 Wetland and riparian habitat in the UMM Subbasin, WA.

Habitat Structure and Composition

Historically, riparian wetland habitat was characterized by a mosaic of plant communities occurring at irregular intervals along streams and dominated singularly or in some combination by grass-forbs, shrub thickets, and mature forests with tall deciduous trees. Beaver activity and natural flooding are two ecological processes that affected the quality and distribution of riparian wetlands.

Today, agricultural conversion, altered stream channel morphology, and water withdrawal have played significant roles in changing the character of streams and associated riparian areas. Woody vegetation has been extensively suppressed by grazing in some areas, many of which continue to be grazed. At lower elevations, agricultural conversions have led to altered stream channel morphology, loss of riparian vegetation and water withdrawals for irrigation.

In some areas, the amount of riparian habitat has increased because of the stability the upstream storage projects provide in periods of high flows. These flows have created suitable habitat for migrant and wintering waterfowl and other species because of the increased open water associated with the reservoirs (T. Dresser, Grant PUD, pers. comm., 2004).

Embayments also provide diverse riparian vegetative communities and important wildlife habitat because of their reduced water fluctuation and protection from wave action. These shallow water habitats are typically connected to the Columbia River via culverts or small channels. Water fluctuates less in many of these areas than in the river because of the elevation of the culvert or inlet channel, and the magnitude of waves is also relatively low. Embayments are of special importance to beaver and also provide protected resting, roosting, and food resources for water birds. (T. Dresser, Grant PUD, pers. comm., 2004)

Status, Trends and Limiting Factors

Protection Status

The vast majority of CCP riparian habitat is designated low or no protection status and is at risk for further degradation or conversion to other uses. The GAP protection status of riparian wetland habitat in the UMM Subbasin is depicted in Table 21.

Table 21 Eastside (interior) riparian wetlands GAP protection status in the UMM Subbasin, WA.

GAP Protection Status	Acres
High Protection	0
Medium Protection	274
Low Protection	647
No Protection	2,974

(IBIS 2003)

Limiting Factors

Factors affecting Eastside (interior) Riparian Wetland habitat are described in section 4.2.10.3 in Ashley and Stovall (unpub. rpt., 2004) and summarized below:

- Habitat is degraded or lost because of numerous factors including riverine recreational developments, inundation from impoundments, cutting and spraying of riparian vegetation for eased access to water courses, etc.

- Habitat, in the tributaries of the Columbia River, is altered by 1) hydrological diversions and control of natural flooding regimes that result in reduced stream flows and reduction of overall area of riparian habitat, loss of vertical stratification in riparian vegetation, and lack of recruitment of young cottonwoods, ash, willows, etc., and 2) stream bank stabilization, which narrows stream channel, reduces the flood zone, and reduces extent of riparian vegetation.

- Livestock overgrazing widens channels, raises water temperatures, and reduces understory cover.
- Native riparian shrub and herbaceous vegetation is converted to invasive exotics such as reed canary grass, purple loosestrife, perennial pepperweed, Russian knapweed, Canada thistle, and Russian olive.
- Large tracts necessary for area-sensitive species, such as the yellow-billed cuckoo, are fragmented and lost.
- Hostile landscapes, particularly those in proximity to agricultural, rural, and residential developments, may have high density of nest parasites (brown-headed cowbird), exotic nest competitors (European starling), and domestic predators (cats), and be subject to high levels of human disturbance.
- High energetic costs associated with high rates of competitive interactions with European starlings for cavities may reduce reproductive success of cavity-nesting species such as Lewis' woodpecker, downy woodpecker, and tree swallow, even when outcome of the competition is successful for these species.
- Riparian habitats are negatively impacted by recreational disturbances (e.g., ORVs), particularly during nesting season and in high-use recreation areas.
- Habitat is altered down to the edge of streams or rivers by farming.

Recommended Future Conditions

Recommended future conditions are described in detail in section 4.1.7.3.3 in Ashley and Stovall (unpub. rpt., 2004). Recommended conditions for riparian wetland habitat are summarized in the following paragraphs.

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

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

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

4.2.5 Herbaceous Wetland Assessment Unit

According to the IBIS database (2003), there are an estimated 3,514 acres of herbaceous wetland habitat currently in the Subbasin, which is an underestimate (see Wildlife Habitat Assessement Methods) while an analysis of NWI data (FWS 1999-0518) estimated 6,032 acres. Subbasin planners relied on a combination of data sources to depict current herbaceous wetlands distribution in the subbasin. Although there are no historic data to make comparisons, the actual number of acres or absolute magnitude of the change is less important than recognizing a loss of herbaceous wetlands habitat has occurred and the lack of permanent protection continues to place this habitat type at further risk.

Habitat Structure and Composition

Physical

Herbaceous wetlands include depressional wetlands of two basic types: lacustrine and palustrine (i.e., around lakes/ponds and swampy areas). This habitat is found on permanently flooded sites that are usually associated with oxbow lakes, dune lakes, or potholes. Seasonally to semi-permanently flooded wetlands are found where standing freshwater is present through part of the growing season and the soils stay saturated throughout the season. In the Columbia Basin, many of the herbaceous wetlands lie in topographic depressions that are not within the active channel of a stream or river. Wetlands in an active channel or that are frequently flooded (at least once every two years) are classified as “Riverine”. Depressional wetlands are located in the channeled scablands, wind blown loess and sand dunes, glacial kettles or potholes, and alluvial and basalt terraces, particularly along the Columbia River (Hruby and Stanley 2000).

Herbaceous wetlands are also classified as either alkali or freshwater wetlands. Alkali wetlands are not as common on the landscape as freshwater wetlands in the Columbia Basin, but they do provide some unique habitat features. The ecological processes in these wetlands are dominated by the high salt concentrations in the water. The most visible result of the salt is a unique set of plants that have adapted to these conditions. Only a few species have adapted to these conditions and the species richness in alkali systems is much lower than in freshwater systems. Although richness may be low, abundance can be very high for those species that have adapted (especially among some invertebrates) (Hruby and Stanley 2000).

Depressional freshwater wetlands are defined as those whose conductivity is consistently below 2000 µSiemens/cm. The water regime in non-alkali wetlands tends to be dominated by surface runoff or groundwater in areas where inflow exceeds water losses through evaporation or evapotranspiration.

Herbaceous wetland habitat is maintained through a variety of hydrologic regimes that limit or exclude invasion by large woody plants. Habitats are permanently flooded, semi-permanently flooded, or flooded seasonally and may remain saturated through most of the growing season. Most wetlands are resistant to fire and those that are dry enough to burn usually burn in the fall. Most plants are sprouting species and recover quickly. Beavers play an important role in creating ponds and other impoundments in this habitat. Trampling and grazing by large native mammals is a natural process that creates habitat patches and influences tree invasion and success (IBIS 2003).

During years with adequate precipitation, wetlands in Grant, Douglas, Okanogan, and Lincoln counties support the most productive and diverse waterfowl breeding communities in the Pacific Northwest. Grasslands and shrubsteppe habitats surrounding these wetlands provide habitat for upland nesting ducks. The Columbia Basin Irrigation Project has created numerous wetlands that are more persistent but less productive for breeding waterfowl as a result of wetland succession and invasion by exotic, undesirable vegetation. The crops that are grown in this Subbasin, in concert with large reservoirs, wetlands, canals, and wasteways provide ideal conditions for many species of migrating and wintering waterfowl (Quinn 2001).

Vegetative

The herbaceous wetland habitat is generally a mix of emergent herbaceous plants with a grass-like life form (graminoids). Various grasses or grass-like plants dominate or co-dominate these habitats. Cattails (*Typha latifolia*) occur widely, sometimes adjacent to open water with aquatic bed plants. Several bulrush species (*Scirpus acutus, S. tabernaemontani, S. maritimus, S. americanus*, *S. nevadensis*) occur in nearly pure stands or in mosaics with cattails or sedges (*Carex* spp.). These meadows often occur with deep or shallow water habitats with floating or rooting aquatic forbs. Herbaceous cover is open to dense. The habitat can be comprised of tule marshes >6.6 ft (2 m) tall or sedge meadows and wetlands <3.3 ft (1 m) tall. Shrubs or trees are not a common part of this herbaceous habitat although willow (*Salix* spp.) or other woody plants occasionally occur along margins. Important introduced grasses that increase and can dominate with disturbance in this wetland habitat include reed canary grass (*Phalaris arundinacea*), tall fescue (*Festuca arundinacea)* and Kentucky bluegrass (*Poa pratensis*) (IBIS 2003).

Many plants found in alkali systems are unique such as *Distichlis spicata, Scirpus maritimus* or *Scirpus americanu*s. These plants tend to be sparse and relatively short (<1m). As a result, alkali systems often have extensive mudflats and meadows of short grass that attract certain species of waterfowl and shorebirds. Alkali wetlands provide critical habitat for many species of migratory birds (Hruby and Stanley 2000).

Fresh water wetlands with water present greater than nine months typically have a ring of bulrush *(Scirpus spp*.) or cattails *(Typha spp*.) around an area of open water (or mudflats in very dry years). White water buttercup *(Ranunculus aquatili*s), burreed *(Sparganium emersum*), American water-plaintain *(Alisma plantago-aquatica*), or American water-plaintain *(Alisma plantago-aquatic*a) can also be present (Hruby and Stanley 2000).

Herbaceous wetlands are often in a mosaic with shrub- or tree-dominated wetland habitat. Woody species can successfully invade emergent wetlands when this herbaceous habitat dries. Emergent wetland plants invade open-water habitat as soil substrate is exposed; e.g., aquatic sedge and Northwest Territory sedge (*Carex utriculata*) are pioneers following beaver dam breaks. As habitats flood, woody species decrease to patches on higher substrate (soil, organic matter, large woody debris) and emergent plants increase unless the flooding is permanent. Fire suppression can lead to woody species invasion in drier herbaceous wetland habitats (IBIS 2003).

Status, Trends, Limiting Factors

Nationally, herbaceous wetlands have declined and the Pacific Northwest is no exception. These wetlands receive regulatory protection at the national, state, and county level; still, herbaceous wetlands have been filled, drained, grazed, and farmed extensively. A keystone species, the beaver, has been trapped to near extirpation in parts of the Pacific Northwest and its population has been regulated in others. Herbaceous wetlands have decreased along with the diminished influence of beavers on the landscape. Quigley and Arbelbide (1997) concluded that herbaceous wetlands are susceptible to exotic, noxious plant invasions.

Direct alteration of hydrology (e.g., channeling, draining, damming) or indirect alteration (e.g., roading or removing vegetation on adjacent slopes) results in changes in amount and pattern of herbaceous wetland habitat. If the alteration is long term, wetland systems may reestablish to reflect new hydrology (e.g., cattail is an aggressive invader in roadside ditches). Severe livestock grazing and trampling decreases aquatic sedge, Northwest Territory sedge (*Carex utriculata*), bluejoint reedgrass, and tufted hairgrass. Native species, however, such as Nebraska sedge, Baltic and jointed rush (*Juncus nodosus*), marsh cinquefoil (*Comarum palustris*), and introduced species dandelion (*Taraxacum officinale*), Kentucky bluegrass, spreading bentgrass (*Agrostis stolonifera*), and fowl bluegrass (*Poa palustris*) generally increase with grazing.

Limiting Factors

- Livestock overgrazing reduces emergent and upland vegetation.
- Upland nesting bird habitat (red-winged blackbird and gadwall) is altered and destroyed by mowing, burning, and tillage.
- Native wetland and upland vegetation is replaced with invasive exotics such as reed canary grass, purple loosestrife, perennial pepperweed, Russian knapweed, Canada thistle, and Russian olive.
- Hostile landscapes, particularly those in proximity to agricultural, rural, and residential developments, may have high density of nest parasites (brown-headed cowbird), exotic nest competitors (European starling), and domestic predators (cats), and be subject to high levels of human disturbance.
- Wetland habitat is disturbed by recreational activities, particularly during nesting season and in high-use recreation areas.
- Exotic wildlife species (e.g., carp) disturb submergent vegetation, destroy habitat for emergent aquatic insects, and affect the productivity of the wetland.
- Habitat within, or adjacent to, herbaceous wetlands is altered by farming.

Protection Status

The vast majority of CCP herbaceous wetland habitat is designated low or no protection status and is at risk for further degradation and/or conversion to other uses. The GAP protection status of herbaceous wetland habitat in the UMM Subbasin is depicted in **Table 22**.

Table 22 Herbaceous wetlands GAP protection status/acres in the UMM Subbasin, WA.

GAP Protection Status	Acres
High Protection	0
Medium Protection	17
Low Protection	118
No Protection	272

(IBIS 2003)

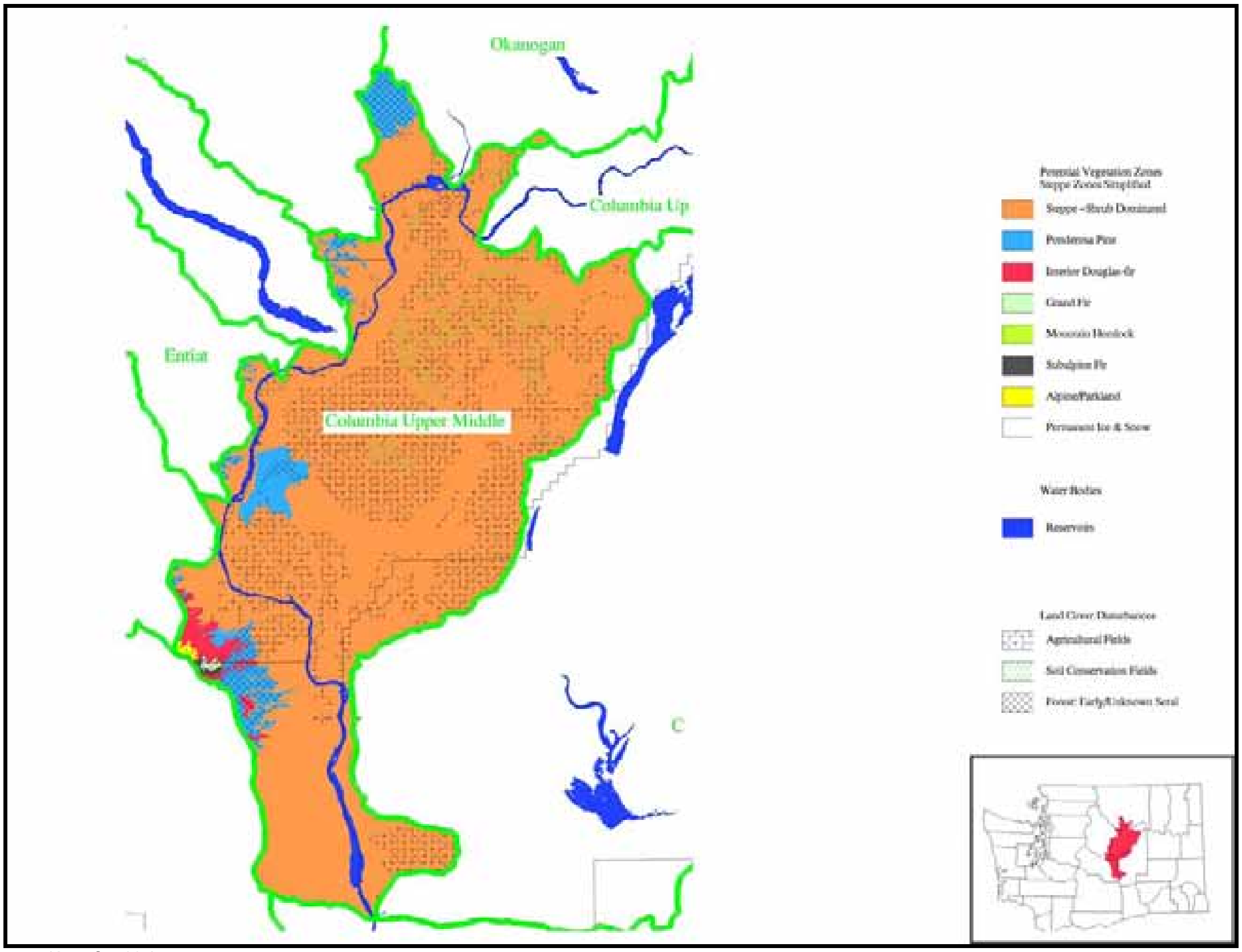
Recommended Future Condition

Recommended conditions for herbaceous wetland habitat are summarized as follows: Condition 1 – Red-winged blackbird was selected to represent the range of habitat conditions of a functional herbaceous wetland and uplands habitat complex to include: Permanent water present at a depth > 20”, Emergent vegetation ≥ 0.25 acre with an optimum of open water to emergent vegetation ratio of 40:60, Larvae of damselflies and dragonflies (order Odonota) present, Surrounding uplands (≤ 200 yds.) should include sturdy, dense, robust herbaceous vegetation not disturbed by grazing, mowing, burning, haying etc.

4.2.6 Agriculture (Habitat of Concern)

Agricultural habitat varies substantially in composition with several cover types. Agricultural extent in the Upper Middle Mainstem subbasin is illustrated in Figure 37. Cultivated cropland is primarily devoted to production of dryland winter wheat. Irrigated agriculture is concentrated along the Columbia River, small tributaries in Chelan County south of Wenatchee, and lower Moses Coulee in Douglas County. Crop production in these areas consists primarily of tree fruit and to a lesser degree forage crops (e.g., alfalfa and grass hay).

Because agriculture is not a focal wildlife habitat type and there is little opportunity to effect change in agricultural land use at the landscape scale, CCP and subbasin planners did not conduct a full-scale analysis of agricultural conditions. However, agricultural lands enrolled in the Conservation Reserve Program can provide benefits to shrubsteppe dependent wildlife.



(Cassidy 1997)

Figure 37 Agricultural extent in the UMM Subbasin, WA.

Conservation Reserve Program (CRP)

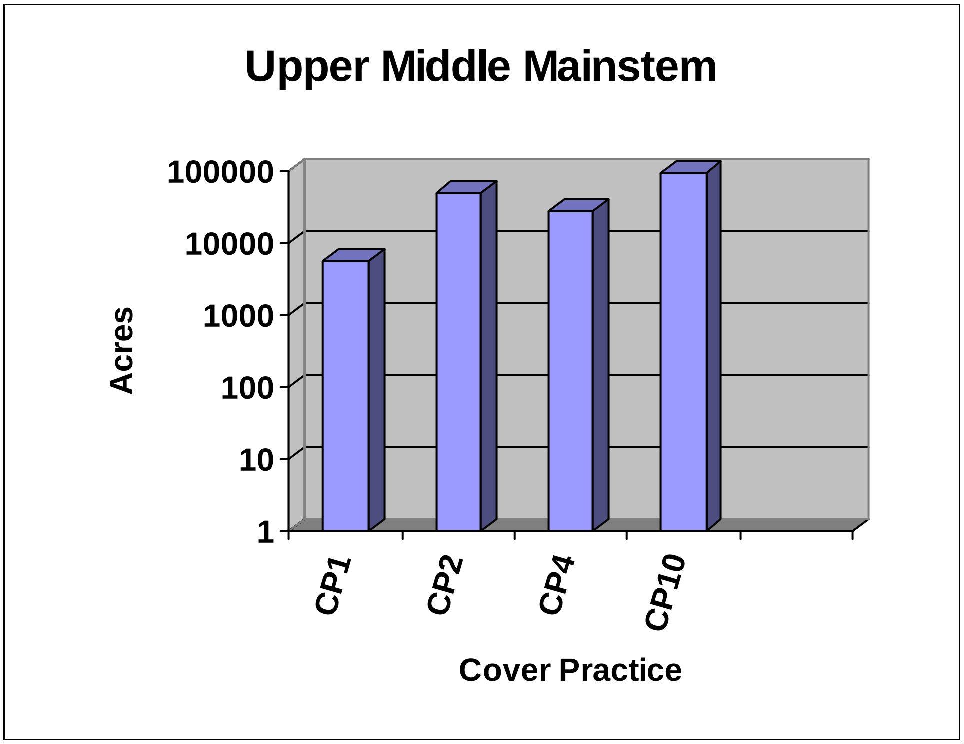
The Conservation Reserve Program (CRP) encourages farmers to convert highly erodible cropland, or other environmentally sensitive acreage, to vegetative cover (native grasses, wildlife plantings, trees, filter strips, or riparian buffer) to establish wildlife habitat, improve water quality by reducing soil erosion and sedimentation, and enhance shrubsteppe and wetland resources. Farmers receive an annual rental payment for the term of the contract, which shall not exceed 10 years per sign-up period. Contract approval is based, in part, on the types of vegetation landowners are willing to plant and cost sharing is provided to establish the vegetative cover practices.

Cover Practice planting combinations are assigned points based on the potential value to wildlife. Cover types that prescribe a mix of native species and are more beneficial to wildlife generally receive the highest scores (FSA, unpub. data, 2003). Cover Practices are summarized and compared in Table 23. Cover Practice seeding requirements change for each signup period. Most of the CRP acreage within the Subbasin (Douglas County) was enrolled in 1997 and 1998. Cover practice participation in the UMM Subbasin is illustrated in Figure 38.

Table 23 Cover Practice descriptions

Cover Practice (CP)	Description
CP1 - Permanent Introduced Grasses and Legumes	Planting of 2 to 3 species of an introduced grass species, or mixture (minimum of 4 species) of at least 3 introduced grasses and at least 1 forbs or legume species best suited for wildlife in the area.
CP2 - Establishment of permanent native grasses	Mixed stand (minimum of 3 species) of at least 2 native grass species and at least 1 forbs or legume species beneficial to wildlife, or mixed stand (minimum of 5 species) of at least 3 native grasses and at least 1 shrub, forbs, or legume species best suited for wildlife in the area.
CP3 -Tree planting (general)	Northern conifers (softwoods) - Conifers/softwoods planted at a rate of 750 to 850 trees per acre depending upon the site index with 10 to 20 percent openings managed to a CP4D wildlife cover, or western pines (softwoods) planted at a rate of 550 to 650 per acre depending upon the site index with 10 to 20 percent openings managed to a CP4D wildlife cover.
CP4B - Permanent wildlife habitat (corridors), non-easement	Mixed stand (minimum of 4 species) of grasses, trees, shrubs, forbs, or legumes planted in mixes, blocks, or strips best suited for various wildlife species in the area. A wildlife conservation plan must be developed with the participant (more points awarded for a minimum of 5 species). Only native grasses are authorized.
CP4D - Permanent wildlife habitat	Mixed stand (minimum of 4 species) of either grasses, trees, shrubs, forbs, or legumes planted in mixes, blocks, or strips best suited for various wildlife species in the area. A wildlife conservation plan must be developed with the participant (additional points awarded for a minimum of 5 species). Only native grasses are authorized.
CP-10 - Vegetative cover: grass – already established	A solid stand of 1 to 3 species of introduced grasses, a solid stand of 1 to 3 species of native grasses, or mixed stand (minimum of 5 species) of at least 3 native grasses and at least 1 shrub, forbs, or legume species best suited to Wildlife in the area (native vegetation maximizes points).
CP11 – Vegetative cover: trees – already established	Solid stand of pine/softwood or solid stand of non-mast producing hardwood species, solid stand of a single hard mast producing species, or mixed stand (2 or more species) of hardwoods best suited for wildlife in the area. Pine/softwood established at, or thinned to provide 15 to 20 percent openings of native herbaceous cover and/or shrub plantings/ natural regeneration best suited for wildlife in the area is awarded additional points.
CP 15 – Contour grass strips	Contour grass strips to reduce erosion and control runoff.

(FSA, unpublished data, 2003)



(FSA 2003)

Figure 38 Cover Practice participation in the UMM Subbasin, WA.

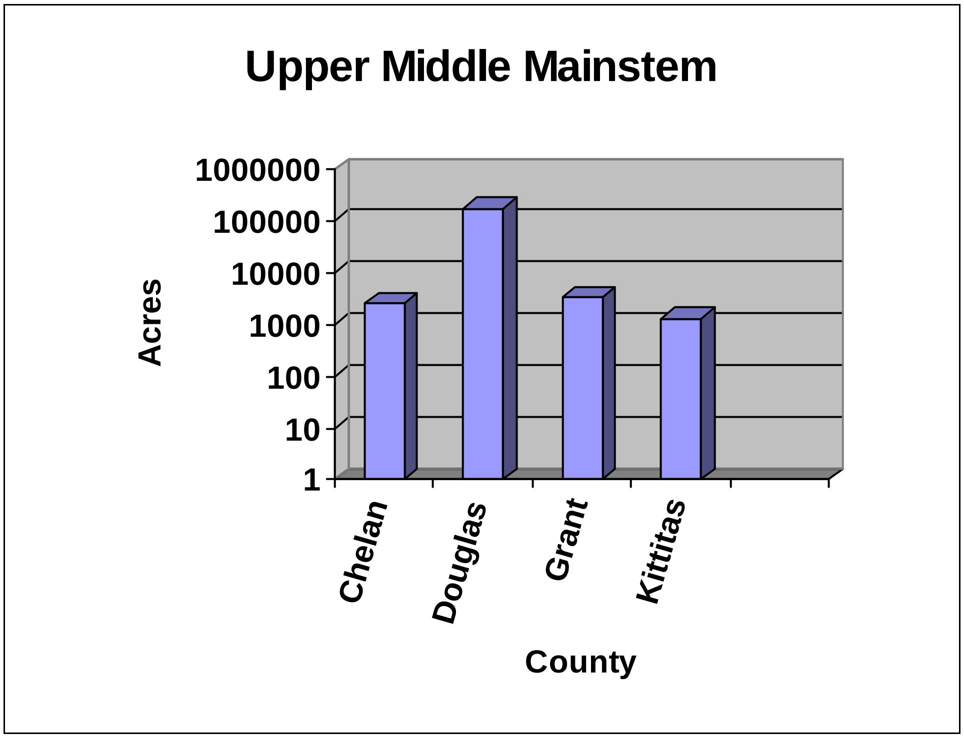
In general, CRP Cover Practices that emphasize wildlife habitat increase the extent of shrubsteppe-like habitats, provide connectivity/corridors between extant native shrubsteppe and other habitat types, reduce habitat fragmentation, increase landscape habitat diversity, reduce soil erosion and stream sedimentation, and provide habitat for a myriad of wildlife species.

Specific wildlife benefits have been documented for sage grouse and sharp-tailed grouse, especially in fields that used multi-species native seed mixes (M. Schroeder, pers. comm., 2004). Additional studies of beneficial aspects of CRP to shrubsteppe dependent birds, mammals and reptiles are currently being conducted by WDFW.

Status, Trends, and Limiting Factors

In the UMM 177,910 acres of cropland are enrolled in CRP. The majority of CRP acreage in the Subbasin occurs in Douglas County (Figure 39). Participation in CRP is limited, by rule, to 25 percent of the eligible cropland in a county. There were provisions included in the program to allow counties to raise the limitation to 33 percent of the total eligible cropland. Douglas County currently falls under this provision. These “waivers” were allowed if there were substantial amounts of highly erodible lands (HEL) or other significant environmental concerns. Present CRP rules no longer allow for waivers based on these criteria. Douglas County currently has approximately 187,000 acres enrolled in CRP in two sign-up periods ending in 2007 and 2008. Due to the loss of the waiver, the total amount of enrolled acres will be reduced by approximately 48,000 acres. This acreage loss will occur when the first re-enrollment period in 2007 begins and represents a direct loss of shrubsteppe-like habitat. Landowners indicate that this land will need to be returned to production to generate needed income (Dudek, pers. comm., 2004). Efforts are underway to work with the NRCS and FSA to avoid this loss or develop a

CRP-like program, independent of USDA, which will keep these CRP fields in perennial cover that is beneficial to wildlife (Hemmer, pers. comm., 2004). The number of acres protected by CRP is compared among the portions of counties included within the Subbasin in Figure 39 and listed statewide by county in Appendix D.



(FSA, unpublished data, 2003)

Figure 39 CRP acres (by county) in the UMM Subbasin, WA.

Protection Status

The vast majority of UMM Subbasin agricultural habitat is designated as low or no protection status and is at risk for further degradation and/or conversion to other uses. Shrubsteppe-like habitat established through implementation of CRP also receives short-term high protection. The GAP protection status of agricultural habitat in the UMM Subbasin is illustrated in Table 24.

Table 24 Agriculture GAP protection status/acres in the UMM Subbasin, WA.

GAP Protection Status	Acres
High Protection	0
Medium Protection	7,415
Low Protection	98,313
No Protection	588,137

(IBIS 2003)

4.2.7 Aquatic/Fish Habitat Conditions

Hatcheries and, or, rearing ponds are located in all of the CCP subbasins , except Lake Chelan, to address natural production of salmon and steelhead and to mitigate for fish lost because of hydroelectric and irrigation development throughout the Columbia River Basin.

4.2.8 Fish Listings

Spring Chinook within the ESU

The Upper Columbia River Spring Chinook (*Oncorhynchus tshawytscha*) were listed as an endangered species on March 24, 1999. The listed Evolutionary Significant Unit (ESU) includes all naturally spawned populations of spring Chinook in accessible reaches of Columbia River tributaries between Rock Island and Chief Joseph dams, excluding the Okanogan River. A few hatchery populations from the Methow and Wenatchee rivers were included in the listed ESU. Critical habitat for the listed ESU was designated on February 16, 2000 and included all river reaches accessible to listed spring Chinook in Columbia River tributaries between Rock Island and Chief Joseph dams, excluding the Okanogan River (Golder Associates 2001). The Assessment Reach of Wanapum Dam to Rock Island Dam was never included as critical habitat for spring Chinook. Both Chinook and steelhead critical habitat were removed temporarily on April 30, 2002 by US District Court.

Adult spring Chinook salmon in the Upper Columbia Basin are not currently known to use the Okanogan River. The temperature regime at the time spring Chinook salmon spawn in the Okanogan River is too high for successful spawning and rearing. Water temperatures are elevated because of natural causes exacerbated by land use practices. In their Endangered Status of One Chinook Salmon ESU Final Rule (U.S. Federal Register 1999), the National Marine Fisheries Service excluded the Okanogan River from their Endangered species listing for the Upper Columbia ESU of spring Chinook salmon. The Okanogan River was excluded because they are extirpated from the basin.

Steelhead within the ESU

Upper Columbia River Steelhead (*Oncorhynchus Mykiss*) were listed as an endangered species on August 18, 1997. The ESU includes all naturally-spawned populations of steelhead in tributaries of the Columbia River upstream from the Yakima River, including the Wenatchee, Entiat, Methow, and Okanogan rivers. The Wells Hatchery steelhead stock were included in the listed ESU because they are considered essential for the recovery of the natural population. Critical habitat for the ESU was designated on February 16, 2000 and included all river reaches accessible to listed steelhead (and associated riparian zones) in Columbia River tributaries between the Yakima River and Chief Joseph Dam (Golder Associates 2001). Steelhead critical habitat was removed temporarily on April 30, 2002 by the US District Court.

Bull Trout

The ‘distinct population segment’ (DPS) for bull trout, incorporating the entire Columbia (i.e., upper and lower), was listed as threatened on June 10, 1998. River reaches within the Columbia have been proposedas critical habitat for bull trout and were selected based on the following factors: connectivity, range wide recovery, genetic diversity, maintenance of multiple life history strategies, and representation of major portions of the species’ historical range. Proposesd bull trout critical habitat is areas currently or historically used by bull trout for foraging, overwintering, and migration and having the potential to support increasing use. These areas must also possess quality habitat containing several primary constituent elements for bull trout (FWS 2002a, 2004).

The Columbia River within the proposed critical habitat reach is adjacent to several bull trout recovery units that extend to the Columbia River. These include the Willamette River, Lower Columbia River, Hood River, Deschutes River, John Day River, Umatilla/Walla Walla River, Middle Columbia River and Upper Columbia River recovery units. Bull trout occur in greatest numbers in the upper Columbia River section of the proposed critical habitat reach where suitable conditions for migration exist in the lower reaches of tributaries. Major tributary systems within the UMM known to support bull trout populations include the Wenatchee, Entiat, and Methow rivers (FWS 2002a, 2004).

Presently, bull trout recovery units for the Columbia River DPS do not include the Columbia River. Although the Columbia has important core habitat elements (foraging, over-wintering, migration, maintaining multiple life history strategies, and providing a corridor to restore connectivity) (Rieman and McIntyre 1993), and bull trout have used or are presently using the Columbia River, sufficient information on the role that the Columbia River should play in bull trout recovery is lacking. To better define the role that the Columbia River will play in the recovery of bull trout, studies to verify their abundance, spatial distribution, and temporal use in the Columbia River are needed (FWS 2002a, 2004).

The FWS has developed a Draft Bull Trout Recovery Plan associated with prosed critical habitat. The critical habitat protion of the plan will be finalized by Septmenber 23, 2004. The Draft Recovery plan encompasses the following objectives: 1) Maintain current distribution of bull trout within core areas in all recovery units and restore distribution where recommended; 2) Maintain or increase bull trout abundance in all recovery units; 3) Restore and maintain suitable habitat conditions for all life history stages and strategies; 4) Conserve genetic diversity and provide opportunity for genetic exchange. Greater use of the Columbia River would be expected through implementation of bull trout recovery plans as habitat conditions improve and populations increase (FWS 2002a, 2004).

4.2.9 Columbia River Assessment Unit

The Columbia River Assessment unit extends from Wanapum Dam at river mile 415.8 to Chief Joseph Dam at river mile 545.1.

Riparian Condition

Undisturbed riparian systems are rare along the UMM. Riparian habitat diversity has declined and is undeveloped in some areas, whereas other areas have increased. Low-bank riparian habitat is extremely rare along the river and some areas that were once dominated by cottonwood have been lost. Some of this habitat was lost because of the development of hydropower on the river that altered the natural flood regime. However, in many areas of the UMM, extremely high flow events prior to installation of the dams scoured what little vegetation there was (Tom Dresser, pers. comm., 2004; Chuck Peven, pers. comm., 2004). Other factors, including agricultural conversion and water withdrawals have also impacted riparian systems in the UMM Subbasin.

As a result, some of the upper middle Columbia now exhibits steep shorelines and sparse riparian vegetation that provide limited fish and wildlife habitat.

Embayments connected to the Columbia River Columbia via culverts or small channels provide special wildlife values. The reduced water fluctuation and protection from wave action is beneficial to wildlife, directly and indirectly, and as a result those conditions promote diverse riparian and wetland vegetative communities.

Fine Sediment

Smoothing of the hydrograph and lack of significant reservoir fluctuation from Columbia Basin hydroelectric development has increased the amount of fine sediment present in Columbia River cobble substrate, especially in the lower portions of reservoirs (Falter et al. 1991). Columbia River anadromous salmonid spawning is concentrated at the upstream portions of reservoirs, where it is generally assumed river hydraulics are sufficient to maintain well-sorted substrates that are relatively free of fine sediment. Water velocity in the upstream reservoir areas is also sufficient for adult anadromous salmonids to move cobble substrate for redd construction.

Water Quantity and Quality

Columbia River flows average more than 180,000 cfs in the UMM. Most of this flow comes from upriver areas in the Columbia River Basin. Upriver contributions from the Columbia Basin in Canada provide 99,200 cfs of average flow in the Columbia River, and much of the balance comes from the Kettle and Spokane rivers. Average flow contributions from the three largest tributaries in the UMM (the Okanogan, Methow and Wenatchee rivers) provide another 7,860 cfs to the Columbia River Columbia River. Hydroelectric operations at Grand Coulee Dam greatly influence river flows for downstream hydroelectric operations.

Maximum pool fluctuations in mid-Columbia reservoirs are generally less than 10 feet. They usually occur during winter when Chinook embryos and alevins are incubating in the substrate. Such fluctuations in water levels in the mid-Columbia region could have an adverse effect on embryos depending upon the degree and duration of the fluctuation and the stage of embryo development. The critical hatching stage of pre-emergent fry susceptible to dewatering occurs annually from late November through late April (Chapman et al. 1982).

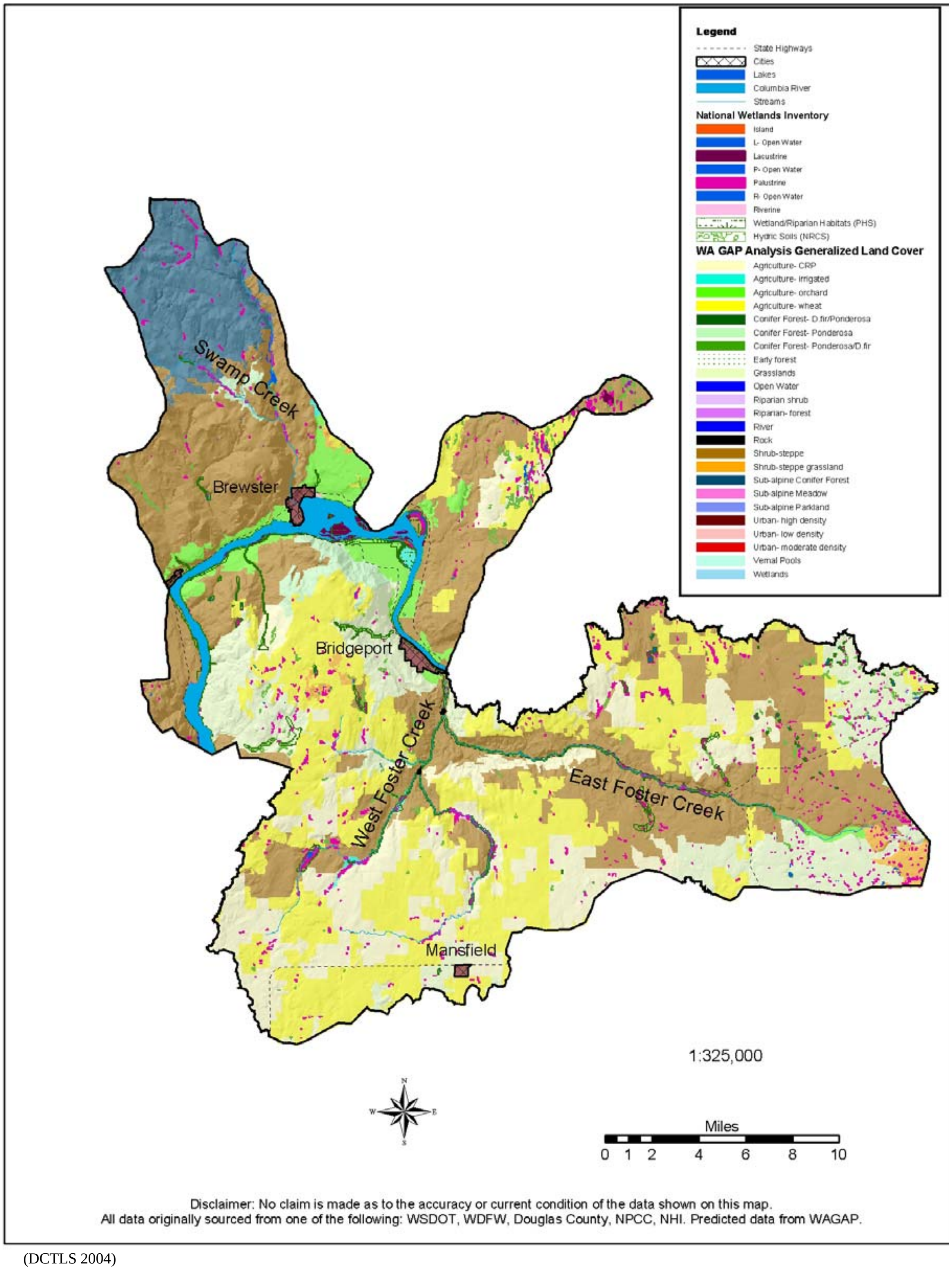
The Columbia River has been classified by the Washington Department of Ecology (WDOE) as a “Class A” water. On a scale ranging from Class AA (extraordinary) to Class C (fair), Class A waters are rated as excellent. State and federal regulations require that Class A waters meet or exceed certain requirements for all uses.

While water quality in the UMM is good compared to other rivers in the United States, there is still cause for concern. Primary concerns include levels of dissolved gases, changes in stream temperatures, turbidity levels and exposure to environmental contaminates above biological thresholds for fish species utilizing the river. These concerns are generally related to hydropower production. The hydroelectric projects on the Columbia River of the Columbia River within the UMM are run-of-river with reservoirs that have little storage capacity. Water velocities are generally fast enough to prevent the formation of a thermocline and the associated depletion of oxygen in deeper waters. Water quality parameters affected by hydropower production, include total dissolved gas (TDG), water temperature, dissolved oxygen, turbidity, suspended sediments and nutrients. The status of each of these parameters in the UMM is summarized in the Appendix E.

4.2.10 Small Tributaries Assessment Unit

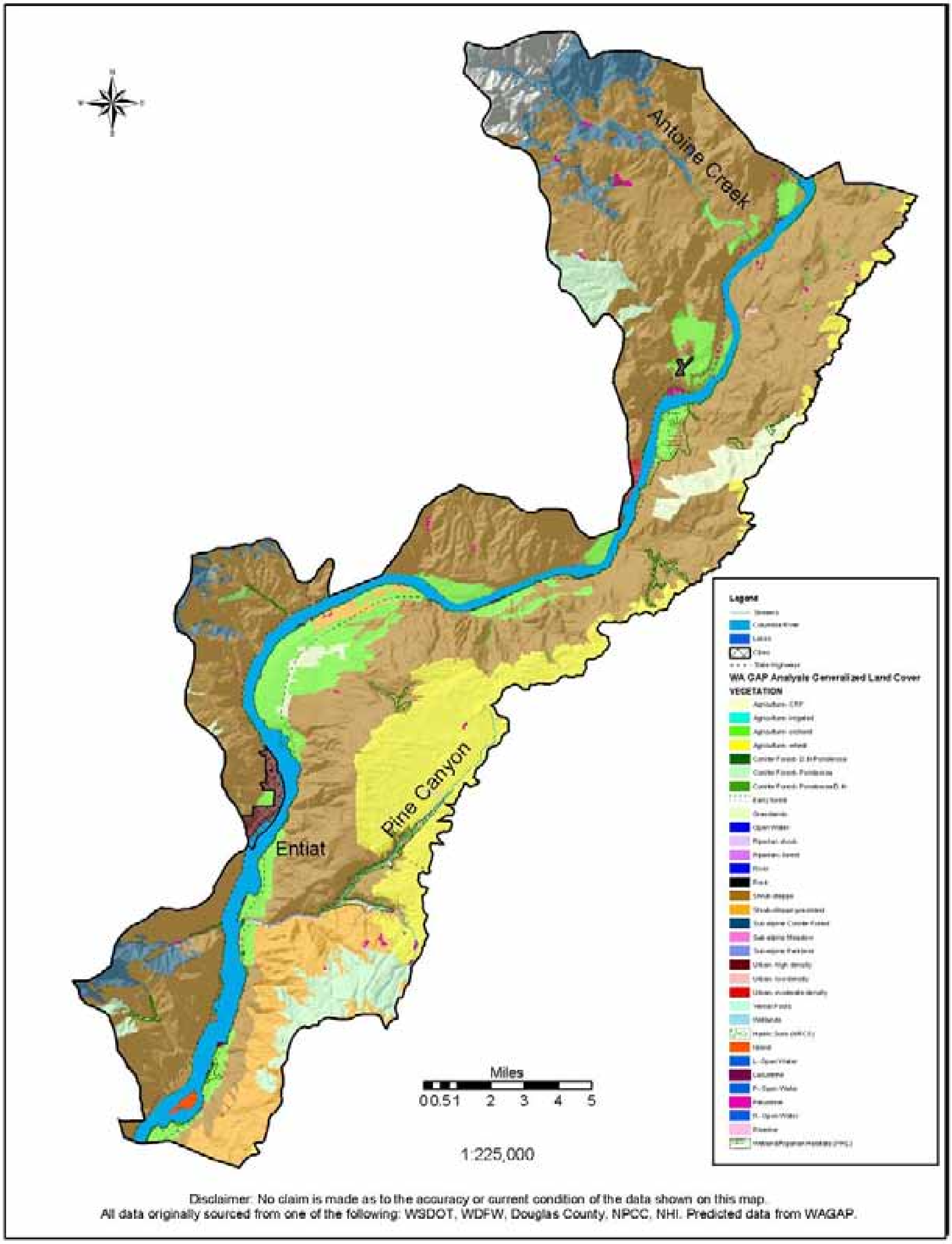
Some generalized statements can be made that apply to all or most of the UMM Subbasin tributaries. Historically, only the very lowest reaches of most of the tributaries would ever have been accessible to Chinook salmon. Most tributaries very quickly become a boulder/cobble-dominated streambed with high gradient runs impassable to spring Chinook. Many of these lower reaches have been inundated by the Columbia River and the habitat dramatically changed as a result of the construction of the Columbia River hydroelectric dams. Rainbow and steelhead would have been distributed throughout the watersheds where habitat was accessible. Maps depicting the location of UMM Subbasin tributaries are shown below (Figure 40 - Figure 43).

In most cases, the extent to which the tributaries can support salmon and steelhead/rainbow trout is most strongly limited by the natural hydrology and geology in this low precipitation region. A large portion of the total annual water production occurs as snowmelt stream flow in April through July. There is an annual excess of available surface water during melt seasons (USFS 1998), but inadequate supplies during the remaining portion of the year. Because of the reliance on snow accumulation and snowmelt to support instream flows in the watershed and the high permeability of the soils, access to habitat is very limited. This condition is worsened during low water years. There is a more detailed account of habitat and stream channel conditions for WRIAs 44 and 50 in *WRIA 44/50 Final Phase 2 Basin Assessment, April 2003*, for Foster Creek Conservation District by Pacific Groundwater Group with Montgomery Water Group and R2 Resource Consultants.



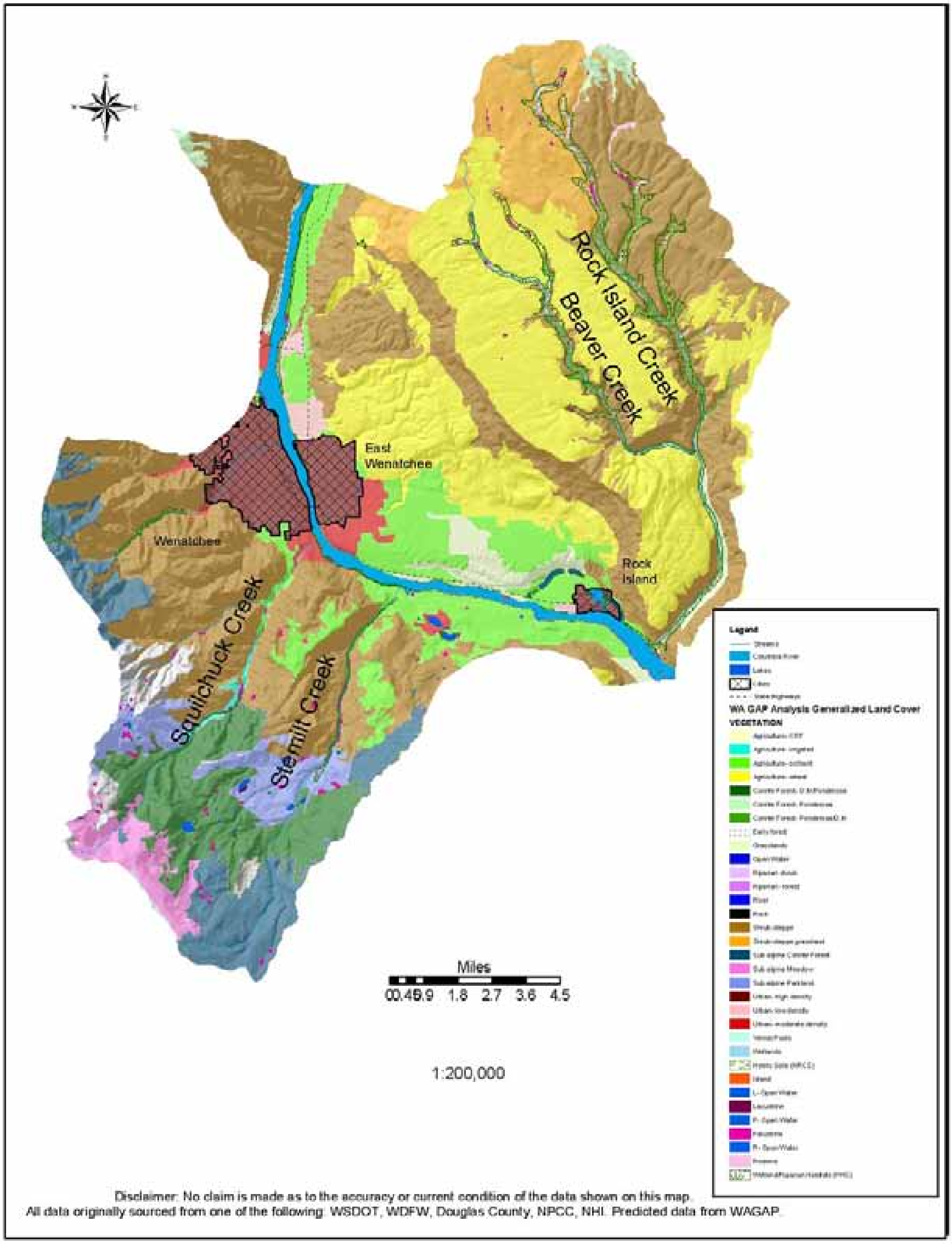
(DCTLS 2004)

Figure 40 Tributaries and land cover in the UMM Subbasin from Wells Dam to Chief Joseph Dam



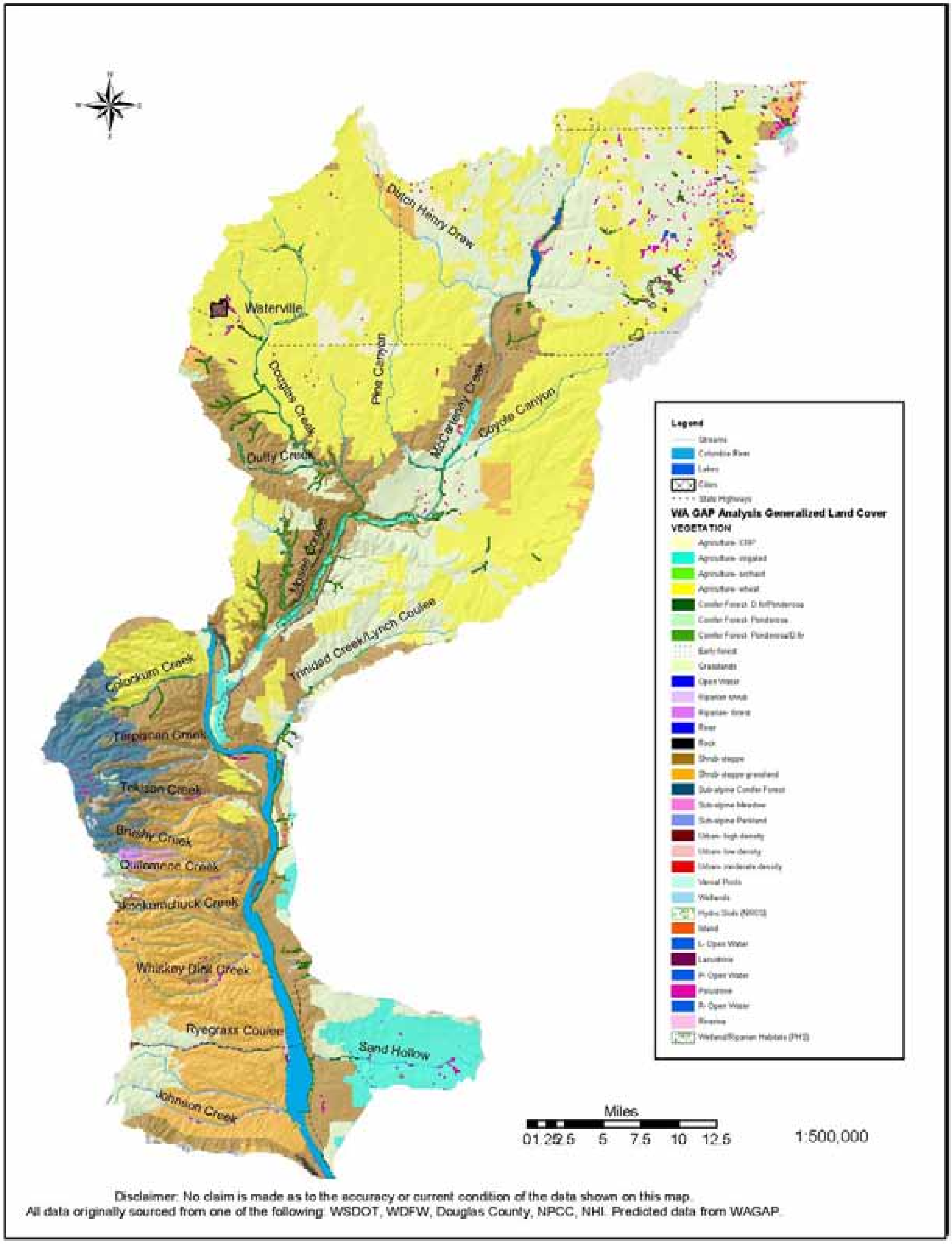
(DCTLS 2004)

Figure 41 Tributaries and land cover in the UMM Subbasin, from Rocky Reach Dam to Wells Dam



(DCTLS 2004)

Figure 42 Tributaries and Land cover in the UMM Subbasin, from Rock Island Dam to Rocky Reach Dam



(DCTLS 2004)

Figure 43 Tributaries and land cover in the UMM Subbasin, from Wanapum Dam to Rock Island Dam

QHA Model

A QHA model (Mobrand, QHA Model, 2003) was used to compare current aquatic and riparian habitat conditions in relation to the habitat requirements of all life stages of rainbow/steelhead trout (*Onchorynchus mykiss*) and Chinook salmon (*Onchorynchus tschawytscha*), with both known and assumed historical habitat conditions on 15 small tributaries in the UMM Subbasin. The QHA facilitates a structured ranking of stream reaches and attributes (Table 25) for subbasin planners. Information used in the analysis was obtained from documents, site visits, field sampling, expert opinion, and speculation.

Many of the small tributaries to the UMM are remote and very little information exists concerning these tributaries. Rigorous field investigations were not conducted because of insufficient funds. Most frequently the expert knowledge of subbasin planners was relied upon to describe physical conditions in the target stream and to create a hypothesis about how well the present habitat conditions provide for the needs of a focal species.

The synopsis of the streams/watersheds (see Environmental Conditions) was based on the QHA analysis and available sources, such as the limiting factors analyses (LFA) and local watershed assessments. The assessments were greatly enhanced by some recent Grant County PUD data acquired through their relicensing process, Foster Creek Conservation District's work in the 2514 Watershed Planning Process, and WDFW staff acquiring data through site visits.

A hypothesis was then created to describe/define how well the present habitat conditions provide for the needs of a focal species. The hypothesis is the "lens" through which physical conditions in the stream are viewed. The hypothesis consists of weights that are assigned to life stages and attributes, as well as a description of how reaches are used by different life stages. These result in a composite weight that is applied to a physical habitat score in each reach. This score is the difference between a rating of physical habitat in a reach under the current condition and the condition of the reach for the attribute in a reference (historical) condition. The result is that the current constraints on physical habitat in a stream are weighted and ranked according to how a focal species might use that habitat.

The attributes are rated for reference (undisturbed or normal) and current conditions and weighted for the effect on a particular life stage survival and capacity- spawning, rearing, and migration. Migration considers both adult and juvenile life stages. Weighting is derived for each habitat attribute in the reference and current conditions using a primary environmental attribute and an associated modifier. For example, the habitat attribute channel stability has a primary environmental attribute of bed scour, and three modifiers- icing, riparian function, and wood.

Table 25 Habitat attributes in the QHA Model

Riparian Condition	**Condition of the streamside vegetation, landform and subsurface water flow.**
Channel Stability	The condition of the channel in regard to bed scour and artificial confinement. Measures how the channel can move laterally and vertically and to form a "normal" sequence of stream unit types.
Habitat Diversity	Diversity and complexity of the channel including amount of large woody debris (LWD) and multiple channels.
Fine sediment	Amount of fine sediment within the stream, especially in spawning riffles.

Riparian Condition	Condition of the streamside vegetation, landform and subsurface water flow.
High Flow	Frequency and amount of high flow events.
Low Flow	Frequency and amount of low flow events.
Oxygen	Dissolved oxygen in water column and stream substrate.
Low Temperature	Duration and amount of low winter temperatures that can be limiting to fish survival.
High Temperature	Duration and amount of high summer water temperature that can be limiting to fish survival
Pollutants	Introduction of toxic (acute and chronic) substances into the stream.
Obstructions	Natural or man-made barriers- documented as to which type.

Grazing management plans or schemes were not assessed as a part of the tributary analysis. Substrate data discussions from WDFW collected information gathered during summer 2004 were based on visual observations, not a quantified data analysis process.

Rainbow trout/steelhead and Chinook were modeled using QHA. For the descriptions below, the term “rainbow trout” is used to represent both forms of that species (resident and anadromous). The stream descriptions include the number of acres per watershed or sub watershed (reach) if available based on HUC 6, USGS data to follow drainage basin boundaries, but truncated and estimated where boundaries crossed into two reaches identified in the QHA process (does not match WRIA boundaries). A description of the streams and reaches for the UMM Subbasin used for our analysis can be found in Figure 49 Comparison of ranked Steelhead/rainbow trout QHA protection and restoration scores for the UMM Subbasin, WA.

Table 26. Stream lengths were estimated using the length of perennial and intermittent flow (ephemeral upper sections were not included); therefore the drainage area lengths may be much longer than the stream lengths.

Ranked protection and restoration scores (Figure 44 - Figure 47) produced by the QHA and the relationship between these scores (Figure 48 and Figure 49) need to be considered along with the description of watershed attributes described for each tributary (Figure 49 Comparison of ranked Steelhead/rainbow trout QHA protection and restoration scores for the UMM Subbasin, WA.

Table 26) in the following section. The range of values for comparison purposes for steelhead are protection 120 to 213, restoration 6 to 117, and for Chinook protection 117 to 213, restoration 4.5 to 96.

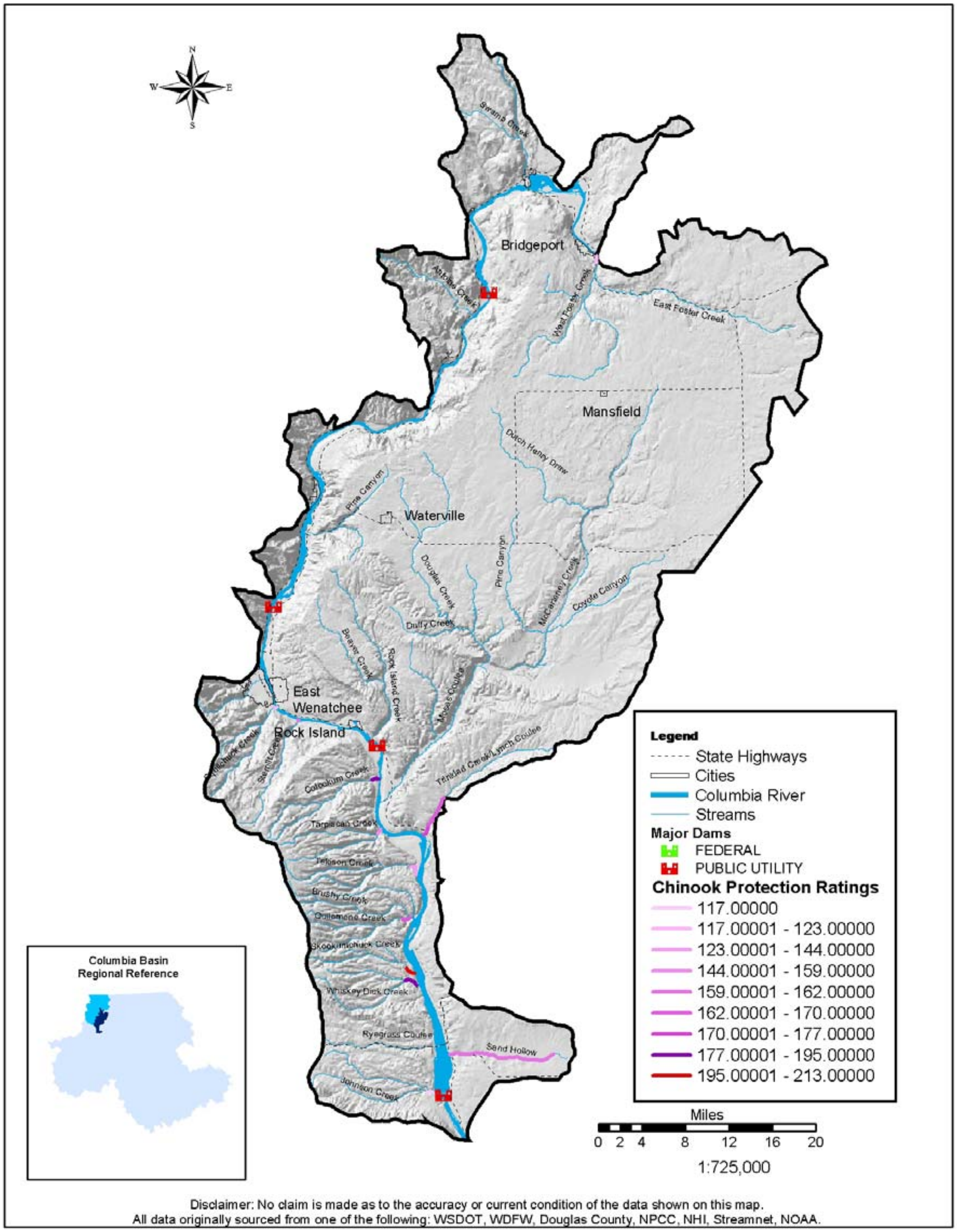


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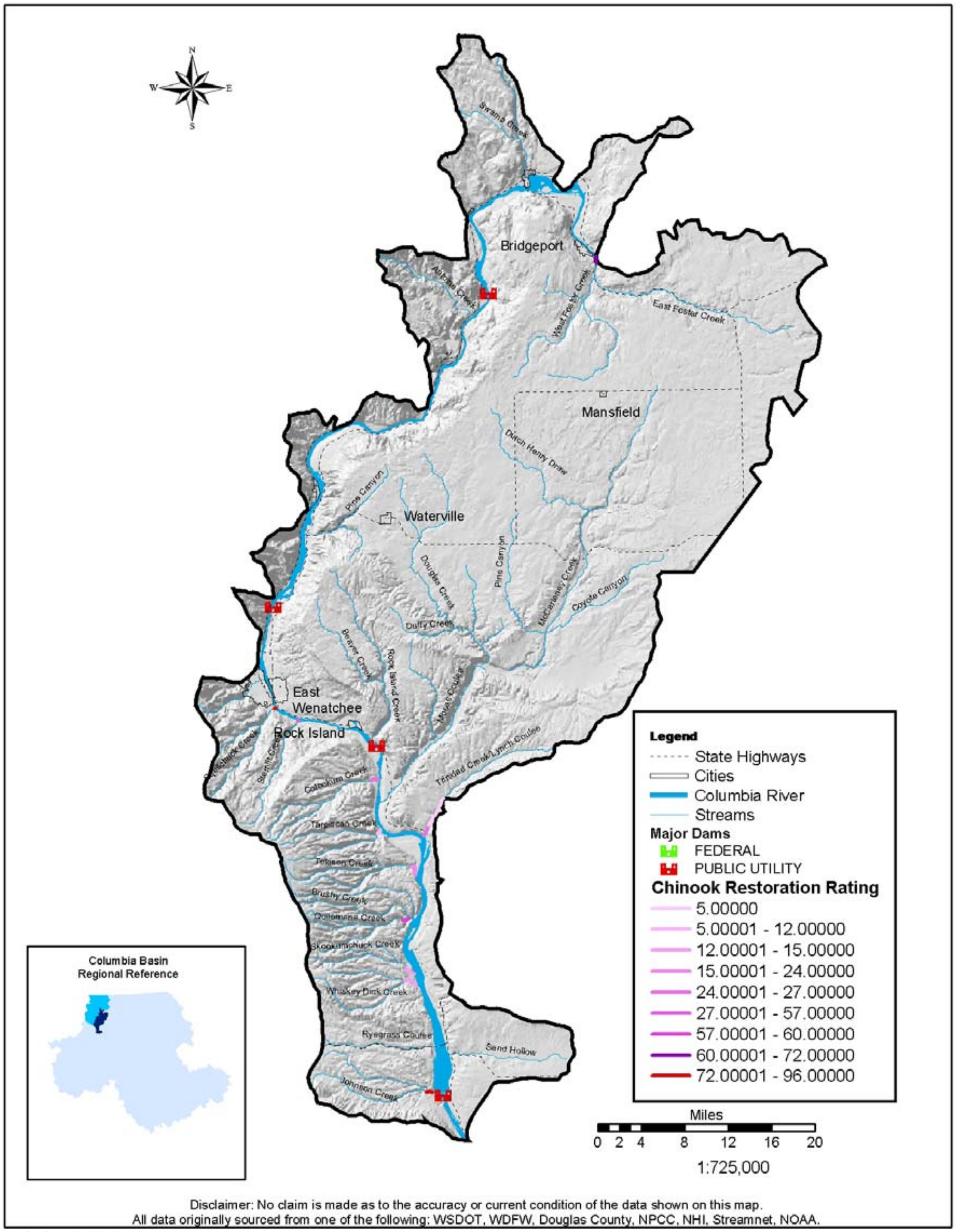
Figure 44 Ranked Chinook QHA protection scores in the UMM Subbasin, WA.



(DCTLS 2004)

Figure 45 Ranked Chinook QHA restoration scores for the UMM Subbasin, WA.

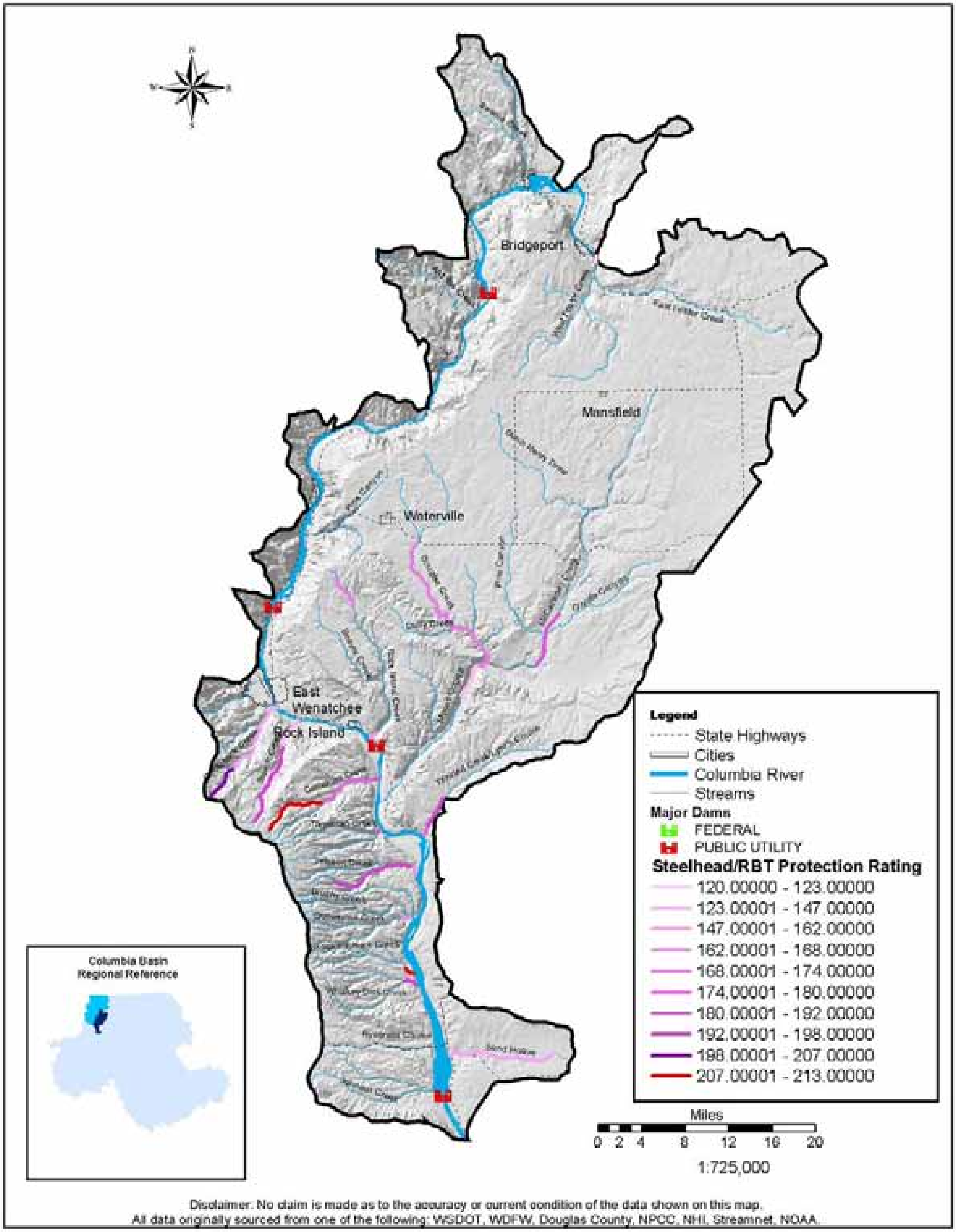


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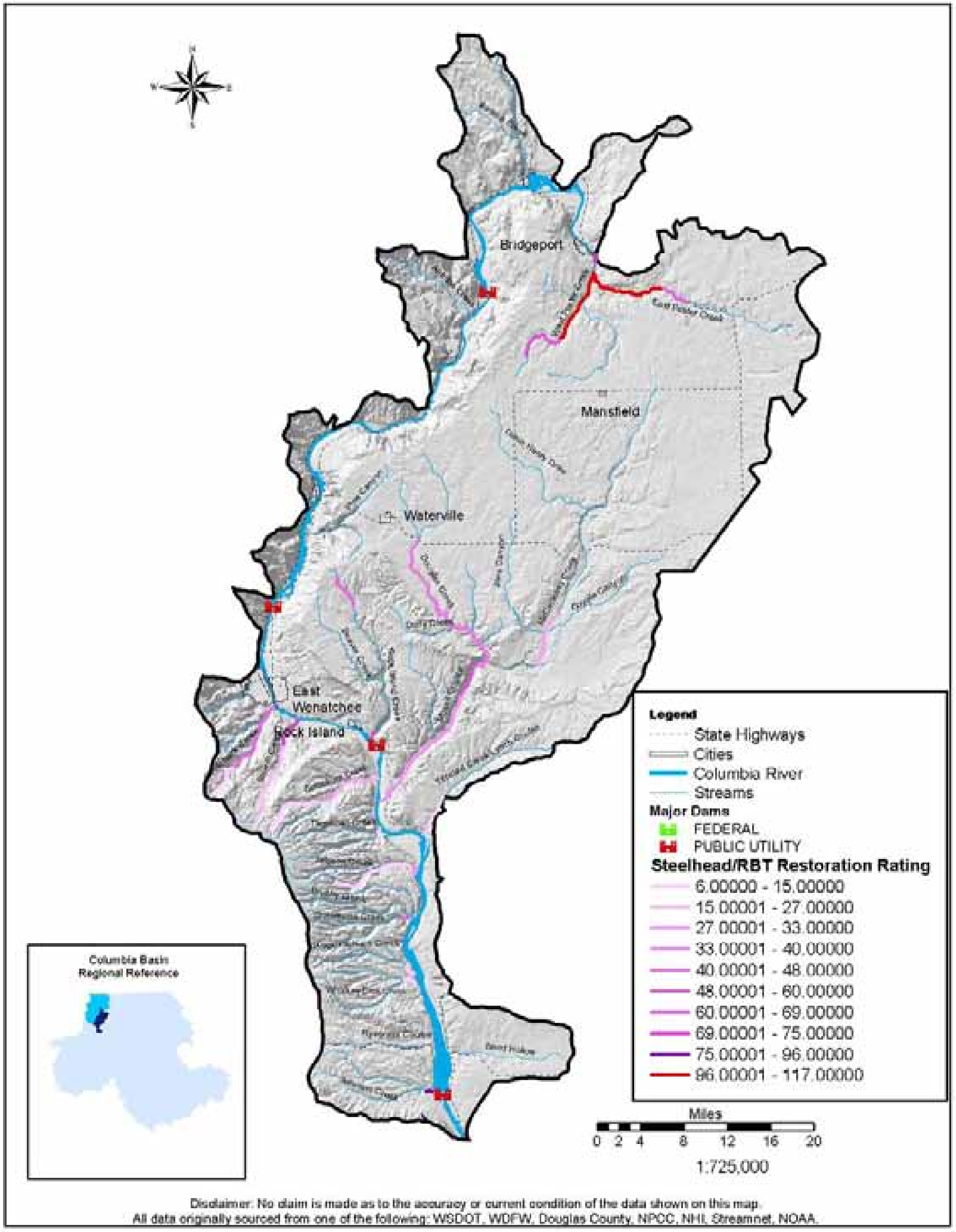
Figure 46 Ranked steelhead/rainbow trout protection scores for the UMM Subbasin, WA.



(DCTLS 2004)

Figure 47 Ranked steelhead/rainbow trout restoration scores for the UMM Subbasin, WA.

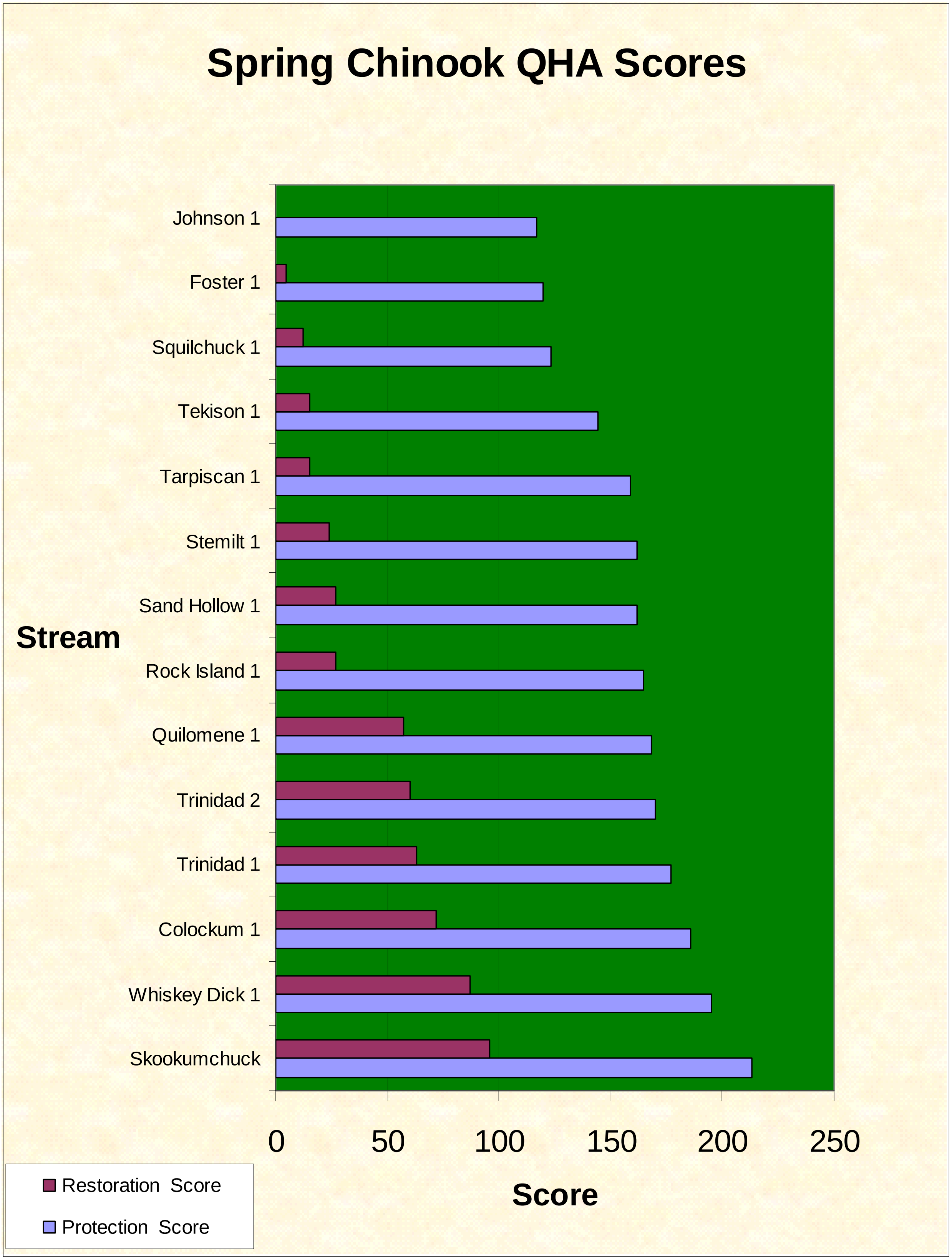


Figure 48 Comparison of ranked Chinook QHA protection and restoration scores for the UMM Subbasin, WA.

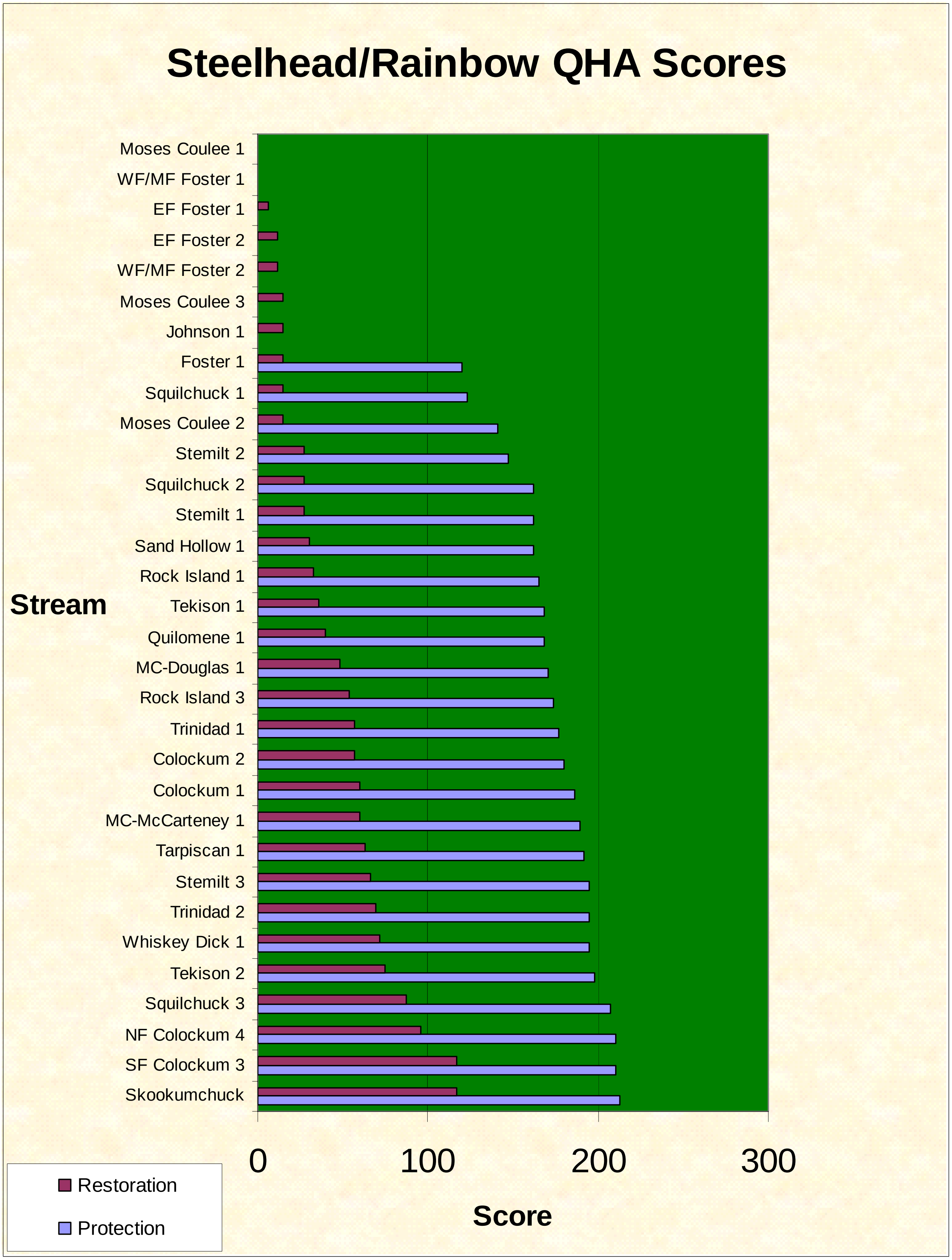


Figure 49 Comparison of ranked Steelhead/rainbow trout QHA protection and restoration scores for the UMM Subbasin, WA.

Table 26 Watershed attributes of streams in the UMM Subbasin, WA.

Stream/watershed	Reaches	Reach Length	Elev Low	High Elev	Acres	Public Acres	% Public
Brushy Creek	Brushy	1.5	599	5,056	13,335	8,812	0.66
Colockum Creek	Colockum	6.6	570	5,053	14,288	7,732	0.54
	SF-Colockum	4.7	2,161	5,761	4,596	3,365	0.73
	NF-Colockum	6.4	2,147	5,818	6,360	4,525	0.71
Foster Creek	Foster	1.8	780	2,616	4,244	757	0.18
	EF Foster	12.3	1,019	2,610	114,615	25,812	0.23
	WF Foster-Includes mainstem above barrier	13.6	1,021	3,175	39,524	7,486	0.19
	MF Foster		1,448	3,113	55,538	303	0.01
	New Foster		780	2,616	2,051	115	0.06
Johnson Creek	Johnson	5.5	591	3,745	38,610	38,344	0.99
Moses Coulee	Moses Coulee	25.7	582	3,600	139,507	75,738	0.54
	Douglas	19.4	1,020	4,173	131,067	22,123	0.17
	McCarteney	19.3	1,174	3,181	321,721	54,483	0.17
Pine Canyon Creek	Pine Canyon	12.0	705	5,325	21,500	1,720	0.08
Quilomene Creek	Quilomene	7.9	603	4,404	15,387	11,003	0.72
Rock Island Creek	Rock Island	18.6	610	4,247	54,822	6,076	0.11
Sand Canyon Creek	Sand Canyon	7.2	608	3,420	3,130	94	0.03
Sand Hollow Creek	Sand Hollow	10.4	569	1,895	35,518	2,085	0.06
Skookumchuck Creek	Skookumchuck	2.1	583	3,660	9,461	3,587	0.38
Squilchuck Creek	Squilchuck	11.5	616	6,802	17,554	4,694	0.27
Stemilt Creek	Stemilt	11.2	607	6,723	21,100	12,291	0.58
Tarpiscan Creek	Tarpiscan	.5	735	5,621	8,180	5,313	0.65
	NF-Tarpiscan	5.7	735	5,621	8,180	5,313	0.65
	SF-Tarpiscan	5.1	734	5,431	7,225	3,722	0.52
Tekison Creek	Tekison	9.2	570	5,456	21,138	14,784	0.70
Trinidad Creek (Lynch Coulee)	Trinidad	4.6	574	2.884	38,926	4,325	0.11
Whiskey Dick Creek	Whiskey Dick	4.0	572	3,867	21,904	14,806	0.68

Brushy Creek

The Brushy Creek Watershed, located in Kittitas County, contains approximately 13,335 acres, of which 66% is publicly owned. Data indicate that steelhead have used the bottom 0.8 miles for migration, the next 0.3 miles for rearing and migration habitat, the next 6.1 miles for spawning and rearing, and finally the last 0.5 miles for rearing and migration (Streamnet 2003).

Two reaches to be used in the QHA model were established on Brushy Creek. Reach 1 extends from the confluence with Quilomene up-stream to RM 1.46. Reach 2 begins at RM 1.46 and extends to the headwaters. Reach 2 was not surveyed because of its remote location. Although reaches were established, values for protection and restoration were not completed on Brushy Creek during the planning process.

Riparian Conditions

As its name implies, both banks of the lower mile of Brushy Creek are densely covered with vegetation common to the area. WDFW staff speculate that the riparian vegetation currently found on this reach is similar to what occurred historically.

Channel Conditions and Diversity

Channel characteristics in Reach 1 remain very similar to historic conditions, but may have been degraded by the excessive cattle grazing that took place in the 1900s (Paschal, pers. comm., 2003).

Fine Sediments

On July 14, 2003 WDFW sampled substrates in Reach 1, we found heavy to moderate siltation. Currently we are unsure of historical substrate conditions but speculate that historical silt loads in the creek were less than currently exits. The existing accumulation of silt is likely a result of historic cattle grazing.

Water Quantity and Quality

WDFW recorded water temperature and DO measurements of 69^0F and 7.5 ppm, respectively (July 14, 2003 at 2:15 P.M). Water flows were judged to be relatively good (50% bank full) for that time of year. Water flow, water temperature, and DO concentrations in Reach 1 were within tolerance limits for both juvenile Chinook and rainbow/steelhead. Currently no information is available concerning year-round daily water temperatures, DO levels, or water quality. Cattle grazing and agricultural practices are assumed to only marginally affect water quality.

Colockum Creek

The headwaters of Colockum Creek lie in the upper reaches of the southernmost extent of Naneum Ridge. Colockum Creek flows in an easterly direction from its headwaters for approximately 12 miles before entering the Columbia River (RM 450.0) fifteen miles downstream of the Wenatchee River confluence. Elevation ranges from 5,600 along Naneum Ridge to 650 feet at the mouth. All of the lower 7.5 miles of stream flows through private land. Colockum Road parallels the stream channel for the first 6 miles.

It is presumed that historically salmon were present only in the lowest reach of Colockum Creek and steelhead/rainbow trout would have been distributed throughout the watershed where habitat was accessible (Steele, pers. comm., 2000; Viola, pers. comm., 2004).

Based on electro-fishing results rainbow/steelhead presently occur from the mouth upstream to Kingbury Canyon (RM 3.8; Steele, pers. comm., 2001). It is assumed that at this time rainbow/steelhead are distributed throughout the watershed where low flows, natural barriers and human-made fish passage barriers do not preclude access to habitat. In 1999 Grant County Public Utility District (GCPUD) surveyed the lowest reach and found several species of fish present; rainbow trout, Chinook salmon, threespine stickleback, chiselmouth longnose dace, and cottids.

There is no published information available on habitat conditions or land use affects on aquatic habitat in the Colockum Creek watershed. There were no culvert fish passage barriers identified in the Harza/Bioanalysts (2000) fish passage barrier inventory, however irrigation diversion structures in the drainage may hinder or block fish passage at some flows (Steele, pers. comm., 2001). These structures have not been evaluated for fish passage concerns (Andonaegui 2001).

For use in the QHA Model, Colockum Creek was divided into four reaches; the mouth to a large gradient change (RM 0.76), from RM 0.76 to the confluence of the north and south forks (RM 6.58), and each of the two forks to the headwaters (NF-6.43 miles, SF- 4.7 miles).

Riparian Conditions

Riparian vegetation on Colockum Creek is, in general, dense and brushy. However, some areas particularly in the middle and lowest reaches have been negatively altered by residential and agricultural activities and road crossings. Vegetative species change with elevation. The upper reaches are dominated by forest vegetation common to the area. Brushy species dominate and the middle reach and riparian vegetation in the lowest reach contains sage and bitter brush.

Channel Condition and Diversity

Present channel condition and diversity in the lowest reach of Colockum Creek has not been thoroughly surveyed; more investigation is needed. The middle reach has been altered substantially by road development, which includes a number of stream crossings. The current channel condition and diversity in reaches 3 and 4 also have been altered by road construction and bridge crossings but to a much lesser degree than the middle reach. Portions of both reach 3 and 4 are unaltered and assumed to be in similar conditions as occurred historically.

There were no culvert fish passage barriers identified in the Harza/Bioanalysts (2000) fish passage barrier inventory, however irrigation diversion structures in the drainage may hinder or block fish passage at some flows (Steele, pers. comm., 2001; Viola, pers. comm., 2003). An irrigation diversion structure located approximately 1.0 mile up Colockum Creek may block fish passage at low flows (Steele, pers. comm., 2001). These structures have not been evaluated for fish passage concerns. Colockum Creek was adjudicated in 1913 with no provisions for maintaining instream flows; certified water rights appear to exceed available surface flow on an annual basis (Monahan, pers. comm., 2001).

Fine Sediments

On July 14, 2003 WDFW briefly sampled substrates in Reaches 1, 2 and 3 of Colockum Creek. We found heavy to moderate siltation in Reaches 1 and 2 and minor siltation in Reach 3. Currently we are unsure of historical substrate conditions but speculate that silt loads in the stream were less than currently exits. The current accumulation of silt is likely a result of agricultural practices and possible historic cattle grazing. Reach 4 was surveyed about a week later and found to be dry, making it difficult to determine substrate characteristics.

Water Quantity and Quality

Average annual precipitation is relatively low with precipitation rapidly decreasing with declining elevation. Runoff comes predominantly from melting of accumulated snow from April through July. Perennial stream channels are limited in this watershed and intermittent flows occur regularly in the upper reaches. Also the stream flow goes subsurface in many sections of the upper reaches. Year-round water quality is unknown. WDFW speculates that cattle grazing and agricultural practices only marginally affect water quality.

WDFW recorded identical water temperature and DO measurements of 62^{0}F and 8.0 ppm, in reaches 2 and 3 (1:00 P.M.) on the July 14, 2003 site visit to Colockum Creek. Water flows were very low. Water flow under normative conditions is not ideal for fish use, but it has also been altered by water diversions from the normative conditions (LFA- Andonaegui, 2001). WDFW also recorded water temperature and DO measurements of 70^{0}F and 7.0ppm (4:00 P.M.), respectively, in Reach 1 (Viola, pers. comm., 2003), which slightly exceeds tolerance limits for both juvenile steelhead and Chinook. Currently no information is available concerning year-round daily water temperatures or DO levels. Due to the remote location of Reach 4, it was not surveyed until a week later and was found to be dry.

QHA Results

Reach one was modeled for both rainbow trout and Chinook salmon (Table 27) and the remaining reaches for rainbow trout only, as there is no documentation of Chinook occurring that far up in the watershed because of steep gradient and insufficient flow. Colockum Creek water quality in all reaches is unknown, but minor contamination may occur because of livestock grazing.

The analyses and ratings for Reach one are the same for both species and have a substantially higher protection rating compared to the restoration rating. In all of the reaches the rainbow trout model depicts high protection ratings when compared to the rest of the tributaries in the Subbasin.

Table 27 QHA habitat scores for Colockum Creek

Reach	Species	Protection Score	Restoration Score
Colockum 1	Chinook	186	27
Colockum 1	Rainbow/steelhead	186	27
Colockum 2	Rainbow/steelhead	180	33
SF-Colockum 3	Rainbow/steelhead	210	12
NF-Colockum 4	Rainbow/steelhead	210	12

Foster Creek

The Foster Creek Watershed is located close to the geographic center of Washington State in the "Big Bend" area of the Columbia River. The watershed drains approximately 214,103 acres in northern Douglas County. There are three main tributaries, Lower (2,311 acres), East (115,872 acres), and West Foster Creek (105,580 acres) that converge and flow northward emptying into the Columbia River downstream of Chief Joseph Dam (Columbia River Mile 545.1) near the town of Bridgeport.

The Foster Creek watershed provides limited habitat for fish. Loss of access to spawning and rearing habitat on Foster Creek was identified as a potential limiting factor for migrating fish. At approximately river mile (RM) 1.03 an irrigation dam stands in a place where a natural falls existed. The irrigation dam is 18 inches taller then the original falls that precluded all fish passage past this point. Surveys have been conducted in the stretch of water upstream of this dam and no anadromous salmonid species were found. Low water flows and direct solar exposure also make it questionable whether or not salmonids could survive in this stretch if given access to it. The lower 1.03 miles of Foster Creek may be blocked off to anadromous salmonids during extreme low flow years because of a 1989 flood that deposited a large gravel bed and reshaped the alluvial fan at the mouth and the channel throughout the reach. The mouth of Foster Creek has also been channelized and rip rapped with rock and wire mesh.

Riparian Condition

Poor quality riparian habitat in the Foster Creek and East Foster Creek drainages may also be a limiting factor for fish. East Foster Creek and Foster Creek above the dam lack large woody vegetation and in several places only the trunks of dead streamside trees are standing.

Channel Condition and Diversity

The stream reach inventory/channel stability evaluation conducted in 2002 indicates a good rating (71 points) for reach one of Foster Creek (PGG et al. 2003).

Fine Sediments

Foster Creek was assessed by R2 Consultants, for Foster Creek Conservation District and found the lowest reach had fines <6mm of 20% in 2002 (PGG et al. 2003).

Water Quantity and Quality

Water quality monitoring has been conducted in the East Foster Creek drainage. Various soil and water problems were identified in this area. Eroding stream banks, channel head cutting, and non-point-source fluvial erosion of croplands and rangelands have all contributed increased turbidity in the stream. Erosion problems occur because of fine-grained soils susceptible to erosion, intense rainfall, or sudden snowmelt.

The Foster Creek drainage receives little yearly precipitation with most occurring during winter months. In the winter, runoff is high and the water is extremely muddy, carrying increased sediment loads associated with loss of riparian vegetation. Some years there are perennial flows in some streams, but this hydraulic continuity is unlikely year-round.

Aside from spring snowmelt, flows in the Foster Creek are generally sustained by groundwater discharge from springs. Intense summer storm events also add to summer flows and some sections of the stream have sub-surface flow. This could restrict any possible dilution of chemical contaminants. It is possible that certain chemical products such as naturally occurring salts and organic materials as well as non-natural substances such as pesticides and herbicides may appear in high concentrations in Foster Creek because of the limited precipitation and flows.

Evidence of contamination, if any in Foster Creek however, is not well documented or not available.

Salmonid productivity may also be negatively affected by warm water temperatures from low flows, arid climates, and lack of riparian shading. The extent to which human activities may exacerbate this condition is unknown. Presently, it is the conclusion of the TAG and landowners that although there are human impacts in the Foster Watershed, these impacts have a very limited affect on anadromous salmonid spawning and rearing use given the natural limitation imposed on the habitat by the arid, shrubsteppe ecosystem.

QHA Results

Foster Creek was sectioned into five reaches: the mouth up to the falls/dam, two reaches in the east fork, and two reaches in the west/middle fork. Overall, the analysis of Foster Creek depicted values higher for restoration than protection (Table 28). The habitat conditions of riparian area, channel stability, diversity, and sediment were fair to poor overall. Water quality, while impaired, does not appear to be as degraded as the physical habitat features. There is a barrier to migration at the end of the first reach, but all of the reaches were modeled for rainbow trout because of the watershed condition and cumulative effects to the lowest reach (i.e., the upstream characteristics appear to be having a larger effect on the first reach, than current conditions indicate). In addition, the resident form of *O. mykiss* could exist above the migration barrier. The lowest reach was also analyzed for Chinook, and the result is nearly identical to that of rainbow trout. No thorough fish surveys have been conducted on the upper reaches to date, but water quality/ quantity and habitat data have been gathered within the last two years or are monitored on an ongoing basis. Reach one has a higher protection value than restoration based on the analysis, but the remaining reaches all have high restoration values compared to most of the streams in the subbasin. Protection values in the upper reaches are zero because the current condition shows no use by the focal species.

Table 28 QHA habitat scores for Foster Creek, Washington

Reach	Species	Protection Score	Restoration Score
Foster 1	Chinook	120	72
Foster 1	Rainbow/steelhead	120	72

Johnson Creek

The Johnson Creek Watershed, located in Kittitas County south of Interstate 90, contains approximately 39,178 acres and is approximately 14 miles in length. Ninety-nine percent of Johnson Creek is located on Public Land (U.S. Army Yakima Training Center, formally Yakima Firing Range). Only the lowest half-mile of stream is privately owned. In 1999 GCPUD surveyed the lowest reach and found several species of fish present; rainbow trout, Chinook salmon, chiselmouth, cottids, largescale sucker, and threespine stickleback. Other data indicate that steelhead have used the bottom 1.6 miles for migration and rearing and fall Chinook for migration (Streamnet 2003). Grant County PUD also found that the population of rainbow trout in this stream might be unique.

Two reaches were established for use in the QHA model. Reach 1 extends from the mouth upstream to RM 0.5. Reach 2 extends from RM 0.5 to the headwaters. We separated these reaches based on ownership. Reach 1 is privately owned, while Reach 2 runs through the U.S Army Yakima Firing Range and has restricted access. Consequently, only Reach 1 was sampled.

Riparian Conditions

On August 18, 2003 WDFW made a cursory survey of Johnson Creek. The riparian zone in Reach 1 of Johnson Creek was extremely degraded compared to assumed historic conditions, and was far more damaged than any other surveyed stream in the UMM Subbasin. Both banks have had most, if not all, of the vegetation removed, leaving only dirt banks. It is believed this was the result of actions taken to clear the site for the current private campground.

Channel Conditions, Diversity, and Fine Sediment

The stream channel has been greatly altered compared to assumed historic conditions. In some places the channel has been straightened, moved, and confined between dirt berms. A deep hole has been dug in the channel to act as a small pond. The lower ¼ mile of stream has been inundated by the Columbia River because of the construction of the Wanapum Dam. A road bridge confines the lowest section of the stream channel. A considerable amount of silt was found in the substrate in Reach 1.

Water Quantity and Quality

Because of complicating circumstances no water quantity or quality samples were taken during WDFW's site visit. More information is needed on year–round flows, water temperatures, and DO concentrations. A comprehensive study of water quality is needed to determine if agricultural or any other chemical contaminants are present at levels that would reduce aquatic system productivity.

QHA Results

Both Chinook and rainbow trout were used in the assessment model (Table 29), although the assessment was only done for Reach one; Reach two is inaccessible because of its location on the Yakima Firing Range. Rainbow trout showed no protection value because the current conditions were not assigned numerical values in the hypothesis section (assessment error). The protection and restoration values for Chinook are misleading; this section of stream is in dire need of restoration for both Chinook and rainbow/steelhead. Riparian and habitat conditions were rated as poor and flow issues, mostly related to natural conditions within the watershed, were identified.

Table 29 QHA habitat scores for Johnson Creek, WA.

Reach	Species	Protection Score	Restoration Score
Johnson 1	Chinook	117	87
Johnson 1	Rainbow/steelhead	Missing	Missing

Moses Coulee

The Moses Coulee Watershed drains approximately 592,833 acres. Moses Coulee extends southwest from central Douglas County before emptying into the Columbia River (Columbia R M 447.0). For subbasin planning the watersheds described include Moses Coulee (including

Rattle Snake Creek, 139,844 acres), Douglas Creek (131,015 acres) and McCartney Creek (321,974 acres). This watershed is one of few in the state with almost no forested areas. It is almost entirely shrubsteppe and agriculture (>99%).

Three streams with a total of six reaches were examined for Moses Coulee. Moses Coulee was broken into 3 reaches: the mouth to where the water flow begins near Palisades, the flowing reach to Douglas Creek, and the area from Douglas Creek to McCartney Creek. The other reaches are Douglas Creek, and two reaches in McCarteney Creek, of which the upper reach is dry throughout most years. All flowing reaches contain fish, including rainbow trout, but no thorough surveys for species composition and population estimates have been done. Some investigations using electroshocking techniques have occurred in the past (Bartu and Andonaegui 2001).

Riparian Condition

Riparian habitat is degraded or lacking in many parts of the Moses Coulee watershed. The lowest reach of Moses Coulee has a channel, but no riparian area as water only flows during extreme flood events (about once every 10-20 years). Reach two is confined and has a limited riparian area that receives water from Douglas Creek. Reach three is above Douglas Creek and has no functional riparian area. Agricultural field development and flood control dikes that capture sediment and energy during extreme events have altered much of that reach. The channel, where it exists, is mostly maintained as a ditched waterway that is dry nearly as much as the lowest reach, under natural conditions. Douglas Creek reaches have fair riparian condition in several areas, although plant composition has many non-native species, such as Russian olive, black locust, and elm trees, orchard grass and knapweed. Reach one of McCarteney Creek has some fair to good riparian cover. Some of reach one has a naturally protected area as it flows between basalt cliffs, and some of the area, where it’s open has had past uses of cattle grazing and crops. There also is an existing non-functional dam that filled in with sediment and has a larger area of wetland/riparian area. Reach two of McCarteney Creek has no riparian area and only flows during extreme flood events.

Channel Condition and Diversity

A natural falls barrier in Douglas Creek hinders upstream fish migration. Rainbow trout, dace, sculpins, and sucker populations are present in the Palisades section and upstream and flourish in a hostile environment: low flows (summer & winter); heavy soil loads from dryland tillage (Waterville Plateau); and infrequent, torrential, floods (Quinn 2001a). Rearing Chinook salmon have been found near the mouth (MR 0-0.1) (WDFW file data) when subsurface flows, during wet weather cycles (several years), are sufficient to come to the surface where the channel gradient drops to the Columbia River.

Rainbow trout are found in McCarteney Creek, likely from private stockings, but have been known since at least 1968 (WDFW file data). Other species may be present, but thorough fish surveys have not been done (Quinn 2001b).

The stream reach inventory/channel stability evaluation conducted in 2002 indicates a fair rating (78 points) for the very lowest section of reach one of Moses Coulee (PGG et al. 2003).

Fine Sediments

No data is available for substrate composition within the Moses Coulee watershed. In the WRIA 44 Basin Technical Assessment, only streams with anadromous salmon potential were surveyed for channel conditions (Dudek, pers. comm., 2004).

Water Quantity and Quality

The substrate of Moses Coulee Creek is often rocky and porous. As a result, runoff that enters the coulee tends to quickly disappear into the stream's floor and permanent flows within upper Moses Coulee are not found until just north of Rim Rock Meadows. McCarteney Creek begins at this point and flows for approximately 6.5 km until it disappears into the Moses Coulee floor.

Douglas Creek is a small stream receiving most instream flow from springs. Flow is southeasterly, into the steep canyon of Douglas Creek, where Duffy Creek, several small streams, and ground water accretion contribute to a permanent flow year round. In most years surface flows seldom reach beyond the Palisades area (Quinn 2001b). Two irrigation diversions are located approximately 0.25 miles from where the stream enters Moses Coulee. During the dry summer months, the lower reach is dewatered with flows either being diverted or going subsurface. Instream flows can intermittently return with a summer thundershower or during high spring run-off events, and the flow during those events can make it to the Columbia River.

Water quality sampling in Douglas Creek in 1989 revealed high levels of nitrates and phosphates. A large percentage of land in the watershed is routinely fertilized for agricultural use and fertilizers contain these two substances. Routine application of these chemicals as well as the arid climate allows for little dilution of the chemicals, which may account for the elevated levels observed in Douglas Creek.

QHA Results

Reach three of Moses Coulee had the highest restoration rating in the watershed (Table 30), which was derived from very low current habitat condition values compared to estimated normative conditions. The three reaches that have high protection ratings are those with continuous water flow: ratings high to low are McCarteney1, Douglas, and Moses Coulee2. Observation of some current land use patterns in these three reaches indicate that accessibility and land ownership patterns (public, private, non-profit) follow the current conditions and protection values. The land ownership is the highest for the private/non-profit status and McCarteney1 has the most restricted access.

Table 30 QHA habitat scores for Moses Coulee, WA.

Reach	Species	Protection Score	Restoration Score
Moses 2	Rainbow/steelhead	141	39.5
Douglas Creek 1	Rainbow/steelhead	171	48
McCarteney Creek 1	Rainbow/steelhead	189	30
Moses Coulee 2	Rainbow/steelhead	0	69

Pine Canyon (Corbaley Canyon)

The Pine Canyon subwatershed contains approximately 21,500 acres (33.6 sq. mi.) and is comprised of two stream reaches. The lower reach is 3.5 miles long and is dry and the upper wet reach is 8.5 miles. Although this stream was not evaluated and does not have access for anadromous fish, rainbow trout of unknown origin rear and spawn up to approximately RM 6 and there is potential for summer steelhead to use this stretch in years when instream flows are sufficient to allow upstream migration of spawning adults or downstream emigration of smolts (Bartu and Andonaegui 2001). Pine Canyon Creek is not accessible to anadromous fish because stream flows are subterranean across the alluvial fan and downstream of the SR 2 Bridge to the stream's confluence with the Columbia River (RM 0.00 to RM 1.23). The quality of the water and habitat is considered relatively good for aquatic production upstream of RM 1.23, but providing sufficient water volumes to allow anadromous fish passage across the alluvial fan appears problematic (PGG et al. 2003).

Historical evidence supports the prior use of Pine Canyon Creek by resident trout species, but not anadromous fish species (PGG et al. 2003). No other fish have been seen in the stream other than rainbow/steelhead trout (Bartu and Andonaegui 2001).

Riparian Condition

There is a dense riparian stand at the mouth of Pine Canyon Creek up to the SR 97 channel crossing (RM 0.25). There is little riparian habitat from RM 0.25 - 2.0 because of lack of water, and brushy riparian habitat consisting of willow, reed canary grass, service berry, pine, wild rose, and other species was found from RM 2.0 - 6.0, (Bartu and Andonaegui 2001). Riparian vegetation is abundant where surface water is present and generally lacking along the dry stream reach. Conditions observed in 1978 photos indicate there has been little change in the location or extent of riparian tree communities in the last quarter of a century (PGG et al. 2003).

Pine Canyon Creek was unique among the channels evaluated because it was the only area where conifer trees were a component of riparian communities. The most downstream portions of the stream are non-forested, but occasional conifers occur along north-and east-facing canyon walls in upper Pine Canyon Creek and its tributaries. A channel segment with scattered hardwood trees was mapped approximately 1.5 miles upstream of the confluence with the Columbia River. The prevalence of medium to large-sized trees indicates that there is a potential supply of large woody debris (PGG et al. 2003).

Trees within the riparian zone bordering the lower channel segment provide shade and represent a potential source of LWD. However, the density of residential and agricultural land uses on both sides of the stream likely limit the longevity of in-channel LWD and shade. Trees that could enter the stream and potentially form log jams or redirect flow or shade orchard trees are probably removed to protect humans and their property (PGG et al. 2003).

Channel Condition and Diversity

The lower reach of Pine Canyon Creek has a small but distinct alluvial fan composed of coarse, subangular sediments deposited as a result of very large floods. The channel gradient in this segment is 4.8 percent. Surface stream flows across the fan are spring fed and go dry/subsurface during the summer months, except during rain-on-snow events, spring run-off, or major storm events. No surface water was flowing on the alluvial fan channel segment downstream of SR 2

Highway bridge (RM 1.23) during all surveys conducted in 2001 and 2002 (Pacific Groundwater Group and Montgomery Water Group 2003). It is thought that the stream used to sustain year-round flows more often than currently (Bartu and Andonaegui 2001).

The pool-riffle reach (RM 1.23 to 1.62) is low to moderate gradient (1.0 to 2.5 percent). The habitat sequence is alternating pools and riffles with only one cobble step classified as cascade habitat. Pool habitat frequency was generally low; less than ten percent of the reach by length is composed of pool habitat. Although a spawning area survey for this stream reach was not conducted, stream bottom substrates were characterized as having a high composition of small to large gravel with occasional cobble accumulations. Channel substrates were generally clean (low percent fines) with silt or sand substrate dominant in only a few habitat units. Although pool habitat was limited, the abundance of available, clean gravel should be conducive to successful spawning and rearing and the production of key prey items for salmonid fishes (PGG et al. 2003).

The middle section of Pine Canyon Creek occupies a steep-sided bedrock canyon. The valley floor is approximately 500 feet wide, and is almost entirely filled with coarse sediment similar to that found on the alluvial fan. Flow across this sediment deposit is subsurface for much of the year. The gradient through this segment is greater than five percent. In fluvially dominated systems, such steep channels are generally able to transport sediment delivered from upstream reaches. The presence of extensive coarse sediment deposits suggests that the system is dominated by mass wasting processes or that a wave of fluvially deposited sediment may currently be working its way through the system (PGG et al. 2003).

At an elevation of around 1,600 feet, Pine Canyon splits into two main tributaries: Pine Canyon and Corbally Canyon creeks. Both of these channels occupy steep-sided V-shaped valleys with gradients in excess of 5 percent. These channels appear to be functioning as transport reaches and no large accumulations of sediment were noted (PGG et al. 2003).

The floodplain consists mostly of river wash that has been moved to form a more permanent channel. There is disconnected hydraulic continuity. The channel at the lower reach (RM 0.0-RM 2.0) consists of river wash and has been diverted to create a permanent channel. The middle reach (RM 2.0-RM 6.0) has a well defined channel, some significant pools, and a dense riparian canopy (Bartu and Andonaegui 2001).

Fine Sediments

Pine Canyon Creek has a unique geology for WRIAs 44 and 50; consisting of biotite gneiss. It supports high levels of mica and likely weathers to fine materials. The stream substrate changes from fine alluvium to bedrock to coarse alluvium as it flows towards the Columbia River. The stream looses water in the coarse alluvium section and is completely dry before reaching the Columbia River. High levels of fine sediment accumulations were not observed in the channel. This observation, in addition to the channel stability and pebble count survey data, suggests the stream is capable of transporting the fine materials. Spawning, rearing, and food production should not be compromised as a result of the fine sediment levels noted in the stream (PGG et al. 2003).

Water Quantity and Quality

Stream flows in the lower reaches (RM 0.0 to 1.23) of Pine Canyon Creek go subsurface and are rare. The last time there were surface flows through this reach was in 1996 because of high snowfall in the upper elevations of the watershed (Waterville Plateau) (Bartu and Andonaegui 2001). Stream flow monitoring at RM 1.62, during the summers of 2001 and 2002, indicates surface water flow between 0.2 and 0.4 cfs. The lowest flows were measured during the month of September. Upstream of the SR 2 Highway Bridge, small volumes of ground or hyporehic water are forced to the surface and flow was present throughout the summers of 2001 and 2002. This expression of surface water may be in relation to zones of shallow bedrock in the vicinity (PGG et al. 2003).

It is uncertain to what extent human land-use activities in the subwatershed may be exacerbating low flow conditions in lower Pine Canyon Creek (Bartu and Andonaegui 2001). It is B. Steele's professional opinion that in the past, perennial flows in the stream were more common and persisted longer into the season following spring snowmelt (WDFW, pers. comm., in Bartu and Andonaegui 2001).

Upper Pine Canyon Creek supports favorable water quality conditions for rearing fish. Data collected during the summers of 2001 and 2002 indicate relatively cool water temperatures (a result of significant springs and groundwater inflows), conductivity exceeding 600 µmhos/cm and pH levels within the Class A water quality criterion of 6.5 and 8.5 pH units (+/- 0.5 pH units). The waters are neutral to slighty alkaline in nature, which is typical of arid and semi-arid conditions. The data indicated relatively low to moderate abundance of organisms. Nevertheless, the stream supported high numbers of taxa and a high level of fish food items (EPT taxa). There was very little evidence of sediment accumulation influencing the benthic invertebrates, perhaps because of a combination of groundwater inputs and channel gradients, which are slightly steeper than in other local streams. The overall B- IBI rating of 31 for benthic invertebrates indicates relatively good water quality and habitat conditions exist for macroinvertebrate community development compared to the other streams surveyed. Lower Pine Canyon creek is not conducive to benthic invertebrate production because of the lack of surface water stream flow throughout the year (PGG et al. 2003).

QHA Results

This stream was not evaluated.

Sand Canyon

Sand Canyon Creek originates in dryland crop and rangeland areas, drains 3,130 acres (4.8 sq. mi.), and flows through the town of East Wenatchee before joining the Columbia River just downstream of the Wenatchee River confluence (Bartu and Andonaegui 2001). Although this stream was not evaluated and is not suitable for anadromous fish use, a small portion of the stream is accesssibe and is used by some anadromous fish. The stream is comprised of three reaches. In the first reach, juvenile summer steelhead and spring and summer/fall Chinook rear up to an impassable culvert/irrigation diversion at State Highway 28 (RM 0.4)(Bob Steele, pers. comm., 2001). Juvenile Chinook and steelhead/rainbow trout were observed from the mouth upstream to RM 0.25 in the early-mid 1990s. There were more juvenile Chinook than steelhead/rainbow that had strayed into Sand Canyon Creek from the Columbia River. It is uncertain, whether fish can currently reach the barrier because of a thicket of golden willow growing horizontally across the stream and a headcut in this lower reach that may be impassable to fish (Bartu and Andonaegui 2001).

The second reach is about 1 mile long and ends at Eastmont Ave., while the third is 5.8 miles and is dry much of the year except for storm flooding events. Steelhead/rainbow trout juveniles found above the barrier are most likely planted rainbow trout (Bartu and Andonaegui 2001). A 2001-2002 study (PGG et al. 2003) noted that although the stream had sporadic observations of anadromous salmonid use from the late 1970s to the early 1990s, here was no evidence of current anadromous fish use.

Juvenile coho have also been found in Sand Canyon Creek and are assumed to be hatchery plants naturalized from the Turtle Rock fish hatchery. Coho have been extirpated from the upper Columbia system since the turn of the century. It is assumed that beavers were historically active in Sand Canyon (Bartu and Adnonaegui 2001).

Riparian Condition

Riparian vegetation is thick at the confluence of Sand Canyon Creek , dominated by cottonwood (*Poplulus trichocarpa*), willow (*Salix spp*.), red osier dogwood (*Cornus stolonifera*), hawthorne (*Crataegus douglasii*), wild rose (*Rosa spp*.), snowberry (*Symphoricarpus albus*), and reed canary grass(*Phalaris arundinacea*) (Washington State Noxious Weed Control Board 1997). The lower 1.5 miles of the stream are bordered by a mixture of residential properties, orchards, and a county park. Riparian vegetation throughout this section consists of an almost continuous but narrow band of small to medium deciduous trees, mixed with areas of shrubs. Upstream of the developed areas and agricultural lands where the channel transitions into the V-shaped valley segment, the channel is bordered by a sparse stand of low shrubs for approximately half a mile. The steep hillsides bordering the headwater areas and tributaries support sagebrush, and streamside trees or shrubs are largely absent (Pacific Groundwater Group and Montgomery Water Group 2003). No aquatic exotic species have been noted, but diffuse knapweed and baby's breath have been observed in the lower reach of Sand Canyon (Washington State Noxious Weed Control Board 1997).

Channel Condition and Diversity

From the base of Badger Mountain foothills to RM 2.0, Sand Canyon Creek is naturally confined in a deep canyon with very little potential for overbank flows (KCM 1995). The stream corridor from RM 2.0 to RM 0.0 has been impacted by development in the East Wenatchee area; in some areas only an orchard or pavement provide the drainage way with no defined channel. The lower reach (RM 0.0 - 0.25) has been channelized, intentionally moved with machinery and placed in its present channel (Bartu and Andonaegui 2001).

The Comprehensive Flood Hazard Management Plan of 1995 addresses flooding in Sand Canyon and its impact on an urban area. Flooding is typically caused by two types of storm events: summer thunderstorms and late winter-early spring rainstorms combined with snowmelt. Although both types of storms can cause extensive flooding, summer thunderstorms have resulted in the most damaging floods to the City of East Wenatchee (KCM 1995). The upper portion of Sand Canyon consists primarily of wheat lands that lie fallow between crop rotations. Minimal vegetative cover during the fallow period results in soils being particularly susceptible to erosion. The canyon descends from the uplands to the terraces where urban areas and orchard lands are located. Sand Canyon also contains active and potential slide zones caused by oversteepened and undercut slopes. Because of the scarcity of drainage facilities below these canyons, floodwaters travel in streets and natural drainage depressions between the streets. Existing drainage culverts and pipe systems are rapidly filled and plugged with sediments during these runoff events, rendering them nonfunctional. The floodwaters, traveling toward the Columbia River, cause extensive erosion damage and fill the existing drainage systems with sediment (KCM 1995).

Fine Sediments

The Sand Canyon Creek Basin is composed of an old massive slump containing abundant, highly erosive fines, silts, and aeolian sands. Hardly any bedrock is exposed in the drainage; therefore little cobble and gravel is present. As a result, the stream exhibits heavy channel loading of fine sediments. The stream does not have the transport capacity to clear the small material from the streambed. The sediment deposition in Sand Canyon Creek is overwhelming the capacity of the stream to transport fines downstream (PGG et al. 2003).

Floods within Sand Canyon Creek are compounded by extreme soil erosion and sedimentation from the sandy soils and lack of cobble in the stream, particularly on steep and barren, or lightly vegetated, slopes. In undeveloped areas, erosion problems are relatively rare because rain infiltrates the highly permeable soils reducing the amount of surface water runoff. Most undeveloped areas also have natural vegetative cover, which helps strengthen the soil surface to reduce the transportation of sediment. However, in developed areas with streets and other impermeable surfaces, large volumes of runoff may rapidly erode the barren soils along the road margins (few roads within East Wenatchee have curbs and gutters). In addition to erosion problems in developed areas, a large amount of runoff and sediment is transported from bare soils in the agricultural areas immediately above East Wenatchee (KCM 1995).

Water Quantity and Quality

Sand Canyon Creek is naturally a seasonal stream that carries spring runoff, generally going dry by early-to-mid-summer except for when instream flows are generated by heavy summer storm events. Irrigation, agriculture, and lawns have increased the baseflow, and currently instream flows are maintained through the irrigation season by irrigation return flows directly to the stream at RM 0.50 from the Wenatchee Reclamation District Irrigation Canal, between late March and October (Bartu and Andonaegui 2001). From May-September 2001, flows ranged between approximately 0.5 and 3.0 cfs, with the lowest flows occurring during the month of August (PGG et al. 2003).

Irrigation return flows from the Wenatchee River maintain a colder consistent temperature compared to natural stream temperature, attracting rearing salmonids from the Columbia River and providing rearing habitat in a tributary that normally would be dry. The loss of irrigation return flows into Sand Canyon Creek would eliminate summer flows and would have a detrimental effect on salmonids. Baseflows in the winter are likely to be a result of the irrigation water infiltration in the lower part of this watershed throughout the growing season. No pools over a foot in depth have been observed to date (Bartu and Andonaegui 2001).

Temperatures in Sand Canyon Creek are too warm for summer rearing fish production. Maximum water temperatures in the stream were very high and exceeded 18ºC almost continuously between mid-June and mid-September, 2001. They exceeded sublethal water temperatures for salmonid fishes and peaked above 24ºC (PGG et al. 2003).

All pH levels monitored during the summer of 2001 were within the Class A water quality criterion between 6.5 and 8.5 pH units (+/- 0.5 pH units). The waters are generally alkaline in nature, which is typical of arid and semi-arid conditions. Sand Canyon Creek water reflected irrigation withdrawals from the Wenatchee River system. The stream was neutral in pH, was low in mineralization (60 to 150 µmhos/cm), and supported relatively soft waters compared to other local streams (PGG et al. 2003). Dissolved oxygen (DO) concentrations in Sand Canyon complied with the state standard throughout the 2001 and 2002 sampling period (PGG et al. 2003).

Sand Canyon Creek contains a low density and diversity of macroinvertebrates and fauna is comprised entirely of short-lived taxa. The majority of the taxa exhibit burrowing habits that allow them to survive in temporary habitats when streamflows cease (PGG et al. 2003).

QHA Results

This stream was not evaluated

Quilomene Creek

The Quilomene Creek Watershed, located in Kittitas County, contains about 14,600 acres. The stream is approximately 10 miles long with one primary tributary, Brushy Creek. Of special note, in some documents Quilomene is considered a tributary to Brushy Creek and others the reverse. Ninety-nine percent of the Quilomene Creek Watershed is located on public land (WDFW Colockum Wildlife Area).

Historically, it is presumed that anadromy extended into the headwaters (Viola, pers. comm., 2004). However, salmon were likely present only in the lowest reach. Steelhead/rainbow trout would have been distributed throughout the watershed where habitat was accessible. In 1999 Grant County Public Utility District (GCPUD) surveyed the lowest reach and found several species of fish present; rainbow trout, Chinook salmon, speckled dace, and bridgelip sucker. Other data indicate that steelhead have used the bottom four tenths of a mile for migration (Streamnet 2003).

For use in the QHA model, Quilomene Creek was broken into two reaches. Reach 1 begins at the mouth and extends up-stream to RM1. Reach 2 extends from RM1 to the headwaters.

Riparian Conditions

The riparian zone adjacent to in Reaches 1 is dense with thick brushy vegetation common to the area. WDFW speculates that the riparian zone on the remainder of the stream is also covered with brushy vegetation, however, only the lower 1-mile of the stream was sampled because of its remoteness.

Channel Condition and Diversity

Channel characteristics in Reach 1 remain very similar to historic conditions, but may have been degraded by the excessive cattle grazing that took place in the 1900s (Paschal J. WDFW pers.

com. 2003). An earthen dam was constructed in 1964 located about half way up the length of the stream (Streamnet 2003). More surveys are needed.

Fine Sediments

Reach 1 was dry when WDFW made a site visit in July of 2003. This condition precluded a reliable estimate of substrate characteristics. WDFW speculates that the stream presently holds considerably more fine sediments than what occurred prior to the extensive cattle grazing of earlier years. More surveys are needed.

Water Quantity and Quality

Very little is known about year–round water flows or the water quality in Quilomene Creek. However, at times, water is absent in the lower reach. The channel in Reach 1 was found to be dry in July of 2003 on a site visit by WDFW staff. Lack of year-round water flow under normative conditions is not ideal for fish use.

QHA Results

Both Chinook and rainbow trout were used in the assessment model for Reach one (Table 31). Reach two was not analyzed because no existing data or field survey information was available, although rainbow trout may inhabit the reach. The restoration ratings for Reach one for both species of fish was about one third of the protection rating. The ratings for Chinook in reach one were identical to the rainbow trout model. Of note, the sediment and high temperature were the two lowest ranked attributes of all of the ratings.

Table 31 QHA habitat scores for Quilomene Creek, WA.

Reach	Species	Protection Score	Restoration Score
Quilomene 1	Chinook	168	60
Quilomene 1	Rainbow/steelhead	168	60

Rock Island Creek

The Rock Island Watershed contains approximately 54,822 acres. Over 85% of the stream runs through private lands. The stream has two primary tributaries: Bevington Canyon and Beaver Creek. Flows in Rock Island Creek are dependent on spring snowmelt runoff and spring groundwater recharge. A spring at RM 0.75 maintains perennial flow from RM 0.75 to the mouth (Bartu and Andonaegui 2001).

Rock Island Creek was broken into three reaches: the first is the flowing portion that is accessible to anadromous fish, the second is a long dry reach with no substantial riparian vegetation (a natural condition), and the third is the entire upper part of the watershed where water flows intermittently in most places, but has significant existing riparian vegetation. Recent surveys indicated that the lowest reach of this stream has Chinook and steelhead use (unpublished data, R2 Consultants, July 2003; Meyers et al. 1998).

Riparian conditions

Currently there are groves of quaking aspen and cottonwoods at the mouth of Rock Island Creek. In 1887 when the Keane family settled at the mouth of Rock Island Creek, it was alive with groves of quaking aspens and cottonwoods. Today's stand is probably a remnant of what once was present. In the upper reaches, riparian habitat is in fair to poor condition.

Channel Condition and Diversity

The stream reach inventory/channel stability evaluation conducted in 2002 indicates a fair rating (79 points) (PGG et al. 2003).

Fine Sediments

Rock Island Creek was assessed by R2 Consultants, for Foster Creek Conservation District and found the lowest reach had fines <6mm of 16% in 2002 (PGG et al. 2003). High levels of fine sediment accumulations were not observed in the channel, likely because of the spring-fed character of the stream. Spawning and rearing habitat and food production should not be compromised as a result of fine sediment levels noted in Rock Island Creek. The present frequency of pools in Rock Island Creek is consistent with pool-riffle channels under low LWD levels that occur in the creek (Montgomery and Buffington 1993)

Water Quantity and Quality

There are no peak stream flow records for Rock Island Creek except for an observation made by Lucy Keane in 1999 and 2000. "In 1999 Rock Island Creek stopped running full length the third week in May until the next spring. There was water intermittently 2-3 miles above the spring. It was dry in-between these places. In the year 2000, the creek started running March 24th full length and stopped March 31. It ran again full length April 2nd to the April 18th but [was] extremely muddy. There has been no water since then in that section" (Keane 2000).

QHA Results

Recent surveys presented during the analysis meetings have indicated that the lowest reach of this stream has Chinook, coho, and steelhead use (Table 32). The second reach was assessed, but since it is usually dry no resulting protection or restoration ratings were calculated. The third reach was assessed for rainbow trout only. For both the lowest and highest reaches the ratings were nearly the same for protection and restoration. The protection ratings for both reaches were higher than the restoration ratings. The ratings for Chinook in reach one were identical to the rainbow trout model.

Table 32 QHA habitat scores for Rock Island Creek, WA.

Reach	Species	Protection Score	Restoration Score
Rock Island 1	Chinook	165	63
Rock Island 1	Rainbow/steelhead	165	63
Rock Island 3	Rainbow/steelhead	174	54

Sand Hollow Creek

The Sand Hollow Creek Watershed, located in Grant County, contains approximately 35,518 acres and is approximately 10.43 miles in length. The stream has no identified tributaries and receives a significant amount of flow from irrigation return(s). Other data indicate that steelhead have used the bottom two miles for migration and spawning and rearing of fall Chinook and summer steelhead (Streamnet 2003). In 1999 GCPUD surveyed the lowest reach and found several species of fish present: rainbow trout, longnose suckers, cottids, largescale suckers, and bridgelip suckers. Only one reach was established for use in the QHA model - from the mouth to RM 10.43/the top of the wasteway.

QHA Results

Both Chinook and rainbow trout were used in the assessment model (Table 33). The rating for restoration was zero because flows are artificially maintained and the reference conditions were set to zero. The protection rating was the same for both species. The habitat conditions were rated moderate to poor because of the large area in agricultural use and irrigation return flow (water quality concerns). Actual conditions need to be investigated and verified.

Table 33 QHA habitat scores for Sand Hollow Creek, WA.

Reach	Species	Protection Score	Restoration Score
Sand Hollow 1	Chinook	162	No scores
Sand Hollow 1	Rainbow/steelhead	162	No scores

Skookumchuck Creek

The Skookumchuck Creek Watershed, located in Kittitas County, contains approximately 12,763 acres. Thirty percent of this stream is publicly owned. The stream has one primary tributary, the North Fork. In 1999, GCPUD surveyed the lowest reach and found only rainbow trout to be present. Two reaches were identified for use in the QHA Model: the mouth to RM 0.75, and RM 0.75 to the headwaters.

Both Chinook and rainbow trout were used in the assessment model (Table 34), although the assessment was only done for reach one; reach two has no information available to date. This stream had the highest protection rating in the Subbasin, and had a low restoration rating. None of the parameters raised “red flags”, but fine sediment had a less than normative rating.

Table 34 QHA habitat scores for Skookumchuck Creek, WA.

Reach	Species	Protection Score	Restoration Score
Skookumchuck 1	Chinook	213	15
Skookumchuck 1	Rainbow/steelhead	213	15

Squilchuck Creek

The headwaters of Squilchuck Creek lie in the upper reaches of Beehive Mountain, Mission Peak, the Naneum Ridge, and Wenatchee Mountain. Squilchuck Creek flows 10.6 miles (USFS 1998) in a northeast direction to its confluence with the Columbia River (RM 464.0), four miles downstream of the Wenatchee River confluence. Elevation ranges from 6,800 feet along the southwest divide near Mission Peak to 653 feet at the mouth. There are approximately 18,167 acres (28.4 square miles) in the watershed, 73% of the watershed is privately owned, with the first 9.0 miles of stream flowing through private and some state land (USFS 1998). The upper 1.6 miles of Squilchuck Creek flow through USFS managed land. County Road 711 parallels the stream channel, crossing it twice. Mission Ridge Ski Area lies at the end of this road.

Topography of the watershed is highly variable with sizeable areas of gentle topography, very steep slopes, numerous natural depressions, and vertical rock cliffs. Geologic processes included extensive erosion of underlying sediments and landslides and earth flows that resulted in talus slopes of the Rubbleland-Rock Outcrop type (USFS 1998). Rubbleland-Rock formations have almost total infiltration so that rain and snowmelt water passes immediately into the fractured basalt and moves through the watershed as subsurface flow. Soils are also extremely permeable, formed when earth flows mixed angular basalt rock with underlying, weathered sandstone formations. Therefore, springs are numerous, but usually surface and then disappear subsurface without developing significant wetlands.

Access to habitat for salmon and steelhead / rainbow trout is very limited because of the low precipitation, reliance on snow accumulation and snowmelt to support instream flows, and high permeability of the soils and geology. This condition is worsened during low water years. Surface water diversions contribute to dewatering and low flows in Squilchuck. Chinook salmon use is naturally limited to the lower reaches of Squilchuck Creek before steep channel gradient precludes upstream fish passage. Adult steelhead trout, being stronger swimmers and entering the drainage during spring runoff, could naturally penetrate higher into the watershed on good water years, given passage at culverts and diversion dams. However, intermittent flows later in the year, coupled with severe habitat degradation present significant limitations to steelhead/rainbow productivity in this watershed (WRIA 45 Report).

For use in the QHA Model, Squilchuck Creek was divided into three reaches; Reach 1 extends 0.5 mile from the mouth upstream to the South Wenatchee Avenue culvert. Reach one and two were split because this culvert is a barrier to fish migration. Reach 2 starts at that culvert and extends 6.0 miles upstream to Squilchuck State Park. Reach 3 begins at the park and extends upstream 2.0 miles to ½ mile west of Mission Ridge Sky Area.

Riparian Vegetation

Riparian vegetation on Squilchuck Creek is generally dense and brushy but occurs in patches because of development (trailer parks, roads, and railroads), and rural/residential and pastureland conversion. Tree cover has been significantly reduced in the upper portion of the drainage from natural conditions (USFS 1998). The once forested area of Squilchuck Creek is now ski runs, chair lifts, and maintenance roads (USFS 1998).

Channel Condition and Diversity

The lower watershed (below Squilchuck State Park at RM 6.0) is dominated by seasonal channels that flow during spring snowmelt runoff or during high intensity summer thundershowers. Perennial streams are limited to the upper Squilchuck area and include Miners Run, Lake Creek, and upper Squilchuck Creek above the Mission Ridge Ski Area chair 2 ski lift. Portions of Squilchuck Creek that flow under the chair 2 ski lift area go subsurface where it flows through rubble rock (USFS 1998). These streams are steep gradient (>10%), boulder and cobble-dominated, stable channel types (Rosgen A and B type channels) confined by narrow canyons (USFS 1998). The USFS surveyed the stream channels and draws on federally managed land in the watershed. Stream channel migration potential is limited by development and land conversion.

Fish passage barriers also exist in Squilchuck Creek: the Burlington Northern yard culvert at RM 0.1 is a partial barrier to fish passage (Heiner, pers. comm., 2001), then the S. Wenatchee Avenue County Road culvert at RM 0.3 is a full barrier to fish passage (Steele, Pers. comm., 2001). Additional barriers have been identified upstream of RM 0.3 (Harza/Bioanalysts 2000).

Water Quantity and Quality

Water quantity in Squilchuck Creek is limited both naturally and by irrigation water withdrawals. Under natural conditions, channels in the lower portion of the Squilchuck watershed are dominated by naturally intermittent drainages that only flow during spring runoff or during high intensity summer thundershowers (USFS 1998).

About 65% of the total annual water production occurs as snowmelt stream flow in April through July. Annually, there is an excess of available surface water during melt seasons (USFS 1998) but inadequate supplies during the remaining portion of the year. This seasonal distribution of water supply has resulted in construction of water storage facilities by agricultural users. Water storage, reservoir management, and water diversions have affected the natural flow regime of Squilchuck Creek (Steele, pers. comm., 2001). Release of irrigation water from the Beehive Reservoir augments stream flow between the reservoir outfall and points of diversion for individual water right holders. The effects of the diversions and return flows on instream habitat conditions are undetermined at this time.

Water quality in Squilchuck Creek is unknown, but is likely compromised by chemical runoff from agricultural practices. On July 14, 2003 at 1:00 P.M during a site visit to the stream mouth WDFW recorded water temperature and dissolved oxygen (DO) measurements of 62^{0}F and 8.0 ppm, respectively (Viola, pers. comm., 2003). That same day, water temperature, DO and creek mouth water flows were well within tolerance limits for both juvenile steelhead and Chinook. Currently no information is available concerning year-round daily water temperatures or DO levels.

Fine Sediments

On July 14, 2003 WDFW briefly sampled substrates in all three reaches of Squilchuck Creek. We found heavy to moderate siltation in Reaches 1 and 2 and minor siltation in Reach 3. Currently we are unsure of historical substrate conditions but speculate that silt loads in the stream were less than currently exists. The current accumulation of silt is likely a result of agricultural practices, possible historic cattle grazing and minor silt contributions form the ski area. However chair lifts and ski runs are completely vegetated with either introduced or native species and, in many cases, have a cover of young tree seedlings. Very little exposed mineral soil exists and that which does will revegetate rapidly. Current use of the ski area has insignificant potential effects on sediment transport or changes in basic hydrology (USFS 1998).

QHA Results

Reaches one and two were modeled for both rainbow trout and Chinook salmon and reach three for rainbow trout only (Table 35), as there is no documentation of Chinook occurring that far up in the watershed. Historically Chinook used reach two, but to what upper extent is unknown. The analysis and rating for reach1 are the same for both species and they have nearly equal protection and restoration scores compared to the upper two reaches. Protection ratings increase with each reach going up the watershed. Restoration ratings decrease by each succeeding reach for the rainbow trout model. The Chinook model shows no protection rating for Reach two because of the lack of access (i.e., current conditions without fish end up having a zero value in the model). Reach 1 had low habitat ratings and all three reaches were rated poorly for obstructions as evident in the Limiting Factors Analysis (Andonaegui 2001).

Table 35 QHA habitat scores for Squilchuck Creek, WA.

Reach	Species	Protection Score	Restoration Score
Squilchuck 1	Chinook	123	96
Squilchuck 1	Rainbow/steelhead	123	96
Squilchuck 2	Rainbow/steelhead	162	57
Squilchuck 3	Rainbow/steelhead	207	15

Stemilt Creek

The Stemilt watershed is approximately 40 square miles in size with the headwaters of Stemilt Creek originating in the upper reaches of Naneum Ridge and Wenatchee Mountain. Stemilt Creek flows in a northeasterly direction from its headwaters for approximately 12.35 miles (Williams et al. 1975) before entering the Columbia River (RM 461.9) six and one half miles downstream of the Wenatchee River confluence (RM 468.4). Elevation ranges from 6,600 along Naneum Ridge to 650 feet at the mouth. The public owns 58% of the land in the watershed. The lowest 5 miles of stream flows through private land. Stemilt Creek County Road parallels the stream channel for the first 6 miles.

Habitat for Chinook and rainbow/steelhead in the Stemilt Creek Watershed is limited. Chinook and rainbow/steelhead juveniles are known to occur in the lower Stemilt Creek Watershed and rainbow trout and brook trout are distributed throughout the watershed where low flows and natural and human-made fish passage barriers do not preclude access to habitat. Surface water diversions contribute to dewatering and low flows in the lower 3 to 6 miles of Stemilt Creek.

For use in the QHA model, Stemilt Creek was divided into three reaches: the mouth to the first large pump (RM 0.1), the pump to the end of water diversions, and from that point to the headwaters. Reach one and two were split because of an existing road crossing. Reach two and three were spilt because of a change in gradient; Reach 3 has a higher gradient than Reach 1 and 2. Reaches 1 and 2 are privately owned.

Riparian Condition

On July 14 2003 WDFW documented various habitat conditions within the Stemilt Creek watershed including riparian condition. They reported very dense brushy vegetation common to the area in the riparian zones on both sides of all three reaches of Stemilt Creek. The only disturbance to these excellent conditions appears to be at a few road crossings at irrigation pumping sites. However, this disturbance is minimal and does not represent a significant factor that would limit fish production.

Channel Condition and Diversity

Currently channel condition and it’s potential for natural movement and habitat diversity is restricted in Reaches 1 and 2 because of the presence of a road that runs adjacent to the creek, a few road crossings, and an undetermined number of irrigation diversion structures. Reach 3 appears to be only slightly altered compared to assumed historical conditions. However, there are an unknown number of water diversion structures on this reach that affect channel condition.

Only one source of published information describing habitat conditions or land use affects on aquatic habitat in the Stemilt Creek watershed was found, the draft Chelan County Fish Barrier Inventory Database (Harza/Bioanalysts 2000). The Harza survey identified the first fish passage barrier culvert on Stemilt Creek at RM 1.6 on a private road crossing.

Fine Sediments

WDFW briefly sampled substrates (July 14, 2003) in all three reaches of Stemilt Creek and found heavy to moderate siltation in Reaches 1 and 2 and minor siltation in Reach 3. Historical silt loads are unknown, but were probably less than currently exists. The present accumulation of silt is likely a result of agricultural practices and possibly, historic cattle grazing.

Water Quantity and Quality

July 14,2003 study results, indicated water quantity and quality parameters in Reaches 1 and 3 were capable of supporting juvenile steelhead and salmon, but Reach two was almost devoid of water. Water temperature was 64^{o} F (July 14, 2003, 11:30 A.M.) and 59^{0}F and DO was 8.0ppm and 9.0pmm (3:30P.M.) in Reaches 1 and 3 respectively. Water flows were estimated to be about 75% of bank full in Reach 1 and 50% in Reach 3. Reach 2 was being dewatered for irrigation purposes. The only water left was stagnating in a few beaver ponds. It is unlikely that juvenile Chinook or rainbow/steelhead would have survived long under these conditions. Year-round water quality is unknown; WDFW suspects that the pesticides used in the prolific orchards in this watershed have the potential to contaminate Stemilt Creek.

Regarding water quantity and use in the watershed, Hammond, Collier, Wade, & Livingstone Associates of Wenatchee, Washington, is currently developing a Comprehensive Water Conservation Plan for the Stemilt Irrigation District. The plan is to analyze the District’s irrigation distribution system and propose measures to conserve irrigation water within the District’s facilities. The report was due out in late 2001.

There are four irrigation districts (Wenatchee Heights, Stemilt, Lower Stemilt, and Kennedy-Lockwood) and numerous private diversions operating in the Stemilt watershed. Information on location and actual water use of surface waters in the watershed is not available at this time. The Stemilt watershed was adjudicated in 1926 with no provisions for maintaining instream flows. As a result, certified water rights exceed available surface flow and reduce the lower two to three miles of Stemilt Creek to a trickle during the irrigation season each year. The amount of available moisture resulting from snowmelt and precipitation affects low flows; the drier the year, the earlier Stemilt Creek will be reduced to a trickle (Viola, pers. comm., 2003, Riegert, pers. comm., 2001). Each year, water use by junior water right holders’ is curtailed as instream flows decrease and some senior water right holders’ may also lose water privileges as flows continue to decline (Riegert, pers. comm., 2001).

Intermittent flows in the upper reaches of Stemilt Creek and its tributaries likely occurs naturally, given the hydrology and geology as it affects the interaction between ground and surface waters. It is possible that dewatering in lower Stemilt may also have occurred naturally on some, if not all years prior to Euro-American influence. The hydrology of the Stemilt watershed is not well known.

QHA Results

Only Reach one was modeled for Chinook (Table 36); it is believed that few Chinook adults would venture into and spawn in Reach two because of water depth. Reaches one, two, and three were modeled for rainbow/steelhead. Historically Chinook may have used Reach two, but to what upper extent is unknown. The model resulted in much higher scores for protection compared to restoration scores.

It is correct that most of this tributary is in need of some protection. However, the habitat conditions that limit fish production the most are the extensive irrigation water withdrawal that reduces the flow in Reach two of Stemilt Creek to a trickle each year and the presence of an unknown number of barriers to fish migration throughout the drainage.

Table 36 QHA habitat scores for Steimilt Creek, WA.

Reach	Species	Protection Score	Restoration Score
Stemilt 1	Chinook	162	57
Stemilt 1	Rainbow/steelhead	162	57
Stemilt 2	Rainbow/steelhead	147	75
Stemilt 3	Rainbow/steelhead	195	27

Tarpiscan Creek

The Tarpiscan Creek Watershed, located in Kittitas County, contains approximately 15,492 acres and is about 6.23 miles in length (north fork). The stream has two primary tributaries, the South and North Forks. Eighty-eight percent of the land adjacent to the stream is in the publicly owned WDFW Colockum Wildlife Area.

Historically, it is presumed that anadromy extended into the headwaters (Viola, pers. comm., 2004). However, salmon were likely present only in the lowest reach. Steelhead/rainbow trout would have been distributed throughout the watershed where habitat was accessible. Other data indicate that steelhead have used the bottom tenth of a mile for rearing and migration and the next upstream 0.7 miles for spawning and rearing (Streamnet 2003). In 1999 Grant County Public Utility District (GCPUD) surveyed the lowest reach and found several species of fish present; rainbow trout, Chinook salmon, longnose dace, brown trout, and bridgelip sucker.

For use in the QHA model, Tarpiscan Creek was divided into three reaches: the mouth to the confluence of the north and south forks (RM 0.51), and the north and south forks, 5.72 and 5.05 miles respectively.

Riparian Condition

The riparian zone adjacent to Reaches 1and 2 are covered with thick brushy vegetation common to the area. Reach 3, was not sampled because of its remoteness, but WDFW staff speculate that the riparian zone on this reach is also covered with brushy vegetation.

Channel Condition and Diversity

Channel characteristics in both Reach 1 and 2 remain very similar to historic conditions, but may have been degraded by excessive cattle grazing that took place in the early-mid 1900s. No passage barriers were found in Reaches 1 and 2. No survey of Reach 3 was completed, but more surveys are needed.

Fine Sediments

Both Reach 1 and 2 were dry when WDFW made a site visit in July of 2003. This condition precluded a reliable estimate of substrate characteristics, however, the dry streambed was sampled. The results lead us to speculate that the stream presently holds considerably more fine sediments than what occurred prior to the extensive cattle grazing of earlier years. More surveys are needed.

Water Quantity and Quality

Very little is known about water flows or the water quality in Tarpiscan Creek. However, we do known that at times water is absent in the lower two reaches. The channel in Reach 1 and 2 were found to be dry in July of 2003 on a site visit by WDFW staff. The absence of year-round water flow under normative conditions is not ideal for fish use.

QHA Results

Reach one was modeled for both rainbow trout and Chinook salmon and Reach two, the north fork, for rainbow trout only (Table 37), as there is no documentation of Chinook occurring that far up in the watershed. In the Chinook model, the spawning and rearing section of the hypothesis was not included in the analysis and resulted in the rating for protection and restoration being lower than that of rainbow trout. The analyses depict a substantially higher protection rating compared to the restoration rating.

Table 37 QHA habitat scores for Tarpiscan Creek, WA.

Reach	Species	Protection Score	Restoration Score
Tarpiscan 1	Spring Chinook	159	12
Tarpiscan 1	Rainbow/steelhead	192	15
Tarpiscan 2	Rainbow/steelhead	N/A	N/A

Tekison Creek

The Tekison Creek Watershed, located in Kittitas County, contains roughly 21,138 acres. The stream is about 7.7 miles in length and has one primary tributary, Stray Gulch. Ninety-five percent of the land adjacent to the stream is in the publicly owned WDFW Colockum Wildlife Area and is currently protected from habitat degradation. Steelhead have used the bottom tenth of a mile for migration and the adjoining 1.3 miles upstream for rearing, migration, and spawning (Streamnet 2003; Viola, pers. comm., 2003).

Tekison Creek was divided into two reaches for the QHA analysis. Reach 1 was established from the mouth to a large gradient change (RM 1.27), and Reach 2 extended up-stream from there to approximately RM 9.18.

Riparian Condition

Both banks of Reach 1 are covered with brushy vegetation common to the area. WDFW speculates that the riparian zone on the remainder of the stream (Reach 2) is also covered with brushy vegetation, but Reach 2 was not sampled because of its remoteness.

Channel Condition and Diversity

We speculate that channel characteristics in both Reach 1 and 2 remain very similar to historic conditions, but may have been degraded by excessive cattle grazing that took place in the 1900s. No passage barriers were found in Reach 1. No survey of Reach 2 was completed, but more surveys are needed.

Fine Sediments

Reach 1 of Tekison Creek was dry when WDFW made a site visit in July of 2003. This condition precluded a reliable estimate of substrate characteristics. However, WDFW did attempt to sample the dry streambed. What we found leads us to speculate that the stream presently holds considerably more fine sediments than what occurred prior to the extensive cattle grazing of earlier years. More surveys are needed.

Water Quantity and Quality

Very little is known about year–round water flows or the water quality in Tekison Creek. However, we do known that at times water is absent in the lowest reach. The channel in the lower reach was found to be dry in July of 2003 on a site visit by WDFW staff and GCPUD also noted it as being dry in previous years (Duvall, pers. comm., 2003). Water flow under normative conditions is not ideal for fish use.

QHA Results

Reach one was modeled for both rainbow trout and Chinook salmon and reach two for rainbow trout only (Table 38), as there is no documentation of Chinook occurring that far up in the watershed because of steep gradient and insufficient flow. In the Chinook model, the spawning and rearing section of the hypothesis was not included in the analysis and resulted in the ratings for protection and restoration being lower than that of rainbow trout. The analyses depict a substantially higher protection rating versus the restoration rating.

Table 38 QHA habitat scores for Tekison Creek, WA.

Reach	Species	Protection Score	Restoration Score
Tekison 1	Chinook	144	24
Tekison 1	Rainbow/steelhead	168	36
Tekison 2	Rainbow/steelhead	198	6

Trinidad Creek

The 17.1-mile long Trinidad Creek located in Lynch Coulee in Douglas and Grant counties drains a watershed of approximately 39,982 acres, 88% of the watershed is privately owned. This stream empties into the Columbia River at the Douglas and Grant County line. The first mile of stream contains habitat suitable for rearing for summer steelhead and Chinook (Streamnet 2003). In 1999 Grant County Public Utility District (GCPUD) surveyed the lowest reach and found several species of fish present; rainbow trout/steelhead, Chinook salmon, long nose dace, cottids, three spine stickleback, bluegill, and northern pike minnow.

For the QHA analysis, Trinidad Creek was broken into two reaches; Reach 1 extends from the mouth upstream 1 mile to just after it crosses under the State Highway 28 Bridge. Reach 2 extends from just after the highway crossing, upstream 6.5 miles to the tunnel at the railroad crossing, and both reaches are privately owned. Reach one and two were split because of an existing road crossing and a change in gradient. Reach two has a higher gradient than Reach 1.

Riparian Conditions

Most of the riparian zone adjacent to Trinidad Creek in Reach 1 is covered with brushy vegetation common to the area. A road crossing and work by heavy equipment has slightly reduced the amount and density of the riparian vegetation in a few places within this reach. The riparian zone on both sides of Reach 2 is completely covered with dense healthy vegetation. The historical condition of the riparian zone on Trinidad Creek is unknown. For the QHA model we speculated that the historical riparian conditions were much like they are today.

Channel Condition and Diversity

Presently the stream channel in Reach 1 is artificially confined between gravel and coble berms that have been bulldozed into place close to both banks. In addition the stream in this reach passes under two road-bridge crossings, both of which also limit lateral movement and channel course. The lowest section of Reach 1 contains an extensive fan created from alluvial deposits. As the stream crosses this fan it becomes wide, shallow and braided. We speculate that certain times the alluvial fan is likely a barrier to up stream migration of adult steelhead and Chinook.

The stream channel in Reach 2 is in a well-defined channel that lacks extensive braiding. Any minor channel migration that might occur over time would not encounter any obstacles, but major movements would be confined by the topography that supports Highway 28. Historical stream channel form is unknown. However, WDFW speculates that the current channel is very similar to what was present in the past.

Fine Sediments

Fine sediment has accumulated in both reaches and is likely the result of up stream agricultural practices. The historical substrate condition is unknown. However, WDFW speculates that much of the fine sediments present today were absent prior to the extensive agricultural activity in this watershed.

Water Quantity and Quality

Current and historical year-round daily water flows and water temperatures on Trinidad Creek are unknown. On July 16, 2003, during a site visit by WDFW, the stream channel at the mouth and two miles upstream was bank full. Water temperature and DO two miles up stream was 64^0F and 8.2 ppm (9:30 A.M.) and 64^0F and 8.7ppm (4:00 P.M.), respectively. Daytime air temperature reached 102^0F (Viola, pers. comm., 2003). Water flow, water temperature, and DO were well within tolerance limits for juvenile steelhead and Chinook. Water flow in Trinidad Creek is augmented by irrigation return flows from the Columbia Basin Reclamation Project.

This information has led WDFW to be optimistic concerning year-round water flow, water temperature, and DO levels in Trinidad Creek. The level of pollutants in Trinidad Creek is unknown but we speculate that water quality may be compromised by chemical runoff from agricultural uses.

QHA Results

Reach one and two were modeled for both Chinook salmon and rainbow trout (Table 39). The protection ratings for these reaches are similar for Chinook and steelhead, and both reaches scored much higher for protection compared to restoration. Reach two was scored much lower for restoration for Chinook than for steelhead or for Chinook in Reach one. It is believed that few Chinook adults would venture into and spawn in Reach two because of water depth, but the rearing potential for juvenile Chinook is probably better in Reach two compared to Reach one. Consequently, the QHA restoration rating may be misleading.

The habitat condition that may limit fish production the most in Trinidad Creek is the extensive fan created from alluvial deposition at the mouth of the stream. As the stream crosses this fan it becomes wide, shallow and braided. We speculate that the alluvial fan is likely a barrier to up stream migration of adult Chinook and rainbow/steelhead at times.

Table 39 QHA habitat scores for Trinidad Creek, WA.

Reach	Species	Protection Score	Restoration Score
Trinidad 1	Chinook	177	27
Trinidad 2	Chinook	169.5	4.2
Trinidad 1	Rainbow/steelhead	177	27
Trinidad 2	Rainbow/steelhead	195	15

Whiskey Dick Creek

The Whiskey Dick Creek Watershed, located in Kittitas County, contains approximately 21,971 acres, is about 13.5 miles in length, and 76% of the stream runs through public land. The stream has one primary tributary; the North Fork. In 1999, GCPUD surveyed the lowest reach and found several species of fish present, rainbow trout, threespine stickleback, tench, and northern pike minnow. Summer steelhead have used the bottom 1.4 miles for migration and rearing of summer steelhead (Streamnet 2003).

Two reaches were established on Whiskey Dick Creek for use in the QHA model. Reach 1 extends from the mouth to RM 1.5. Reach 2 extends from RM 1.5 to the headwaters. These reaches were separated at the location (RM 1.5) where the relatively level gradient of Reach 1 begins a sharp climb into the steep gradient of Reach 2.

Riparian Conditions

On August 18, 2003 WDFW surveyed Reach 1 of Whiskey Dick Creek. Both banks were covered with dense riparian vegetation and were assumed to be similar to what occurred historically. However, a dense growth of Purple Loosestrife can be found at the mouth of this stream; this vegetation was likely not present during historic times.

Channel Conditions and Diversity

Channel condition and diversity in Whiskey Dick Creek were in excellent condition and presumably similar to historic conditions. Fine sediments were relatively common in Reach 1 and are presumed to be greater that what occurred historically. This may be a result of the excessive cattle grazing that occurred in the early-mid 1990s.

Water Quantity and Quality

Very little is known about year-round water flows in Whiskey Dick Creek. On August 14, 2003 at 11:20 A.M. a relatively good flow of water was found in the stream. Water temperature was 60^{0}F and DO was 8 pmm, well within the tolerance limits of Chinook salmon and rainbow/ steelhead.

Both Chinook and rainbow trout were used in the assessment model, but the assessment was only done for Reach one; Reach two has no information available to date (Table 40). Steelhead and Chinook had the same ratings and protection ratings were very high compared to restoration. The stream may also have some flow issues because of natural conditions within the watershed. The water quality appears fairly good, but more information is needed. Sediment was the only other element that is depicted as contributing to a potential limiting factor.

Table 40 QHA habitat scores for WHiskey Dick Creek, WA.

Reach	Species	Protection Score	Restoration Score
Whiskey 1	Chinook	195	15
Whiskey 1	Rainbow/steelhead	195	15

4.2.11 Limiting Factors

Fish and wildlife species in the UMM Subbasin have been affected primarily by agricultural, urban, and rural development, livestock grazing, exotic species, predation, hydropower development and operation, and harvest practices. These activities have lead to habitat degradation, fragmentation, and losses and have negatively impacted the presence, distribution, abundance, and productivity of fish and wildlife.

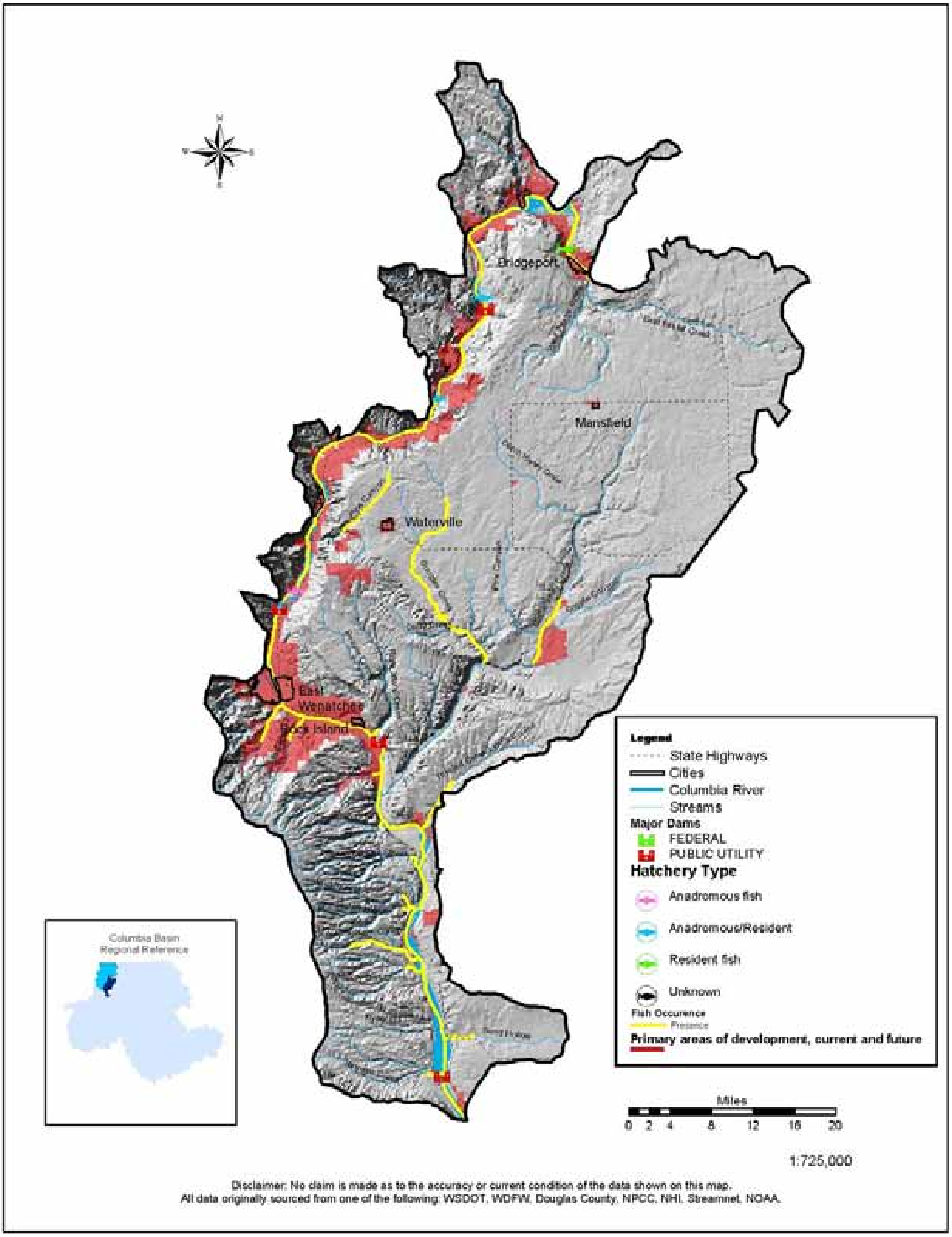
Agricultural Development

Agricultural development in the UMM Subbasin has altered or destroyed approximately one third of the native shrubsteppe habitat and fragmented riparian/floodplain habitat. Agricultural operations have increased sediment loads and introduced pesticides and fertilizers into streams, wetlands, and other waterbodies. Conversion to agriculture has decreased the overall quantity of habitat for many native species, but disproportionate loss of specific communities, such as deep soil shrubsteppe may be particularly critical for certain habitat specialists. The quality of remaining habitat is reduced as fragmentation increases especially for core sensitive species.

Urban and Rural Development

Residential/urban sprawl and rural development have resulted in the loss of large areas of habitat and have increased fragmentation and harassment of wildlife, particularly large areas of habitat that functions as winter refuge for native wildlife. In the UMM most of these areas are at low elevations and are along the Columbia River corridor (Figure 50). In addition, the lower Moses Coulee area serves as winter range for several species, primarily mule deer. As the human population continues to grow, urban and rural residential areas continue to spread into once wild areas and agricultural lands that may have been prime habitat for wildlife. Also, proximity to agriculture or suburban development leads to a high density of nest parasites (brown-headed cowbird), exotic nest competitors (European starling), and domestic predators (cats). Disturbance by humans in the form of highway traffic, noise and light pollution, and recreational activities (particularly during nesting season and in high-use recreation areas) also have the potential to displace fish and wildlife and force them to use less desirable habitat. For example, the state highways along both sides of the Columbia River from Wenatchee to Brewster have high rates of automobile accidents involving deer.

While urban areas comprise only a small percentage of the land base within the UMM Subbasin (0.5 percent), their habitat impacts are significant. Cities and towns within the Subbasin are largely built along streams and rivers. Channelization and development along streams has eliminated riparian and wetland habitats. Expansion of urban areas creates stormwater drainage, and homes built along streams have affected both water quality and the ability of the floodplain to function normally. Removal of woody, overhanging vegetation along some of the stream corridors may have increased stream temperatures to the point that they are unable to support coldwater biota. In addition, mowing, burning, and tillage of developed uplands removes habitat for upland nesting birds such as red-winged blackbird and gadwall.



(DCTLS 2004)

Figure 50 Primary areas of current and future development in the UMM Subbasin, WA.

Rural development patterns in the UMM Subbasin are also a great concern for fish, wildlife, and their habitats. Several areas have had land subdivided into lots small enough that fragmentation, noxious weeds, continuous disturbance by domestic animals, and similar issues are having negative impacts. Some examples of these are:

Badger Mountain is an island of ponderosa pine habitat within Douglas County, which has been divided into 5 acre lots. Although it is being developed at a rural density, most of the functional use of the habitat is being eliminated for many species. Other similar patterns in the area are likely affecting the species composition of deer. As the open area declines from development patterns, a shift can occur from mule deer use to whitetail deer. The whitetail deer will also eventually disappear as development density increases (Knight 1998, Vogel 1989). This pattern appears to be occurring in the McNeil Canyon area (Jones, personal observation through land owner interviews in 2002), but has not been studied thoroughly.

Rimrock Meadows was originally developed around a now non-functional horse race track in Moses Coulee. Most of the lots are less than one acre, some of which TNC has purchased development rights to. Other recreational lots lie between TNC's owned and managed lands and the WDFW pygmy rabbit habitat area creating fragmentation of the shrubsteppe habitat.

Columbia River shoreline development is occurring in many places and is at high risk of negatively affecting fish and wildlife on both sides of the river from Chief Joseph Dam to Wanapum Dam. Shoreline development in this area is likely to affect migrating birds and water quality, and it separates the shore from the uplands for terrestrial species.

Livestock Grazing

Habitat degradation from livestock overgrazing reduces emergent vegetation and upland vegetation. Livestock grazing in shrubsteppe can result in the reduction of cover that is used by wildlife, such as rodents, sharp-tailed grouse, deer and elk. It can also lead to an increase in shrub density unsuitable for many shrubsteppe obligates. In grazing areas near water sources, the riparian vegetation is often preferred in the dry season, and trampled down for water access. Soils can become compacted, and banks have been eroded. This has resulted in a loss of deciduous tree cover and sub-canopy/shrub habitat for wildlife that use these areas, loss of cover and shade for nearby streams, increases in water temperatures, and increased sedimentation in streams.

Exotic Species

The spread of non-native plant and wildlife species poses a threat to wildlife habitat quality and to fish and wildlife species. Noxious weeds (e.g., cheatgrass, thread-leaved sedge, diffuse knapweed, Dalmatian toadflax, reed canary grass, purple loosestrife, perennial pepperweed, Russian knapweed, Canada thistle, Russian olive, etc.) can threaten the abundance of native wetland and upland plant species utilized by wildlife. For example, Eurasian water milfoil surveys conducted by the CCPUD during the mid 1980s found that milfoil is infiltrating native aquatic plant beds and displacing these native plant species (NPPC 2002). Knapweed and Dalmatian toadflax are two target species of plants that several agricultural programs work to retard along roads and in shrubsteppe areas. Exotic fish and wildlife species (e.g., carp, European starling, walleye, and smallmouth bass) can compete with native fish and wildlife for resources, potentially leading to the decline of the native species. For example, carp within a wetland disturb submergent vegetation and destroy habitat for emergent aquatic insects and thus affect the productivity of the wetland.

Hydropower Development and Operation

The development and operation of the hydropower system has resulted in widespread changes in riparian, riverine, and upland habitats in the UMM. Biological effects related to hydropower development and operations on fish and wildlife and their habitats may be direct or indirect. Direct effects include stream channelization, inundation of habitat and subsequent reduction in some habitat types, and degradation of habitat from water level fluctuations and construction and maintenance of power transmission corridors. Indirect effects include the building of numerous roads and railways, presence of electrical transmissions and lines, the expansion of irrigation and industry, and increased access to and harassment of wildlife.

Several habitat types have been reduced or altered while other habitat types, such as open water and riparian areas, have increased as a result of hydropower. Natural flooding regimes, which affect ecological process in shoreline areas, were altered by the development of hydropower on the Columbia River. Prior to dam construction shoreline habitats were scoured by annual flood events generally producing a habitat of cobble and sand with sparse vegetation; something less than what is traditionally thought of as riparian areas. In general, there has been a decline in the amount of shoreline habitats, but an increase in the amount of riparian habitat due to the stability the upstream storage projects provide in periods of high flows.

Hydroelectric project operations along the Columbia River also directly influence water quality. Water quality parameters affected by hydropower production include total dissolved gas (TDG), water temperature, dissolved oxygen, turbidity, suspended sediments and nutrients. Efforts are underway to reduce hydro impacts on fish and wildlife habitat through various mitigation measures.

Columbia River flows are highly regulated by the hydroelectric complex and seasonal discharge is influenced by water storage at Chief Joseph, Grand Coulee, and Canadian dams and water use practices (Ebel et al. 1989). Dams have created a series of reservoirs and altered the food webs that support juvenile salmonids and other resident fishes, delayed the time when thermal maximums are reached and when cooling begins in late summer (BPA et al. 1994), and lessened the frequency and severity of high flow events that typically modify channels in less controlled circumstances (Stanford et al. 1996). In addition, surface water diversions contribute to dewatering and low flows, and limit access to habitat.

Beak (MCMCP 1995) reported that the productivity in the UMM reservoirs is now limited because of rapid flushing rates, cold temperatures, and lack of shallow water areas. The food that is available in the UMM reservoirs typically provides lower amounts of energy levels than that found in free-flowing areas such as the Hanford Reach (MCMCP 1995). Reduced productivity in the reservoir may affect feeding efficiency of fishes (Rondorf and Gray 1987) but whether or not this acts as a limiting factor in the UMM is not known. Exotic fish species such as carp, have established populations in slackwater areas of the reservoirs. However, whether or not their presence is a limiting factor for salmonids is unknown as well.

All hydroprojects in the UMM currently have operational plans to aid the migration of anadromous salmonids. Juvenile salmonid plans incorporate juvenile bypass facilities as well as spill programs. Adult migration is addressed by the operations of fishways at all hydropower projects below Chief Joseph Dam.

Predation

With the addition of large reservoirs associated with major hydroelectric projects, predator-prey relationships in the UMM have changed. The introduction of non-native predator fish species, increase in populations of indigenous predator fish species, and the immigration of diving piscivorous birds into the UMM are potential limiting factors for juvenile salmonids in the UMM

Smallmouth bass and walleye are not native to the UMM region of the Columbia River. They were introduced into the Columbia River system in the 1940's and 1950's to provide sportfishing opportunities (MCMCP 1995). WDFW stocking records indicate the presence of established populations of bass and sunfish by before 1933 as well. Both species are known to prey upon juvenile salmonids when the opportunity presents itself. Research has shown that smallmouth bass however, are responsible for only a small amount of the predation on juvenile salmonids in Columbia River reservoirs (Rieman et al. 1991). Individual walleye, however, consume as many juvenile salmonids as individual northern pikeminnow (Rieman et al. 1991). Walleye are less abundant than northern pikeminnow, thus their impact on juvenile salmonids is believed to be much less (Beamesderfer and Rieman 1991).

Northern pikeminnow are native to the Columbia River and are abundant and widely distributed. Loch et al. (1994) reported that northern pikeminnow accounted for 75 percent of the total catch of predator fish in the UMM region of the Columbia River in. Their widespread distribution and abundance combined with the knowledge that northern pikeminnow can consume up to 8% of the annual total number of outmigrating juvenile salmonids (Beamesderfer et al. 1996) makes them a predation threat in the UMM to juvenile salmonids.

Caspian terns and double-crested cormorants have been immigrating into the UMM section of the Columbia River in recent years (Todd West, pers. comm., 2001). Nesting periods for these birds is generally during the juvenile salmonid outmigration. Studies conducted in the lower Columbia from April to July on the diet composition of both bird species found that up to 95.3 percent of the double-crested cormorants diet and 99.4 percent of the terns diet by mass consisted of juvenile salmonids (Roby et al. 1997). Data from PIT tag recovery operations at nesting sites found near the UMM showed that nearly 5 percent of the PIT tagged juvenile steelhead and 4 percent of PIT tagged juvenile coho tagged for the Rocky Reach fish bypass evaluations were consumed by avian predators before they reached the ocean in 2001 (unpublished data, Chelan County PUD 2001). PIT tag recovery operations in the lower Columbia River also showed that 15% of the PIT tagged juvenile steelhead that reached the estuary in 1998 were preyed upon by piscivorous waterbirds (Collis et al. 2001). Gulls are also increasing in the UMM and they feed opportunistically on the food source that is available at a given time. During salmonid outmigration in the Lower Columbia, juvenile salmonids were found to comprise 48.9% of gulls diet by mass (Roby et al. 1997). This information indicates that the immigration of piscivorous birds into the UMM may be a limiting factor for juvenile salmonid survival.

Harvest

Where large populations of hatchery fish become the target of heavy fishing pressure and wild races are intermixed, wild fish may be harvested inadvertently at a much greater proportion relative to their total population.