5 Fish Assessment

5.1 Introduction

The subbasin assessment is a technical analysis to determine the biological potential of the subbasin and the opportunities for restoration. It describes the existing and historic resources, conditions, and characteristics within the subbasin with the emphasis on designated focal fish and wildlife species and focal habitat types. The bulk of the assessment work was was done by the Yakama Indian Nation and WDFW with support and involvement of Klickitat County and Oregon Department of Fish and Wildlife.

5.1.1 Fish Focal Species and Species of Interest

Four fish species were selected as primary focal species for this planning effort: white sturgeon (LMM) and steelhead, fall chinook, and coho. Lamprey were selected as species of interest.

Table 18 Fish focal species and their distribution within the Lower Mid-Columbia Mainstem subbasin

Focal Species	Distribution
White Sturgeon	Lower Mid-Columbia River Mainstem
Summer Steelhead	Lower Mid-Columbia River Mainstem, Rock Creek, Spanish Hollow, Fulton Canyon
Fall Chinook	Lower Mid-Columbia River Mainstem, Rock Creek
Coho	Lower Mid-Columbia River Mainstem, Rock Creek

5.1.2 Rationale for Selection of Focal Fish Species

Focal species and species of interest were chosen with the following considerations: 1) status under the Endangered Species Act; 2) ecological significance; 3) cultural significance; 4) *US v. Oregon* guidance. The determinations made by the aquatic technical committee to identify a species as a ‘Focal Species’ or ‘Species of Interest’ were made in consideration of the above factors as well as the amounts and types of information available. In addition, the committee limited the scope of focal species selection to a number of species that could be assessed within the limited time available.

Table 19 Focal Species and Criteria Used For Selection in LMM subbasin

Focal Species Criteria	Steelhead/Rainbow	Coho	Fall Chinook	White Sturgeon
ESA Status	Threatened	None	None	None
US v Oregon Significance	Yes	Yes	Yes	Yes
Has Ecological Significance	Yes	Yes	Yes	Yes
Has Cultural Significance	Yes	Yes	Yes	Yes
Anadromous and/or Resident	A and R	A	A	A

The following species were chosen as species of interest:

Table 20 Species of Interest and Criteria Used for Selection

Focal Species Criteria	Pacific Lamprey
ESA Status	None
US v Oregon Significance	No
Has Ecological Significance	Yes
Has Cultural Significance	Yes
Anadromous and/or Resident	A

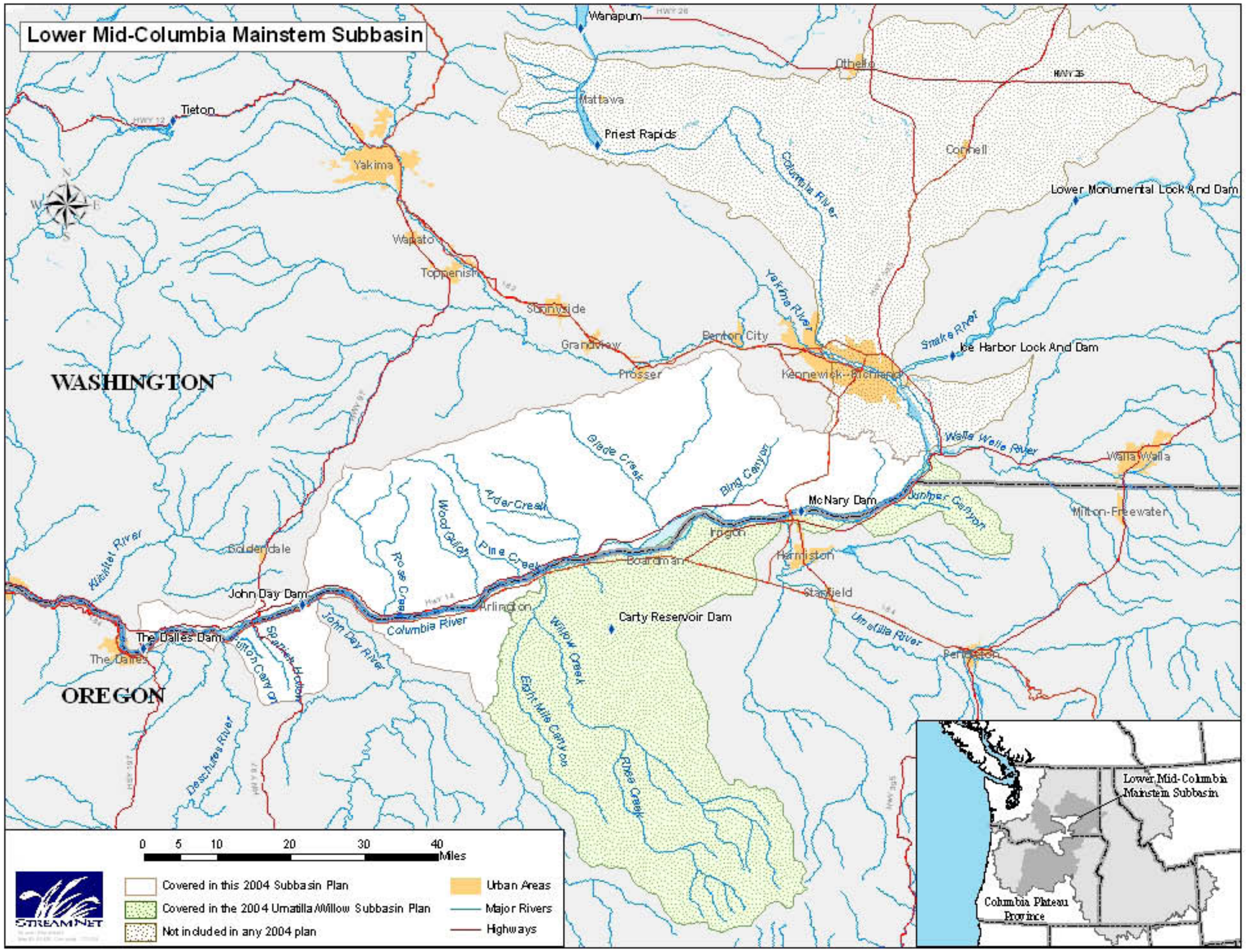


Figure 19 General location map for Lower Mid-Columbia Mainstem Subbasin

5.2 White Sturgeon

Rationale for Selection

White sturgeon (*Acipenser transmontnus*) are the largest of the North American sturgeon and the largest freshwater fish found in North America. Historically, a majority of these fish in the Columbia were anadromous, inhabiting the Columbia River from the mouth upstream into Canada, the Snake River upstream to Shoshone Falls and the Kootenai River upstream to Kootenai Falls (Miller et al, 2004, Scott and Crossman 1973). White sturgeon are found in the lower Mid-Columbia mainstem of the Columbia River, they are a culturally and economically significant species, and there is limited information regarding this species in the lower mid-Columbia mainstem of the Columbia River. For these reasons, white sturgeon were selected as a focal species for subbasin planning in the Lower Mid-Columbia Mainstem Subbasin Plan.

Key Life History Strategies, Relationship to Habitat

Historically, it is believed that a majority of white sturgeon in the Columbia River were anadromous. However, the construction of hydropower dams throughout the Columbia River Basin has resulted in fragmented populations of white sturgeon throughout the Basin. Miller et. al, (USGS Website 2004) identify three distinct populations of white sturgeon in the Columbia River, those below the lowest dam (Bonneville) with access to the ocean, fish isolated between dams (as in the Lower Mid-Columbia Mainstem), and fish in several large tributaries. Although research is limited, existing studies indicate that the dams have not only blocked upstream access for spawning and feeding, but have also impacted the amount and location of spawning habitat and may have altered food availability, natural flow patterns, and water temperatures.

Sturgeon spawn in the Columbia River from May to July in water temperatures of between 48 and 63 degrees F (Wydoski and Whitney, 1979). In an aquaculture setting, maturation seems to be determined more by size than by age (PSMFC 1992). However, maturation in an aquaculture setting may not relate directly to maturation in the wild.

Quoted from PSMFC (1992):

> In the wild, the size or age of first maturity is extremely variable. Wild males begin to mature at about 49 in (125 cm) and 26 lb (12 kg) as 12-year-old fish. In the Snake River, some males may mature at 28 in (71 cm) and about 2.4 lb (1 kg; Cochnauer 1981). Females require a longer period to mature, generally 15-32 years. A few fish mature as younger, smaller fish, but an increasing proportion of the population matures as size and age increase (Beamesderfer et al. 1989, 1990a). In the lower Columbia River 95% of female white sturgeon mature between 124 and 196 cm, corresponding to an age of 16 to 35 years (Welsh and Beamsesderfer 1993; DeVore et al. 1995). Welch and Beamesderfer (1993) estimated median length-at-maturity of 165 cm for female sturgeon in the Bonneville and The Dalles reservoirs, and 193 cm for female sturgeon in the John Day Reservoir.

Fecundity of white sturgeon varies with size, Wydoski and Whitney report that a 95.5 lb sturgeon contained 1.7 million eggs but that total fecundity could be as high as 3 million eggs. In a summary of the Columbia River sturgeon, Worldstar.com states that "spawning sturgeon generally avoid slack water for spawning preferring to deposit their eggs in rocky areas with fast flowing water". Parsley et al (1993) state that spawning and egg incubation occurred in water velocities that ranged from .8 – 2.8 m/s over substrates that were generally cobble, boulder or bedrock. Parlsey and Beckman (1994) report that there is suitable spawning habitat in the tailraces of four lower Columbia River Dams (McNary, John Day, The Dalles, and Bonneville) and that the amount of suitable spawning habitat tends to increase with increased river flow. The relationship between river flow and young of the year indexes of recruitment (and therefore spawning success), is depicted in **Figure 20**.

The incubation period of sturgeon eggs is 7-14 days, depending on water temperature (Bajkov 1951; Conte et al. 1988). Cultured broods tend to hatch synchronously (Conte et al. 1988). Hatching is complete within 20-48 hours (ODFW 2004a). Most hatching occurs in darkness in the laboratory and may represent adaptive avoidance of visual predators (Brannon et al. 1986). The optimum incubation temperature for subsequent larval viability in a culture situation is 52-63o F (11-17o C). Higher temperatures of 17-20o C result in higher mortality and hatching at earlier developmental stages (ODFW 2004a).

A recent hypothesis proposed by Coutant and cited in ODFW (2004a) suggests that riparian areas may provide important habitat for newly spawned eggs and emerging larvae. If substantiated, this theory could identify a limiting factor in white sturgeon spawning success. Riparian flooding is directly related to hydrograph operation and reservoir level.

Parsley et al (1993) report that young of the year white sturgeon were found at depths of 9-57 m., at water velocities of 0.6 m/s or less, and over substrates of hard clay, mud, silt, sand, gravel and cobble. Fish passage upstream is very limited for white sturgeon.

McCabe and Tracy report that young-of-the-year white sturgeon have been captured less than two months after spawning was estimated to have begun. Young sturgeon grow rapidly during their first summer, reaching a minimum mean total length of 176 mm and weight of 30 g by the end of September (McCabe and Tracy 1993). Juvenile (those over 1 year old) sturgeon were found by Parsley et al (1993) in water depths of 2-58 m., at water velocities of 1.2 m/s or less, and over substrates that consisted of hard clay, mud, silt, sand, gravel, cobble, bounder and bedrock.

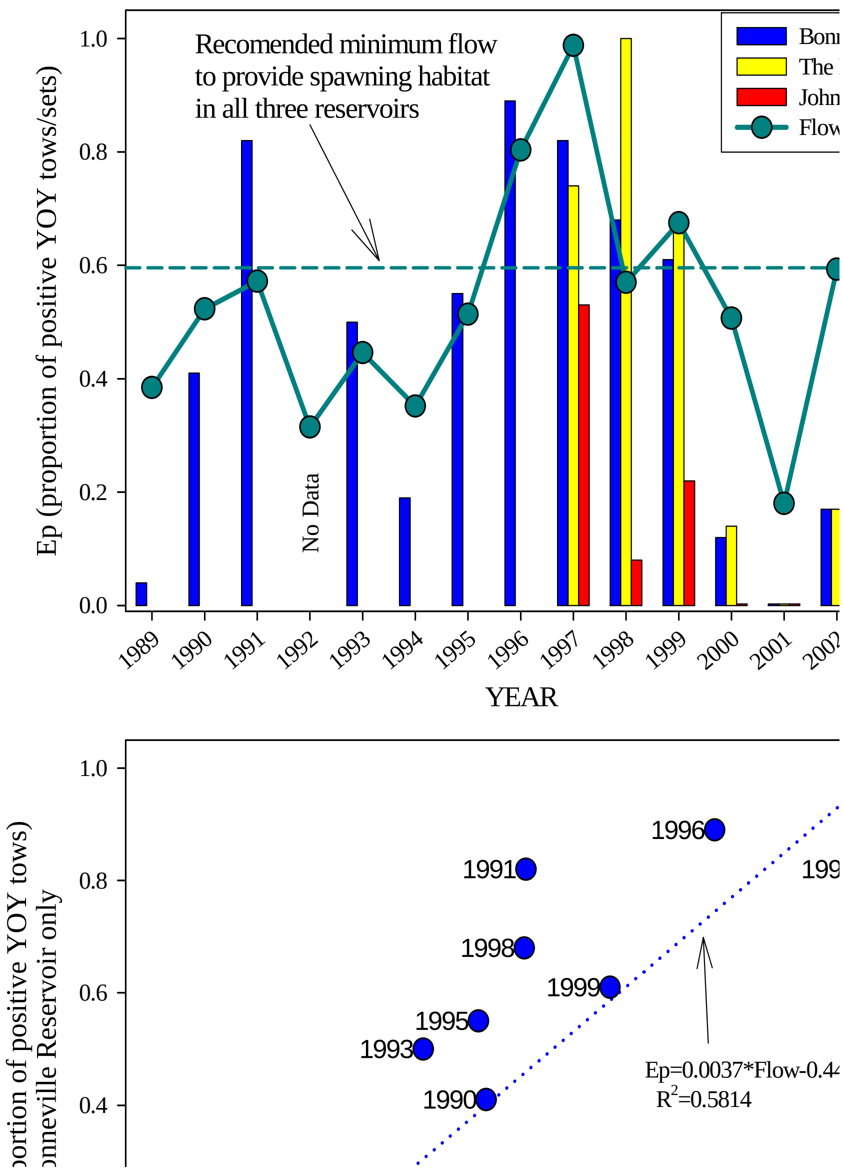


Figure 20 Recruitment index for white sturgeon (proportion of sets capturing one or more young-of-year fish) in Bonneville, The Dalles, and John Day reservoirs, and average daily flow at McNary Dam (April-July)

Note: The Bonneville index is based on standardized trawl efforts 1989-2003. The Dalles and John Day indexes are based on standardized gill-net effort initiated in 1997. All information is preliminary.

Relationship with Other Species

Adult sturgeon in the Columbia River have been reported to feed on clams, crayfish, smelt, suckers, northern pikeminnows, sockeye salmon, and Pacific lamprey, one stomach was reported to contain a house cat (Wydoski and Whitney, 1979). Sturgeon also ingest plant material but researchers believe that they ingest this plant material incidentally (Semakula and Larkin 1968; Cochnauer 1983). Juvenile white sturgeon feed primarily on algae and aquatic insects (PSMFC.Org, 2004). Adult sturgeon in the Columbia River have no natural predators, although, larval, young of the year, and juvenile white sturgeon likely experience predation from a variety of predator species. Predation on larval and juvenile white sturgeon was documented in a laboratory study by Gadomski et al (2001) who determined that size had a greater effect on the number of sturgeon eaten by predators than did turbidity. They determined that prickly sculpins ate white sturgeon up to a mean size of 53 mm total length while channel catfish only ate relatively small sturgeon, about 30 mm total length or less. In contrast, northern pikeminnows reduce their predation on white sturgeon only when they reached a mean total length of 120 mm (Gadomski et al 2001).

Population Delineation and Characterization

White sturgeon are distributed throughout Columbia River reservoirs. Although there is some upstream movement past hydroprojects, white sturgeon do not readily move upstream through fish ladders, it has been theorized that there may be a net downstream movement of white sturgeon past individual hydroelectric projects.

The following quoted text is from ODFW 2004a:

> From 1987 through 2003, 49,000 white sturgeon were tagged in the four lowermost (downstream) Columbia River reservoirs; of these fish, 6,200 (13%) were recaptured by ODFW. During these years, 6,100 (98%) of these fish were recaptured in the reservoir of original capture and tagging, 106 (2%) were recaptured in downstream reservoirs, and 23 (0.4%) were recovered in an adjacent upstream reservoir (Chris Kern, ODFW, from a presentation at the annual meeting of the Oregon Chapter of the American Fisheries Society, February, 2004). To ensure consistency of mark interpretation and reporting, these data do not include creel survey recoveries. White sturgeon marked in the four reservoirs have been recaptured downstream from Bonneville Dam in the unimpounded section of the Columbia River and in coastal tributaries. From 1988 through 1999, 11,755 white sturgeon were tagged in Bonneville Reservoir. Including creel survey recoveries, 1,161 fish were recaptured during this period: 1,127 (97.8%) were recaptured within the reservoir, 33 (2.8%%) were recaptured downstream from Bonneville Dam, and only 1 (0.1%) was caught upstream from The Dalles Dam (Kern et al. 2002).

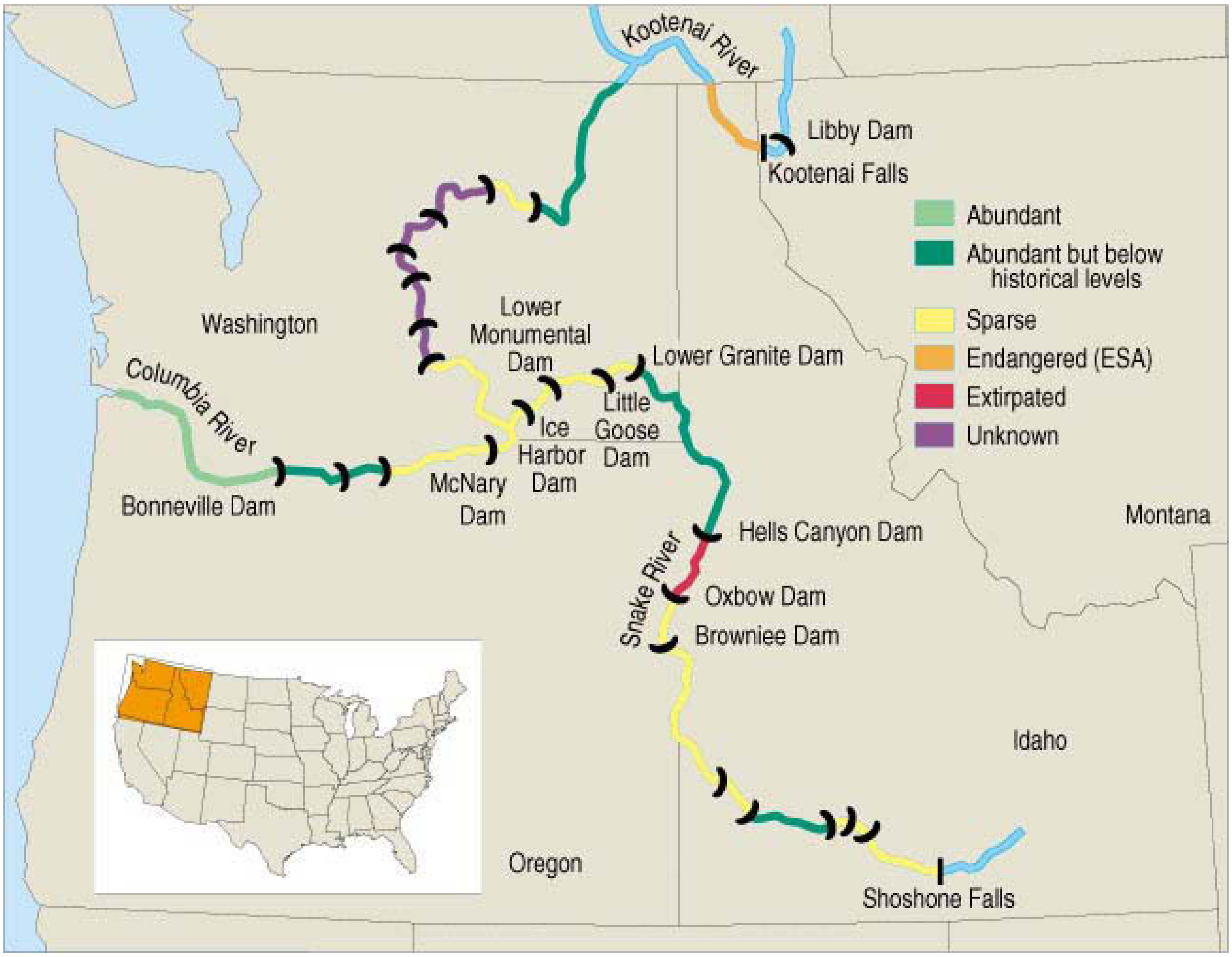


Figure 21 Distribution and status of white sturgeon in the U.S. portion of the Columbia River Basin

Population Status

Miller et al (2004) state in an article located at biology.usgs.gov that the population of sturgeon is "abundant but below historical levels" in The Dalles reservoir but that white sturgeon are relatively scarce in the John Day and McNary reservoirs. The most recent abundance estimate for The Dalles Reservoir was 104,300 fish greater than 24 inches total length in 2002. In John Day there were 30,000 fish greater than 24 inches in 2001. Population numbers have increased in these reservoirs in recent years but most of the increases are in numbers of fish less than 48 in. Abundance of fish in the legal size range (48-60 in.) has fluctuated largely in response to fishery harvest. Estimated abundance of over-legal sized fish has recently increased to levels similar to those estimated prior to 1980 (**Figure 22**, **Figure 23**, **Figure 24**). These white sturgeon populations are less abundant than areas downstream, but still able sustain recreational and tribal commercial fisheries. In 1995, abundance in McNary reservoir and the Hanford Reach was estimated as 8,250 fish greater than 24 in. (**Figure 25**).

Density was higher in McNary Reservoir than in the Hanford Reach. The higher number of white sturgeon in The Dalles reservoir may be a result of more favorable conditions in that reservoir or may be a result of a net downstream movement of sturgeon through the hydrosystem. Further research would be necessary to determine the cause of the varying density in the reservoirs of the Lower Mid-Columbia Mainstem Columbia River.

White sturgeon often experience year-class failures and poor recruitment to young of the year in mainstem reservoirs (Parsley and Beckman 1994). Although recent population estimates in John Day and The Dalles reservoirs (Ward 1998; Ward 1999) are higher than previous estimates (Beamesderfer et al. 1995), larval and juvenile fish have remained relatively scarce. Kern et al (2001) report that sampling of The Dalles, John Day, and McNary reservoirs in 2000 captured young of the year sturgeon only in The Dalles reservoir, an indication of poor spawning success and recruitment in 2000. A possible cause of the poor recruitment in 2000 could be that the peak runoff occurred in April and May, before water temperatures had reached the preferred spawning temperature of white sturgeon. White sturgeon spawning was documented for the first time in Priest Rapids Reservoir in 2000 (Grant PUD, unpublished data).

Total Length	Year				
(inches)	1987	1988	1994	1997	2002
30 - 72	23,600	9,000	9,700	59,800	33,000
(95% CI)	(15,700-33,600)	(7,300-11,000)	(7,500-14,000)	(52,400-68,100)	(26,200-42,000)
24-36	7800	4200	5800	26500	82900
36-48	11,000	4,300	5,700	38,500	13,500
48-60	6,100	1,500	800	8,100	5,900
60-72	1,800	500	<50	200	1,200
72+	1,000	800	300	200	800
24-72+	27,700	11,300	12,600	73,500	104,300

Figure 22 The Dalles Reservoir abundance estimates by total length increment (inches), 1987-2002 (Kern et al. 2004) .

Total Length (inches)	Year			
	1979	1990	1996	2001
18 - 72	15,971	--	--	--
30 - 72	--	3,900	27,100	19,600
(95% CI)	(13,836-18,651)	(2,300-6,100)	(23,800-30,800)	
24-36	--	16600	5800	14900
36-48	--	1,700	19,700	12,800
48-60	--	400	4,050	1,100
60-72	--	100	350	300
18-36	4,757	--	--	--
36-72	11,214	2,200	24,100	14,200
72+	1,019 [a]	500	700	900
24-72+	16,990	19,300	30,600	30,000

Figure 23 John Day Reservoir abundance estimates by total length increment (inches), 1979 (Macy et al. 1997) and 1990-2001 (Kern et al. 2004).

Note: (a) In 1977 the estimated abundance applied only to fish 18-72 inches and 6% of sampled catch was >72 inches (Macy et al. 1997).

Total Length (inches)	1995
30 - 72	5,234
(95% CI)	(3,782- 9,086)
24-36	900
36-48	2,700
48-72	3,400
72+	1,250
24-72+	8,250

Figure 24 Abundance of white sturgeon between McNary Dam and Priest Rapids Dam by total length increment (Kern et al. 2004)

Population Management Regimes and Activities

Hatchery Effects

Past Management Practices

There is currently one licensed private aquaculture facility downstream from Bonneville Reservoir (Troutdale, OR). This operation is permitted by the State of Oregon to rear progeny of broodstock collected from below Bonneville Dam. Juveniles are sold to the aquarium trade, and some are released into the upper Willamette River as mitigation for the loss of reproduction to the lower Columbia River. Currently, none of these operations directly affect the upstream white sturgeon populations. In recent years the development of more successful hatchery technology has resulted in a growing commercial aquaculture industry in California and the potential for further commercial and enhancement hatcheries in the Columbia River Basin.

The White Sturgeon Management Framework Plan (Fickeisen 1985) identified development of white sturgeon aquaculture as a key action to help restore white sturgeon populations above Bonneville Dam. Beginning in 1999, CRITFC and USFWS biologists began development of a hatchery program to supplement poor recruitment in these reservoirs by hatchery spawning of broodstock collected from the wild. Beginning in 2003, juvenile white sturgeon from these activities were available for release to supplement reservoir populations. Details on the history and achievements of this program can be found in Parker et al. (2004). In 2003, this program produced juvenile white sturgeon for supplementation research. In the same year, funding for the program was eliminated and the project was halted. There are currently no plans to re-establish funding for this program.

Current management Practices

Additionally, there have been efforts to capture, transport, and transplant young of the year white sturgeon from the relatively robust population below Bonneville Dam into The Dalles and John Day reservoirs. This activity has several advantages over other supplementation activities including the elimination of non-natural selection process that may occur in a hatchery environment and will increase the net upstream movement of sturgeon in the Lower Mid-Columbia Mainstem Columbia River. The “trawl and haul” program to transplant sturgeon from below Bonneville Dam to The Dalles and John Day reservoirs was first tested in 1993 and was implemented in 1994 and 1995. Fish transported in these years were all marked with PIT tags, and were all released in The Dalles Reservoir. In 1997, a study was conducted to assess the survival of these releases concurrently with stock assessment activities in The Dalles Reservoir. The results of this study were published in Rien and North (2002). Estimated survival rates from release to recapture in 1997 were 99% for the 1994 release, and 80% for the 1995 release, indicating that survival of transplanted fish was high.

The Trawl and Haul program was fully implemented in 1998. The stated goals of the program are to transplant up to 10,000 juvenile sturgeon (30 – 90 cm fork length or 1 – 6 years old) per year to The Dalles and John Day reservoirs. Because the population density in John Day Reservoir is lower than that in The Dalles Reservoir, about 2/3 of the fish transported annually into John Day Reservoir. As of 2003, about 41,000 juvenile white sturgeon have been transplanted to these reservoirs; 26,000 to John Day, and 15,000 to The Dalles (table 15).

Facilities and Programs

The USFWS, as a part of a cooperative effort funded by BPA, captured wild maturing sturgeon in the Columbia River in 1999 and 2000. They held these fish at Abernathy Creek through the spawning season and released them back to the site of origin. During the 1999 testing, viable gametes were collected from both male and female sturgeon but synchronous spawning did not occur (Holmes 2001). In 2000, lack of oocyte maturation resulted in the collection of no viable gametes. After the 2000 season, it was decided that the 12.5 degree well water that had been used for these experiments was not sufficient to trigger sexual maturation and it was decided to move the program to the U.S. Army Corps of Engineers facility at McNary Dam to provide the adult holding/spawning with water directly from the Columbia River (Holmes 2002).

Effects on Population

At this point, we are unaware of any documentation of the effect of hatchery practices on white sturgeon populations in the Lower Mid-Columbia Mainstem Columbia River.

Table 21 Releases of trawl and haul-transplanted fish, 1994 – 2003

	Release Reservoir		
Year	**The Dalles**	**John Day**	**Total**
1994	2,935	--	2,935
1995	5,611	--	5,611
1998	3,257	5,534	8,791
1999	77	4,171	4,248
2000	1,163	4,019	5,182
2001	1,257	5,195	6,452
2002	941	4,177	5,118
2003	10	2,951	2,961
Total	15,251	26,047	41,298

Hydroelectric Effects

Past Management Practices

The construction of hydroelectric dams on the mainstem of the Columbia River resulted in the fragmentation and inundation of the white sturgeon habitat in the Columbia River and may have created what are believed to be fragmented populations of white sturgeon and reduced spawning habitat. What may have been a continuous population of white sturgeon throughout the Columbia River may potentially be a series of separated populations between mainstem hydropower dams. However, there may be some recruitment into these potentially isolated population through a net downstream movement of white sturgeon past mainstem hydroelectric projects.

Construction and operation of the mainstem Columbia River hydroelectric projects has also affected the spawning habitat of white sturgeon (Parsley and Beckman 1994). White sturgeon spawning and egg incubation usually occur from April through July in the swiftest water available, generally within 8 km of a hydroelectric project (Parsley et al 1993). The amount and quality of spawning habitat is related to total river flow, with the quality and quantity of spawning habitat generally increasing as river flows increase (Parlsey and Beckman 1994). However Ebel et al. (1989) state that the operation of the Columbia River Hydrosystem has reduced the spring and summer flows in the Columbia River. Therefore, in years of relatively low river discharge, the lack of high quality spawning habitat in the Columbia River may preclude successful spawning of white sturgeon.

Parsley and Beckman (1994) state that hydroelectric development in the Columbia River Basin may have resulted in an increase in the amount of rearing habitat suitable for young of the year and juvenile white sturgeon in the impounded reaches of the Columbia River. Impoundment has resulted in increased water depths in the Columbia River reservoirs and, since juvenile sturgeon prefer to use deep water, the total amount of rearing habitat has increased. It is believed that the limited amount of successful spawning and, therefore, recruitment into the population, has resulted in more rearing habitat than the current population can utilize.

Current Management Practices

Work to evaluate and mitigate the effects of the hydropower system on white sturgeon has been systematic and comprehensive. Work commenced in 1983 and between 1983 and 1992 the work concentrated on determining the status and habitat requirements of white sturgeon in the Columbia River. Conclusions from this work led to recommendations for further work including (1) intensified management of fisheries for impounded populations, (2) evaluations of mitigation actions for impounded populations such as transplanting juvenile white sturgeon from below Bonneville Dam and refining and evaluating hatchery technology, and (3) quantifying habitat available and evaluating constraints on enhancement. Work since 1992 has been based on these recommendations. Intensive management of sport and treaty fisheries is ongoing, as are annual transplants of juvenile fish. A broad recommendation for flows that will provide spawning habitat in reservoirs has been developed and final recommendations for operation of the hydropower system is forthcoming. Response of the white sturgeon populations to these actions will be monitored and documented.

The USACE has also recently funded a study conducted by USGS to investigate behavior of white sturgeon near hydroprojects and fishways at The Dalles Dam. Work is scheduled to begin in March 2003 (study code ADS-04-NEW). Objectives are to 1) Describe the distribution, movements, and behavior of white sturgeon immediately downstream from dams including fish ladder entrances and exits, in fishways, navigation locks, and immediate tailrace areas; and 2) Determine routes of passage taken by downstream migrants and if fallback occurs for fish that ascend fishways.

Facilities and Programs (an inventory)

There are three hydropower projects located within the Lower Mid-Columbia Mainstem Columbia River. The Dalles Dam marks the lower end of the Lower Mid-Columbia Mainstem, John Day Dam is located upstream of The Dalles, and McNary Dam is the furthest upstream of the hydroelectric projects located in the Lower Mid-Columbia Mainstem. All of these hydroelectric projects engage in activities designed to mitigate the impact of construction and operation on anadromous fish (primarily salmonids).

From ODFW 2004a:

> Historically, fish lifts that seemed to move white sturgeon effectively were operated at both The Dalles and at Bonneville dams (4,711 fish moved upstream past Bonneville in 12 years). However, these fish lifts are no longer in operation. Fish ladders are less effective at passing white sturgeon upstream than were fish locks, typically when the fish lifts were in operation, less than 30 fish used the ladders at Bonneville annually. Summaries developed by

Warren and Beckman (1993) showed passage at viewing windows at Bonneville, The Dalles, and John Day dams totaled 3,464 fish from 1986-1991. Over 90% (3,181 fish) of these occurred at The Dalles Dam. The east ladder at The Dalles accounted for the vast majority of sturgeon passage at this dam, and by extension, the majority of passage at all three dams as well. The authors noted that counts for other species were also higher at this location than at others. Total length of fish using ladders: appears to range from 1 to 7 feet. Most are around 3 feet and this average size is consistent at all three locations. White sturgeon as long as 11 feet have been reported at The Dalles. One fish counter here noted that extremely large fish turned sideways to negotiate the window orifice. Most passage reported appears to have been upstream in direction. This runs counter to information from tag recoveries that document very few tagged fish recaptured in reservoirs upstream from the tagging location - the majority of fish that are recovered outside the marking reservoir are seen downstream from the reservoir they were marked in. Most white sturgeon passage has been observed from May through November. Peak passage is usually in July and August. Recently USACE has agreed to incorporate white sturgeon counts into their data entry and regular reporting of fish passage numbers.

Effects on Population

Construction and operation of the Columbia River hydrosystem has disrupted the historical migration patterns of white sturgeon and resulted in fragmentation of habitat and populations. Furthermore, the operation of the hydrosystem has affected the productivity of the populations in the impoundments created by the dams, generally reducing the amount and quality of spawning habitat while increasing the amount of rearing habitat.

White sturgeon are not uniformly distributed in The Dalles or John Day reservoirs. Densities (inferred from catch rates) were more than three times greater in the tailrace area immediately below upstream dams than in the rest of the area and densities were lowest in the forebays of downstream dams. White sturgeon of all sizes tended to be distributed more downstream in July than in May, June, July, or September; fish were distributed furthest upstream in September. Fish in The Dalles or John Day reservoirs tended to move more than those in Bonneville Reservoir. Still more than 25% of recaptured white sturgeon had not moved since tagging and over 55% had moved less than 10 km. Catch rates at different depths were significantly different. Using setlines deployed overnight, catch rates in water less than 10 m deep were lowest, fairly uniform from 10 to 30 m, and greatest at sites >30 m deep, however the size-depth interaction was not statistically significant (North et al. 1993).

Harvest Effects

Past Management Practices

A long-lived fish like the sturgeon (life span may exceed 100 years) is susceptible to over harvest. In the 1800s there was a large commercial fishery for white sturgeon that peaked with a total catch of nearly 2,500,000 kg in 1892 and fell to less than 45,000 kg by 1899 (Parsley and Beckman, 1994). Annual harvest was low until the 1940s when the commercial fishery expanded. At this time, a 6-foot maximum size limit was enacted to prevent further population collapse (Miller et al. 2004) The adoption of management practices resulted in recovery of the stocks but yields of sturgeon in the Columbia River did not increase substantially until the 1970s (Parsley and Beckman, 1994).

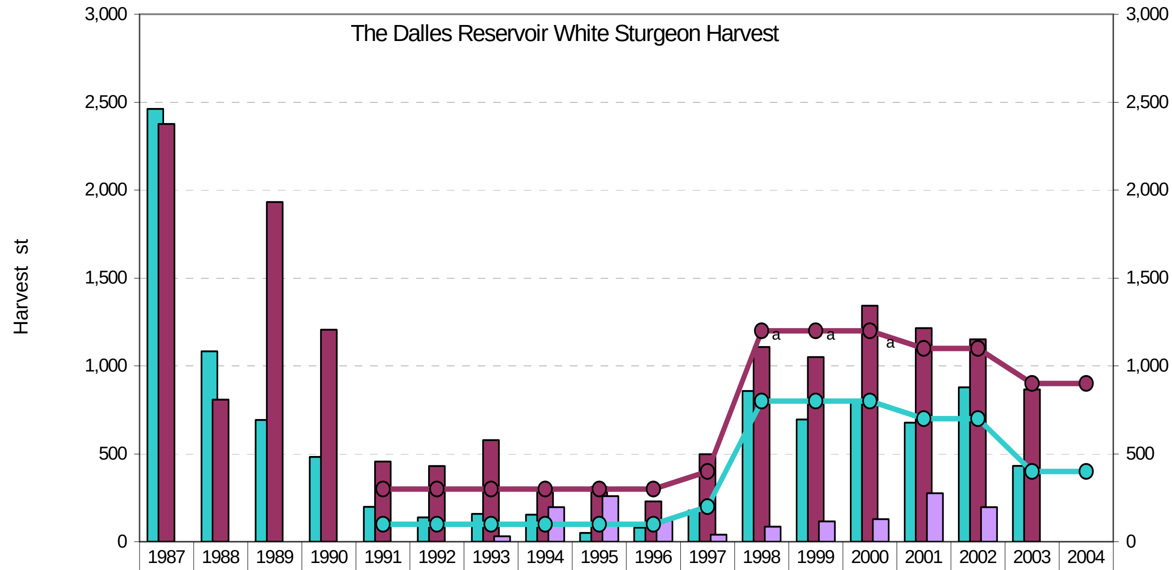
Current Management Practices

Up to 10 sturgeon each year may be caught by anglers, with a daily catch limit of 1 fish and length parameters of 48-60 in (WDFW 2003). In 1990, the sturgeon fishery below Bonneville was estimated to be 17,300 and 5,200 for the recreational and commercial fisheries respectively. From 1983 to 1994, 15 substantial regulations were enacted downstream of McNary Dam to protect white sturgeon from overfishing (Miller et al 2004). Columbia River white sturgeon support an economically important commercial, tribal and recreational fishery that was valued at $10.1 million in 1992.

Harvest estimates are available for white sturgeon in the Lower Mid-Columbia Mainstem Columbia River. Between 1997 and 2003, the recreational fishery in The Dalles reservoir ranged from 178 – 878 fish, for the same time frame, the commercial fishery ranged from 498 – 1,342 fish and the subsistence fishery ranged from 40 – 276 fish (Figure 26). Harvest in the recreational fishery in the John Day reservoir from 1997 – 2003 ranged from 163 – 593 fish, the commercial fishery captured 1,260 – 265 fish, and the subsistence fishery ranged from 24 – 63 fish (Figure 27). There are no estimates of the number of sturgeon harvested from the McNary reservoir (James et al 2001).

Effects on Population

The effects of the historical harvest on white sturgeon were devastating, reducing the population to below commercial harvest levels before the turn of the century. However, current regulations on the fishery and other management practices may have resulted in a white sturgeon population that is capable of sustaining ongoing sport, treaty, and subsistence harvests.

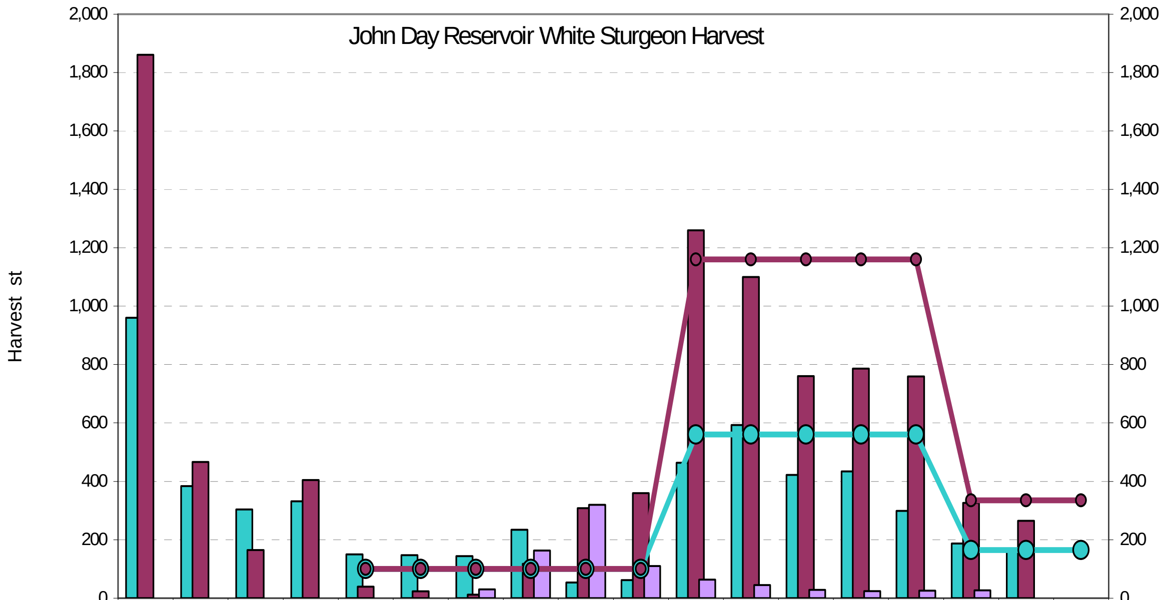


	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Recreational	2,462	1,083	693	482	199	139	158	154	50	80	178	857	695	809	677	878	432	
Commercial	2,376	808	1,932	1,206	457	431	579	309	312	230	498	1,108	1,051	1,342	1,215	1,152	866	
Subsistence							31	197	260	120	40	86	116	128	276	197		
Rec guideline					100	100	100	100	100	100	200	800	800	800	700	700	400	400
Com Guideline					300	300	300	300	300	300	400	1,200	1,200	1,200	1,100	1,100	900	900

Year

Figure 25 White sturgeon harvest in sport (rec), tribal commercial, and tribal subsistence fisheries, The Dalles Reservoir 1987-2004.

Note: (a) During 1998-2000 sport and commercial guidelines were expressed as ranges of 600-800 and 1,000-1,200 respectively (ODFW 2004a)



	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Recreational	960	384	304	331	150	147	144	234	53	62	464	593	422	434	299	187	163	
Commercial	1,861	466	165	405	39	23	12	117	308	360	1,260	1,100	760	786	759	326	265	
Subsistence							30	163	320	110	63	45	28	24	26	27		
Rec guideline					100	100	100	100	100	100	560	560	560	560	560	165	165	165
Com Guideline					100	100	100	100	100	100	1,160	1,160	1,160	1,160	1,160	335	335	335

Year

Figure 26 White sturgeon harvest in sport, tribal commercial, and tribal subsistence fisheries, John Day Reservoir 1987-2004. During 1998-2000

Note: (a) Guidelines were expressed as a range: recreational was 600-800 fish and commercial was 1,000-1,200 (ODFW 2004a)

5.3 Steelhead

Historical Distribution and Abundance

In the LMM subbasin, steelhead (*Oncorhynchus mykiss)* are the second most abundant anadromous fish, fall chinook salmon being the most. Steelhead upstream of The Dalles Dam are summer-run steelhead and are considered to have originated as indigenous species present within the subbasin prior to European settlement (NRIMP 1999). Historically, most of the rivers and streams draining into the lower mid-Columbia mainstem, the John Day, Deschutes, Umatilla, Rock Creek, Fulton Canyon, and Spanish Hollow among others, produced steelhead. In the lower mid-Columbia mainstem, these steelhead stocks mixed with migrating steelhead from numerous stocks upstream of McNary Dam from the Snake River and upper Columbia. Historically steelhead also spawned in the mainstem Columbia, including in the lower mid-Columbia. Presently steelhead stocks in the subbasin are sustained by a mix of hatchery, native, introduced, and wild and/or natural populations (NRIMP 1999).

The Columbia River tribes whose ancestors relied heavily on the lower mid-Columbia stocks, fished for steelhead along with other salmonids in this stretch of river. Prior to Euro-American settlement, steelhead were particularly important to Rock Creek Band members for both sustenance and trade. Steelhead are presumed to have utilized virtually all of the major streams and tributaries of Rock Creek for some aspect of their life history. Historical spawning distribution probably included all accessible portions of the Rock Creek watershed. The highest spawning densities are presumed to have occurred similarly to current practice, in the more complex, braided reaches of the lower mainstem of Rock Creek, as well as in third and fourth order tributaries with moderate (1-4%) gradients.

Life History Forms

Oncorhynchus mykiss, of which steelhead and rainbow trout are members, displays a wide variety of life history strategies. (Rainbow trout are also referred to as Columbia River redband trout.) Anadromy is not obligatory in *O. mykiss* (Rounsefell 1958, Mullan et al. 1992Cpa). Progeny of anadromous steelhead can spend their entire life in freshwater, while progeny of rainbow trout can migrate seaward.

Rainbow trout is not widely distributed within Rock Creek; anecdotal evidence suggests greater historical distribution and population numbers. The rainbow trout co-occur with the anadromous steelhead form of *O. mykiss* within the ESU (Evolutionarily Significant Unit), which includes this subbasin and generally coincides with the Columbia Plateau Province. According NOAA/Fisheries Biological Recovery Team, the two forms may not be reproductively isolated, except where there are barriers (NMFS Tech Memo-27, 1997). Questions also remain about the frequency of residualism within this ESU as well as reproductive isolation. Anadromous steelhead is the focus of interest within Rock Creek. Limited knowledge is available due to a historical lack of resources available for monitoring and evaluation. However, many steelhead have been observed in Rock Creek, warranting greater interest and attention within the Mid-Columbia ESU. (See Current Distribution and Abundance below for more about this Mid-Columbia ESU.)

Steelhead may be classified into two runs (Smith 1960; Withler 1966; Everest 1973; Chilcote et al. 1980). Winter-run fish ascend streams between November and April, while summer-run fish enter rivers between May and October. All steelhead in the Columbia River Basin upstream of The Dalles Dam, with the possible exception of Rock Creek, are summer-run fish (Reisenbichler et al. 1992; Chapman et al. 1994). Although steelhead in the Rock Creek watershed have appeared in some documentation classified as summer-run, there is some evidence that suggests both winter and summer steelhead may utilize Rock Creek. Not all steelhead die after spawning. A small proportion of spawners (known as kelts) may return to the ocean for a short period and repeat the spawning migration. Spawning adults typically range between three and seven years of age.

Two groups of summer-run steelhead migrate through the Columbia River. An early segment known as A group enters the Columbia River in June and July. 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 river drainages (Chrisp and Bjornn 1978).

A small number of steelhead in Columbia Basin, estimated between 1.6-17%, are able to be repeat spawners (Hatch et al. 2003). Steelhead kelts are those that spawn, survive, and outmigrate again. Researchers are currently investigating ways to reinvigorate kelts to increase their likelihood of survival and successful repeat spawning. See more discussion below in "Population Management."

Current Distribution and Abundance

The hydropower system has eliminated steelhead spawning in the mainstem, with the likely exception of Hanford Reach, which is not in the current planning area of the LMM subbasin. Today steelhead use the mainstem Columbia primarily as a migration corridor and holding area. Steelhead adults stay for extended periods in mainstem reservoirs and near the mouths of major tributaries prior to migrating further upstream. Steelhead in the LMM subbasin are part of the Mid-Columbia Evolutionarily Significant Unit (ESU) and were listed as threatened under the ESA in March of 1999 (NMFS 1999). The Mid-Columbia steelhead ESU, as described by NMFS (now NOAA/Fisheries), occupies the Columbia River Basin from Mosier Creek, Oregon, upstream into the Yakima River subbasin in Washington. In proposing to list this ESU, NMFS cited low returns to the Yakima River, poor abundance estimates for Klickitat River and Fifteenmile Creek winter steelhead, and an overall decline for naturally producing stocks within the ESU (NMFS 1999). (Some populations of Columbia River rainbow trout are on the USFWS Candidate List for proposed listing under the ESA.)

Since NMFS listed steelhead in the Mid-Columbia Evolutionarily Significant Unit (ESU) as threatened, there is evidence that trends in abundance of naturally spawning steelhead are moving upward in the major basins of Mid-Columbia ESU (Cramer 2003).

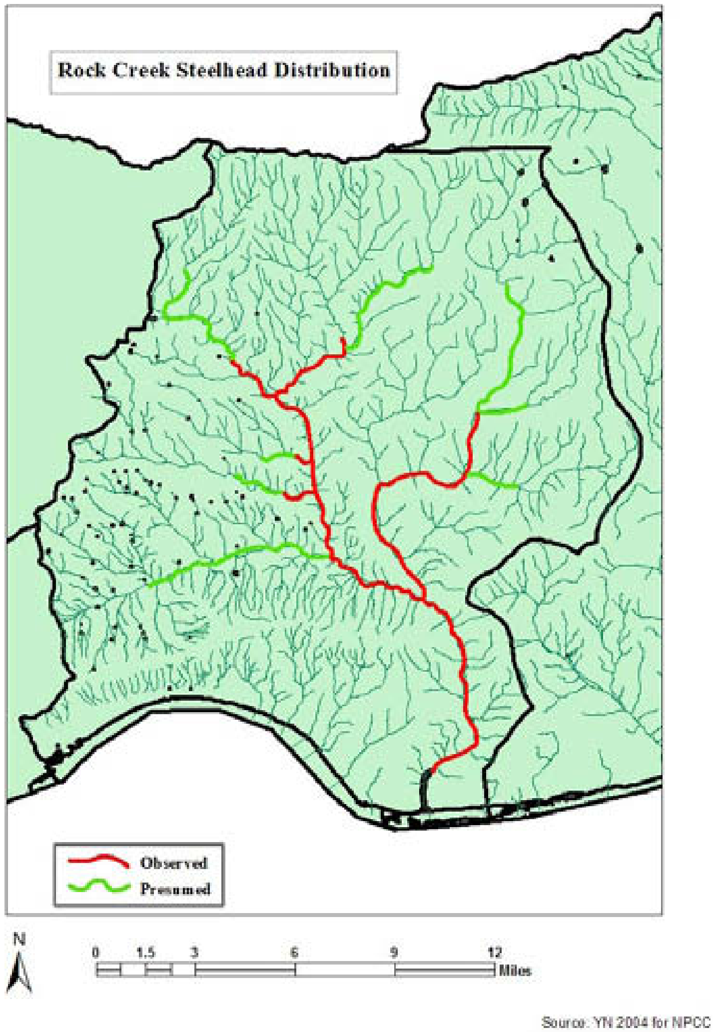


Figure 27 Observed and presumed steelhead distribution in the Rock Creek watershed

The four watersheds in the LMM subbasin (besides the mainstem) that steelhead use include Rock and Pine creeks on the Washington side and Fulton Canyon and Spanish Hollow creeks on the Oregon side. Steelhead use Fulton Canyon and Spanish Hollow Fulton Canyon and Spanish Hollow abundance estimates are unknow, but believed to be low (R. French pers. comm. 2004).

The current range of steelhead in the Rock Creek watershed is presumed to be very similar to historic conditions. However, sections of some streams thought to formerly support spawning and rearing may now be utilized only as migration corridors due to habitat degradation. Estimates of Rock Creek abundance are unavailable. Sporadic redd surveys have been committed by the Yakama Nation in 2002, 2003, and 2004. However, multiple passes have not been able to be done, and only one index reach has been repeated each year (Rock Creek mainstem bottom 3 miles). Spawning is densest in the lower five miles of Rock Creek, with 34-45 redds per mile being observed (YN).

The Columbia tributaries draining directly into the LMM Subbasin that contribute significantly to steelhead populations in the mainstem are: east- and westside tributaries of the Deschutes; Rock Creek; the lower mainstem, the North Fork, Middle Fork, South Fork, and upper mainstem

John Day; and the Umatilla. Other Columbia and Snake river tributaries use the lower mid-Columbia mainstem as a migration corridor for steelhead.

John Day River is the largest producer of naturally spawning steelhead that migrate through the lower mid-Columbia mainstem. The Umatilla and Deschutes rivers produce large numbers of hatchery steelhead. The Upper Columbia and Snake River tributaries above McNary Dam produce both wild and hatchery steelhead.

Steelhead abundance has increased over the past decades. A review of this data illustrates that steelhead abundance was significantly greater in 1999-2003 than in the earlier years of 1992-1997. For the most recent period the recovery targets were met in all five independent population areas. In 1992-1997 the interim targets were met in all of the population areas except the Upper John Day. See **Table 22** for overview of steelhead abundance and trends.

Table 22 Adult steelhead counts at LMM subbasin dams from 1994-2003

	The Dalles Dam		John Day Dam		McNary Dam	
	Steelhead	Wild Steelhead*	Steelhead	Wild Steelhead*	Steelhead	Wild Steelhead*
2003	273,172	85,287	286,176	83,959	230,418	66,554
2002	387,920	116,565	390,300	112,755	286,805	81,439
2001	503,327	125,117	483,409	112,335	389,784	94,384
2000	205,241	53,711	220,325	56,798	130,063	31,072
1999	156,874	41,379	165,314	41,316	84,088	17,711
1998	116,682	22,302	158,567	31,286	99,705	17,859
1997	164,756	20,399	157,088	21,513	129,817	16,707
1996	162,456	23,583	156,002	23,157	124,177	16,733
1995	145,844	19,484	123,240	NA	114,821	NA
1994	112,253	20,263	93,075	17,343	94,427	17,202
10-year averages	222,853	52,809	223,350	55,607 (9 yr. average)	168,411	35,966 (9 yr. average)

*Wild steelheadare a subset of the steelhead count

Life History

Rearing

Young steelhead typically rear in streams for some time prior to migrating to the ocean as smolts. Steelhead smolts have been shown to migrate at ages ranging from 1-5 years, with most populations smolting at ages 2 or 3 (Shapovalov and Taft 1954; Withler; 1966; Hooton et al. 1987; Loch et al. 1988)—usually 2 years in the mid-Columbia (NMFS/BRT Tech Memo 27. 1997).

Steelhead use Rock and Pine creeks as spawning, rearing, and migratory habitat. A few miles of Chapman Creek, near the mouth of Rock Creek, is used for spawning and holding. Some juvenile steelhead appear to rear in the upper Rock Creek watershed for a period of several months between May and October. It is unknown if they undertake a winter migration to positions lower in the basin. Because the lower mainstem goes intermittent from July to September, a number of life strategies must be employed. It appears that upper watershed juveniles remain to rear in the upper watershed. Lower watershed juveniles move out of the system, take advantage of pools (but encounter small mouth bass), and may move higher in the watershed.

Although steelhead may use Fulton Canyon and Spanish Hollow for rearing or spawning, whether they do so in any given season is highly related to environmental conditions, particularly streamflow.

Outmigration

Steelhead outmigration generally peaks in late April and early May. How this variation is expressed by the Rock Creek steelhead is unknown. Some juveniles are presumed to leave the system after emergence in May and June, while juveniles that overwinter are presumed to leave the system in March.

Steelhead grow rapidly after reaching the ocean, where they feed on crustaceans, squid, herring, and other fishes (Wydoski and Whitney 1979; Pauley et al. 1986). The majority of steelhead spend 2 years in the ocean (range 1 - 4) before migrating back to their natal stream (Shapovalov and Taft 1954; Narver 1969; Ward and Slaney 1988).

Adult emigration

Wild steelhead juveniles emigrate during the spring, passing mid-Columbia dams from April through June. Adult steelhead have also been observed entering the mainstem and tributaries in late February to early March. Once in the river, steelhead apparently rarely eat, and grow little, if at all (Maher and Larkin 1954). These various behaviors, in combination, produce fish that range between three and seven years of age at the time of spawning.

Spawning

Observed spawn timing throughout the Rock Creek has some variation. It is likely triggered by a combination of environmental cues including flow and temperature. Spawning begins in the middle of March and reaches its peak in early April. Upper watershed steelhead appear to average later spawn times by about three weeks. There is some uncertainty as to whether the upper watershed steelhead are a distinct run.

For Spanish Hollow, spawning appears to occur within the first approximately 10 downstream miles and during January 1- May 15 (DEQ/EPA 2003). Spawning begins earlier, about October 15, in the first few miles of Fulton Canyon, however, further upstream spawning appears to begin only after January 1 (DEQ/EPA 2003). Steelhead are thought to use both watersheds (not only the mainstems portions) as rearing and migratory areas depending on environmental conditions. See Appendix X for maps that include the Fulton Canyon and Spanish Hollow areas.

Incubation and Emergence

Unlike other species in the *Oncorhynchus* genus, steelhead eggs incubate at the same time temperatures are increasing. In the lower mainstem Rock Creek where densities are highest, fry emerge very rapidly. Densities from electro-shocking suggest approximately 60 days.

Population Management

Hatchery

Over 10 million steelhead smolts are released from hatcheries in Upper Columbia and Snake River tributaries above McNary Dam; a smaller number of wild steelhead smolts are also headed for the lower mid-Columbia on their way to the ocean. By far the most hatchery-reared steelhead are produced in the Snake River basin; most of the production is required mitigation for Snake River dams.

The Irrigon hatchery, near Irrigon, Oregon, one of two hatcheries within the subbasin, produces steelhead for acclimation and release in the Imnaha, Grande Ronde, and Wallowa rivers.

Kelt Reconditioning

Steelhead can express a repeat life history strategy. Because steelhead kelts "have experienced and survived stochastic events and selective forces and reached a life stage that is less prone to mortality factors than any previous stage," Hatch and his co-authors (2003) argue that investing in reinvigorating these steelhead before they make their repeat outmigration is an effective tool in restoration. Kelt reconditioning involves special feeding in a captive environment to encourage growth and redevelopment of mature gonads. To date, these efforts, primarily in the Yakima River, report benefits and support for continued reconditioning efforts, including research, as a means to increase naturally spawning steelhead populations.

Harvest

Table 23 Non-Indian and Indian Columbia River harvest of steelhead above Bonneville Dam

Upriver Steelhead*												
	Upriver A Hatchery			Upriver A Wild			Upriver B Hatchery			Upriver B Wild		
	Columbia River Run	Non-Indian Total	Treaty Indian Total**	Columbia River Run	Non-Indian Total	Treaty Indian Total**	Columbia River Run	Non-Indian Total	Treaty Indian Total**	Columbia River Run	Non-Indian Total	Treaty Indian Total**
2004	NA	NA***	9,400	NA	909	2,790	NA***	NA	5,470	NA	214	1,730
2003	215,850	25,005	14,710	70,870	883	3,690	55,240	6,660	8,550	11,600	203	1,720
2002	238,430	24,225	6,173	87,470	969	1,814	99,040	10,375	3,866	32,460	457	1,908
2001	386,510	43320	17,178	137,940	641	5,509	75,800	1,298	1,260	12,180	4,774	1,388

*Steelhead destined above Bonneville Dam ** Includes ceremonial, subsistence, and commercial. *** Total non-Indian mainstem hatchery A & B was 1,123. Source: OR/WA Joint Staff Report 2004

Hydrosystem

Hydrosystem impacts are discussed in general terms in 3.2.8 Anthropogenic Disturbances on Aquatic and Teresstrial Environments and in 5.7.2 Lower Mid-Columbia Mainstem Assessment Unit.

Relationship with Other Species

Walleye, smallmouth bass, northern pikeminnow, and channel catfish are important predators of all juvenile salmonids in reservoirs, including steelhead. Rieman et al. (1991) estimated 148,000 steelhead were lost to predation in John Day Reservoir (cumulative April – June, 1983-1986). This represented 11-13% of all juvenile steelhead entering the reservoir. Northern pikeminnow were the dominant spring predator. Walleye and smallmouth bass predation rates increased in summer when steelhead outmigration declined, reducing the magnitude of their contribution to steelhead mortality. Steelhead in northern pikeminnow stomachs ranged from 80-210 mm (back-calculated fork length) (Zimmerman et al. 1999).

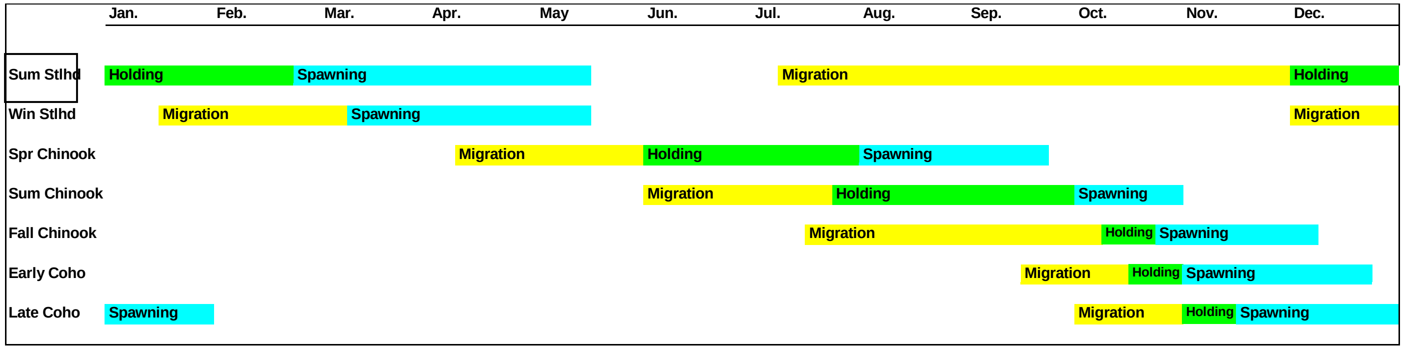


Figure 28 Spawn timing for salmon and steelhead

5.4 Coho

Historical Distribution and Abundance

Coho (Oncrhynchus kisutch) were widespread in the Columbia Basin. Now naturally spawning coho runs are very small. Historically, the Umatilla River, Rock Creek and other watersheds draining into the LMM subbasin produced coho. Endemic stocks of coho in these tributaries were extirpated early in the 20th century. Coho have recently been reintroduced into the Umatilla River. These coho historically mixed in the lower mid-Columbia with migrating coho from numerous stocks upstream of McNary Dam from the Snake River and upper Columbia. A century ago the annual average coho return to the Columbia River a century ago has been estimated at over 600,000 fish.

Key Life History Strategies and Relationship to Habitat

Adults begin entering the Columbia in July and migrate past Bonneville Dam from July through November, with a peak in September. Adults will remain in the mainstem until there are sufficient flows brought about by fall rains, generally, in October or November. Spawning occurs shortly after stream entry, and continues until mid-December. Fry emerge in March and early April, and will rear in available stream habitat through the following winter. Juvenile coho stay in fresh water for a year or longer, making them particularly vulnerable to stream disruptions. Smolting and emigration occurs in April through mid-May. Most coho adults are 3-year-olds, spending about 18 months in fresh water and 18 months in salt water (Shapovalov and Taft 1954; Wright 1970).

Emigrating smolts occupy near-shore habitat in Lake Umatilla at this time. For example, some utilization by juveniles has been noted in the lower portion of Chapman Creek and along the shore of Lake Umatilla. Potential coho habitat has been identified in the lower portion of Glade Creek (Lautz 2000).

There is incidental use associated with upriver migration of adults or downriver migration of juveniles from other Columbia River stocks; this use would generally be restricted to the shore of Lake Umatilla or pool areas near stream mouths. Juvenile coho likely used off-channel areas and tributary mouths for rearing and over-winter habitat (personal communication, Steve Pribyl, ODFW). Coho adult likely use the mainstem for holding as well as migration.

With the exception of spawning habitat, which consists of small streams with stable gravels, summer and winter freshwater habitats most preferred by coho salmon consist of quiet areas with low flow, such as backwater pools, beaver ponds, dam pools, and side channels (Reeves et al. 1989). Habitats used during winter generally have greater water depth than those used in summer, and also have greater amounts of large woody debris. Coho are good indicators of ecological health because they require good water quality and quantity.

Current Distribution and Population Status

In the LMM subbasin, coho currently occupy habitat in the Rock Creek watershed (Figure x) as well as using the lower mid-Columbia mainstem for migration.

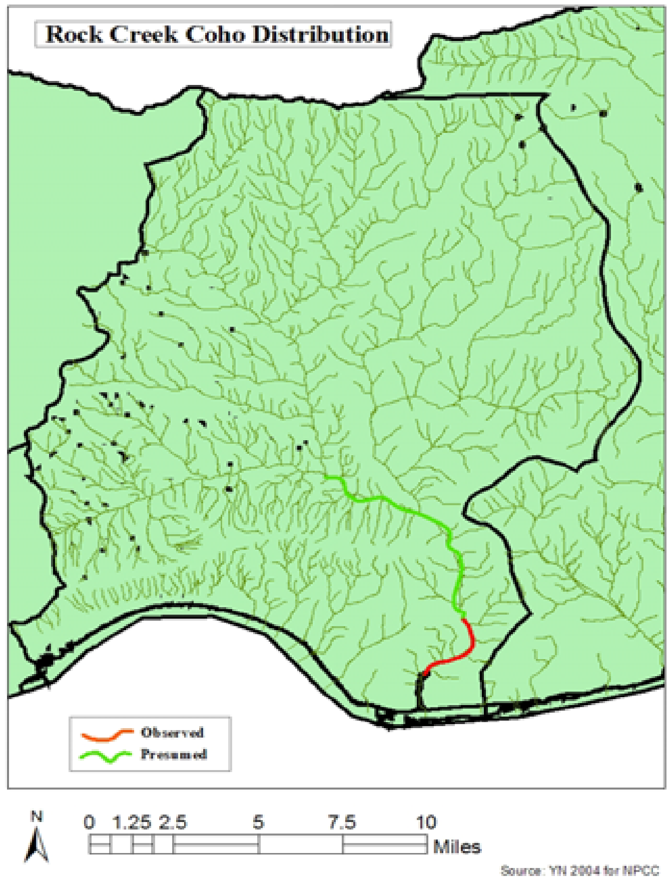


Figure 29 Observed and presumed coho distribution in the Rock Creek watershed

Coho returning to the LMM subbasin and areas above The Dalles Dam are still predominantly hatchery fish, as is the case throughout the Columbia Basin. Most of the Columbia Basin-wide production occurs in Mitchell Act mitigation hatcheries below Bonneville Dam. In recent years, however, more coho are being released in areas above The Dalles Dam, where some are beginning to spawn naturally (Umatilla Subbasin Plan 2004); the majority of these coho returns are hatchery releases from the Yakima, Umatilla, and Clearwater rivers mandated by the *U.S. v. Oregon* Columbia River Fish Management Plan.

Below Bonneville Dam, wild coho from numerous Columbia River tributaries have been been designated as an ESU (Evolutionarily Significant Unit) and are listed under the Endangered Species Act. NMFS (now NOAA/Fisheries) determined that coho stocks upstream of Bonneville Dam were extirpated, in other words, there were virtually no wild coho to list.

The 10-year trend for upriver coho, those returning to spawn upstream of The Dalles, John Day, or McNary dams, is presented in **Table 24**. Hatchery and naturally spawning coho are not differentiated in the dam counts.

Table 24 Adult coho counts at LMM subbasin dams from 1994-2003

	The Dalles Dam	John Day Dam	McNary Dam
2003	42,563	34,453	18,095
2002	9,765	7,669	2,144
2001	62,378	48,870	22,918
2000	24,966	20,560	11,173
1999	13,393	11,901	4,736
1998	8,196	7,646	5,959
1997	4,067	3,518	2,261
1996	3,622	3,289	1,281
1995	2,786	1,913	914
1994	3,786	2,455	1,347
10-year averages	17,552	14,227	7,083

Recently upriver coho counts—after passing Bonneville, salmon stocks, including coho, are considered upriver runs—have been stronger than they were since the early 1970s, with only a few exceptions. The increases are largely attributable to hatchery supplementation projects in the Umatilla, Clearwater, and Yakima subbasins. In fact, coho found in the Rock Creek and adjacent streams are believed to be straying hatchery fish, possibly colonizing or re-colonizing new areas. A small number in Rock Creek also appear to be spawning naturally. No specific life history information exists for coho that utilize subbasin streams; this is inferred from information about Columbia River hatchery stocks (Lautz 2000).

Population Management

Hatchery

The Confederated Tribes of the Umatilla Indian Reservation and ODFW are re-introducing coho in the Umatilla River; the Nez Perce Tribe is re-introducing coho in the Clearwater River, and the Yakama Nation and WDFW are re-introducing coho in Yakima, Little White Salmon and Klickitat subbasins. The Yakama Nation's most recent efforts in the Wenatchee and Methow subbasins have also met with positive results (Rowan 2002; Peven 2003). These releases are not only for harvest augmentation, but also for re-establishing naturally spawning coho stocks in areas above Bonneville Dam.

Harvest

The coho that traverse this portion of the mainstem are harvested by members of the Columbia River treaty tribes and are usually harvested as incidental catches during summer and fall harvest seasons. Fishing regulations as they apply to coho and other species are negotiated as part of the *United States v. Oregon* Columbia River Fish Management Plan. Non-Indian, largely commercial, harvests occur as the adult coho migrate upstream throught the lower Columbia. The following table shows the 2002 and 2003 harvests of upriver coho stocks.

Table 25 Non-Indian and Indian Columbia River harvest of upriver coho above Bonneville Dam

Upriver Coho						
	Ocean Catch/ Mortality	Columbia River Run	Bonneville Dam Passage*	Non-Indian Commercial Total	Sport Total	Treaty Indian Total**
2004	45,359	104,135	72,862	31,273	1,260	NA
2003	30,176	77,195	55,057	22,138	1,260	NA
2002	8,001	32,319***	87,800	43,484***	1,260	1,649
2001	39,299	343,639	259,500	43,580	1,260	NAxs

*Based on Bonneville Dam count ** Includes ceremonial, subsistence, and commercial ***Unknown decrepancy between harvest being more than river run size
Source: OR/WA Joint Staff Report 2004

Hydrosystem

Hydrosystem impacts are discussed in general terms in 3.2.8 Anthropogenic Disturbances on Aquatic and Teresstrial Environments and in 5.7.2 Lower Mid-Columbia Mainstem Assessment Unit.

Relationship with Other Species

Walleye, smallmouth bass, northern pikeminnow, and channel catfish are important predators of all juvenile salmonids in reservoirs, including coho. Rieman et al. (1991) estimated 2,484,000 coho and chinook were lost to predation in John Day Reservoir (cumulative April-August, 1983-1986). This represented 8-61% of all juvenile salmon entering the reservoir. Northern pikeminnow were the dominant spring predator, but walleye and smallmouth bass predation rates increased in summer, which contributed to very high predation rates in August.

5.5 Fall Chinook

Historical Distribution and Abundance

Both distribution and abundance were greater historically than now. Chinook (spring, summer and fall together) were the most abundant salmonids in the Columbia River Basin prior to 1850. Fall chinook run sizes are estimated to have ranged from about 1.5 million to 3.5 million fish annually (NWPCC 1987). Historically fall chinook salmon spawned in the mainstem Columbia River from near The Dalles, Oregon, upstream to the Pend Oreille and Kootenai rivers in Idaho (Fulton 1968) and were along with other salmon species, a staple of the diet of native peoples living in the Columbia Basin. Mainstem spawning still occurs in the Hanford Reach (Dauble and Watson 1997), but fall chinook have also been reported to spawn in the tailraces of Wanapum and McNary dams and a few other mainstem locations. (See below.)

Rock Creek fall chinook are also likely to have diminished in abundance. Although Rock Creek distribution is presumed to have been similar to current distribution, easily accessed areas with historically suitable habitat also would have been Squaw Creek 1 and lower Luna Gulch.

Historical distribution, abundance, and use of Fulton Canyon and Spanish Hollow watersheds by fall chinook is unknown.

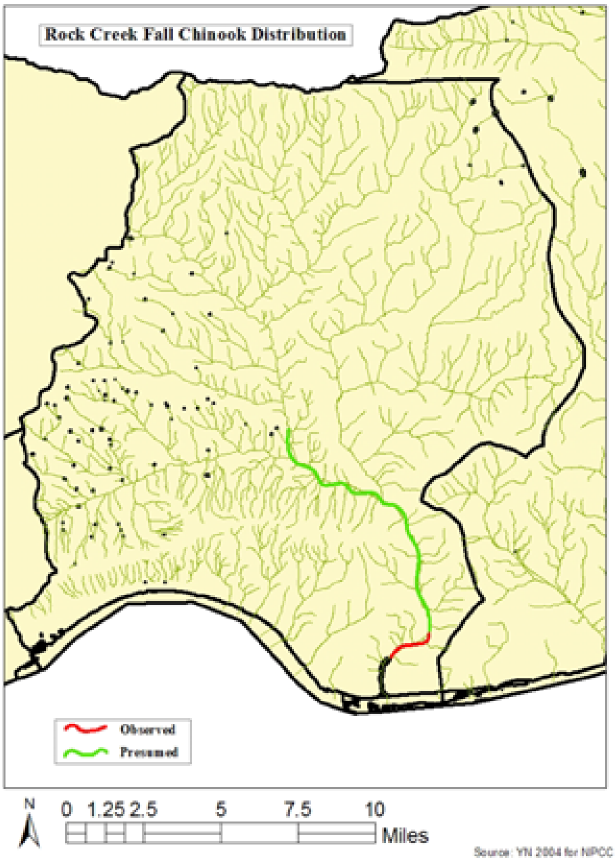


Figure 30 Observed and presumed fall chinook distribution in the Rock Creek watershed

Current Distribution and Abundance

Today fall chinook salmon are the most abundant salmonid in the Columbia River Basin, in large part, because of the naturally spawning stock from Hanford Reach. Hanford Reach, upstream of the active planning area of the LMM subbasin, produces 20 million to 30 million fall chinook salmon fry annually (WDFW, unpublished data). Since 1948 aerial counts of fall chinook salmon redds at Hanford Reach since have provided an index of relative abundance among spawning areas and years. Redd counts during peak spawning were less than 1,000 annually from 1948 to 1961, but they increased to as high as 8,800 in 1989 after construction of several mainstem dams on the Columbia and Snake rivers had inundated more natural fall chinook spawning areas.

The vast majority of the fall chinook migrating through the lower mid-Columbia mainstem is what are referred to as upriver brights or URB stock. (All the fall chinook produced above Bonneville Dam are, in aggregate, the upriver run.) This stock description is quoted from the Joint Staff Report Concerning the 2003 Fall In-River Commercial Harvest of Columbia River Fall Chinook Salmon, Summer Steelhead, Coho Salmon, Chum Salmon, and Sturgeon:

> Most of the upriver brights (URB) are wild fish destined for the Hanford Reach section of the Columbia River. Smaller upriver bright components are destined for the Deschutes, Snake, and Yakima rivers. Snake River wild fall chinook (SRW) are a sub-component of the upriver bright stock. The mid-Columbia brights originated from, and are considered a component of the

upriver bright stock. The upriver mid-Columbia bright component (Pool Upriver Brights or PUB stock) is comprised of brights that are reared at Bonneville, Little White Salmon, Irrigon, and Klickitat hatcheries and released in areas between Bonneville and McNary dams. Natural production of URB derived from PUB stock is also believed to occur in the mainstem Columbia River below John Day Dam, and in the Wind, White Salmon, Klickitat, and Umatilla rivers.

Juvenile fall chinook likely used off-channel areas and tributary mouths for rearing and over-winter habitat (personal communication, Steve Pribyl, ODFW). Adult fall chinook use the mainstem for migration and holding.

Fall chinook are the dominant salmonid present during spring in nearshore areas of the lower mid-Columbia mainstem Columbia River. Fall chinook salmon also use the upper portions of McNary and John Day reservoirs for rearing, but do not prefer riprap habitats that constitute a large portion of reservoir shorelines (USGS, unpublished data). Releases from Priest Rapids and Ringold hatcheries in June artificially increase the juvenile fall chinook salmon population. Additional fall chinook salmon enter McNary Reservoir from the Snake River and include ESA-listed natural fish produced in Hells Canyon and fish from Lyons Ferry Hatchery.

Rock Creek fall chinook runs, with loss and degradation of habitat within the watershed and the overall reduction in Columbia River populations are presumed to have diminished in abundance. Although Rock Creek distribution is presumed to have been similar to current distribution, easily accessed areas with historically suitable habitat also would have been Squaw Creek 1 and lower Luna Gulch. Rock Creek fall chinook are presumed to be upriver brights, related to the Hanford Reach population.

Current fall chinook utilization of Fulton Canyon and Spanish Hollow watersheds is unknown.

Upriver fall chinook runs have been strong in recent years, often surpassing management goals. The 2003 return of upriver brights (URBs) comprised 42% of the total fall chinook adult return to the Columbia River mouth—the largest since 1987, but below 1987's 420,600 return. The estimated Columbia River return of the ESA-listed Snake River wild chinook was 6,900, two times greater than 2002 (Joint Staff Report 2004). Wild returns to Snake River exceeded the management goal in 2003 and met the goal in 2004 (Joint Staff Report 2003, 2004).

Table 26 Adult fall chinook counts at LMM subbasin dams from 1994-2003

	The Dalles Dam	John Day Dam	McNary Dam
2003	313,697	215,483	178,951
2002	245,928	164,920	141,682
2001	181,316	124,747	110,517
2000	124,967	102, 903	67,572
1999	131.786	78,237	78.356
1998	92,932	86,805	63,791
1997	117,986	88,050	67,192
1996	117,144	68,107	73,929
1995	90,820	86,202	68,186
1994	109,969	59,039	85,932
10-year averages	152,655	107,449	93,611

Life History

Run-Timing

Fall chinook salmon are somewhat unique in that they spend the entire freshwater portion of their life cycle in mainstem habitats. Fall chinook runs generally return to natal streams for spawning September through November.

Adult fall chinook typically return to Rock Creek from the ocean, as 3, 4, or 5 year olds, from October through November. Following spawning, incubation, emergence, and fry growth, outmigration likely extends from May through June. Flow likely dictates run-timing. In Rock Creek the limiting factor is flow. When flows reconnect the lower miles of Rock Creek and provide access, fall chinook enter and distribute themselves upstream. In Rock Creek, timing of the spawning run has consistently been in October and November, when flow allows access.

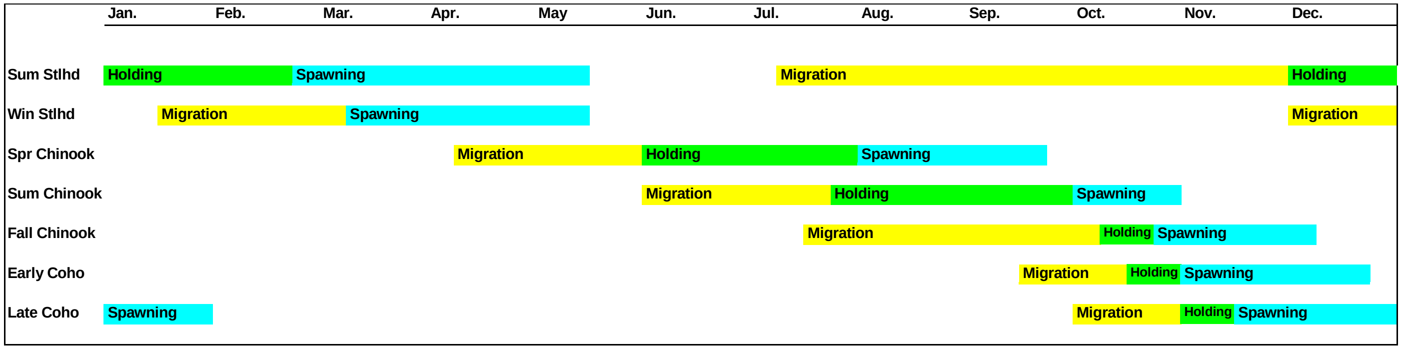


Figure 31 Spawn timing for salmon and steelhead

Spawning

Some spawning occurs in the lower mid-Columbia mainstem outside of the Hanford Reach area. Substantial natural production of brights derived from the mid-Columbia bright component (also called PUB stock) is occurs in the mainstem below John Day Dam (Joint Staff Report 2004). For example, see Figure 32, which shows redd clusters estimated to amount to 1,043 in the John Day tailrace. Similar spawning has not been found below McNary Dam (personal communication, Ron Boyce, ODFW) Lower mid-Columbia mainstem spawning apparently occurs between October and November. Rock Creek fall chinook spawning begins about the middle of October, peaks the first week of November, with water available throughout the spawning window. It is usually complete by the middle of November. It is limited to the lower Rock Creek mainstem and extends as far upstream as is accessible. Spawning may include some fish that spawn much later than the norm. There have been some observations by locals of spawning in late December; however, these are unconfirmed.

Incubation and Emergence

Incubation starts as early as October and can extend as late as late April. There is presumed to be a typical incubation period of 4-5 months, followed by emergence of the fry. Incubation likely extends throughout the winter and spring, followed by the emergence of fry with growth and outmigration in the February to May period. This comparatively short instream development, followed by outmigration to saltwater prior to reaching a full year in age, places fall chinook in the “ocean-type” life history category.

Rearing

There is very little true rearing that occurs in freshwater since smolt outmigration occurs almost immediately after fry colonization. Small, relatively slow swimming juvenile fall chinook are the dominant salmonid during spring in nearshore areas of the lower mid-Columbia mainstem. Fall chinook salmon also use the upper portions of McNary and John Day reservoirs for rearing, but do not prefer riprap habitats that constitute a large portion of reservoir shorelines nearshore areas of the three LMM reservoirs (Ward 2001).

Smolt Outmigration

Outmigration likely occurs in late April and May, followed by the emergence of fry with growth and outmigration in the February to May period. This comparatively short instream development, followed by outmigration to saltwater prior to reaching a full year in age, places fall chinook in the “ocean-type” life history category, including Rock Creek fall chinook.

Figure 32 Video survey of fall chinook redds below John Day Dam

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

Population Management

Hatcheries

The lower mid-Columbia bright component includes of brights that are reared at Bonneville, Little White Salmon, Irrigon, and Klickitat hatcheries and released in areas between Bonneville and McNary dams. Releases from Priest Rapids and Ringold hatcheries in June also increase the juvenile fall chinook salmon population. Additional fall chinook salmon enter McNary Reservoir fish produced in Lyons Ferry Hatchery.

Harvest

Chinook, and in recent decades, fall chinook in particular, have become the backbone of tribal subsistence and commercial fisheries. Fishing regulations for fall chinook (and other species) are negotiated as part of the *United States v. Oregon* Columbia River Fish Management Plan. The following table shows recent harvests of upriver fall chinook stocks. Like other Columbia upriver chinook and coho stocks, fall chinook are harvested in the ocean and lower river before they reach spawning upriver fisheries and spawning areas. Columbia River chinook stocks play a significant role during the development of harvest sharing agreements between the United States and Canada.

Table 27 Non-Indian and Indian Columbia River harvest of upriver fall chinook above Bonneville Dam

Upriver Fall Chinook *															
	Ocean Catch and Mortality		**Columbia River Run**		**Bonneville Dam Passage***		**Non-Indian Commercial Total****			**Sport Total**			**Treaty Indian Total*****		
	URB	PUB	URB	PUB	URB	PUB	URB	PUB	SWR	URB	PUB	SWR	URB	PUB	SRW
2004	6,580	1,130	286,980	49,500	264,595	45,684	22,400	3,820	7.80%	1,300	440	0.45%	66,130	13,700	23.04%
2003	9.730	1,640	258,400	43,500	238,250	40,060	20,150	3,430	7.80%	1,170	390	0.45%	59,530	18,250	23.04%
2002	7,400	1,240	276,870	48,120	257,710	45,170	19,350	2,770	6.88%	1,260	40	0.46%	57,250	8,090	20.68%
2001	3,280	470	232,600	33,240	34,920	318,90	12,780	1,350	5,50%	1,020	400	0.44%	34,820	4,410	14.97%

*Fall chinook harvested in Bonneville pool included
**Not including the ocean catch
***Ceremonial, subsistence and commercial harvests included. Source: OR/WA Joint Staff Report 2004

Hydrosystem

Hydrosystem impacts are discussed in general terms in 3.2.8 Anthropogenic Disturbances on Aquatic and Teresstrial Environments and in 5.7.2 Lower Mid-Columbia Mainstem Assessment Unit.

Relationship with Other Species

Walleye, smallmouth bass, northern pikeminnow, and channel catfish are important predators of all juvenile salmonids in reservoirs, including chinook. Rieman et al. (1991) estimated 2,484,000 coho and chinook were lost to predation in John Day Reservoir (cumulative April-August, 1983-1986). This represented 8-61% of all juvenile salmon entering the reservoir. Northern pikeminnow were the dominant spring predator, but walleye and smallmouth bass predation rates increased in summer, which contributed to very high predation rates in August. Chinook in northern pikeminnow stomachs ranged from 40-200 mm (back-calculated fork length). Fewer salmon were found in smallmouth bass and walleye stomachs and the length range was narrower (Zimmerman et al. 1999).

5.6 Lamprey

Historical Distribution and Abundance

Pacific Lamprey (or “eel”) are restricted in North America to the Pacific Coast and coastal islands from the Aleutians to Baja, California. They were once widely distributed throughout the Columbia Basin in Oregon, Washington, and Idaho. Pacific lamprey remain the largest and most abundant of three native lamprey species in the Snake and Columbia River system (Kan 1975; Wydoski and Whitney 1979). A widespread decline in numbers of Pacific lamprey has occurred since the 1960s coincident with completion of the FCRPS. This decline has been attributed to a number of causes, including habitat loss, water pollution, ocean conditions, and dam passage (Close et al., 1995). On January 23, 2003, eleven conservation groups filed a petition to list these three species as endangered or threatened under the Endangered Species Act.

Pacific lamprey are highly regarded as traditional food by Native American tribes. Former lamprey abundance provided both tribal and non-Indian fishing opportunities throughout Columbia River Basin tributaries. Pacific lamprey collection at Willamette Falls for fish food processing in 1913 was documented at 27 tons (CRITFC 1999). Commercial fishermen in the 1940s harvested 40 to 185 tons annually (100,000 to 500,000 adults) at Willamette Falls for use as vitamin oil, protein food for livestock, poultry, and fish meal. Because of declines in abundance, the Willamette River commercial fishery was closed beginning in 2002.

Current Distribution and Abundance

Pacific lamprey are distributed throughout Columbia Basin tributaries upstream to Chief Joseph and Hells Canyon dams. They have been observed as juveniles in smaller tributaries (Viento and Purham creeks; personal communication, T. Murtagh, ODFW). Although tribal accounts recognize historic lamprey in the mainstem of Rock Creek, lower Luna Gulch, and Squaw Creek, no observations of lamprey have been made by Yakama Nation Fisheries personnel during the 2001-2004 period. The current stock status and distribution in Rock Creek is completely unknown.

Although adult lamprey counting at mainstem Columbia and Snake River dams is not standardized, population trends indicate precipitous declines; however, the increases in 2002 and 2003 were much higher than previous years and, according to the Lower Columbia Subbasin Plan, similar to the average for the 1938-1969 period. As of November 1, 2004, an estimated 14,873 lamprey have passed The Dalles Dam.

The Columbia Basin Pacific lamprey work group (CBPLTWG 1999) identified habitat of juvenile and adult life histories as a critical uncertainty. Ongoing projects have focused on evaluating population status in tributaries (Hatch and Parker 1998) and passage requirements at mainstem dams (Mesa et al. 2000; Moursund et al 2000). There have been no studies to assess the relative importance of mainstem habitats on the spawning and rearing of Pacific lampreys.

Table 28 Pacific lamprey counts at LMM subbasin dams from 1997-2003

	The Dalles Dam	John Day Dam	McNary Dam
2003	28,995	20,922	13,325
2002	23,417	26,821	11,282
2001	9,061	4,005	2,539
2000	8,050	5,844	1281
1999	NA	4,005	NA
1998	NA	NA	NA
1997	6,066	9,327	NA

Life History

Spawning

Habitat requirements of Pacific lamprey share several common features with salmonids. Lamprey build nests in gravel in stream riffles and the eggs develop in the substrate. Cool, clean, well-oxygenated water is required.

Lamprey typically reach spawning grounds in mid-summer (Kan 1975; Beamish 1980) and generally spawn the following spring, spending spend approximately 1 year in freshwater.

Spawning generally occurs in small tributary streams. Both sexes construct a crude redd (Scott and Crossman 1973), generally located in the center of the stream near the tailout of a pool in riffles, immediately upstream of shoreline depositional areas (Beamish 1980). Mating is repeated several times in the redd. Each mating is followed by actions that move substrate over newly laid eggs (Kostow 2002).

Water temperatures of 10-15ºC have been measured in Clear Creek, a tributary of the John Day River, during spawning (Kan 1975). After spawning, adults die and provide nutrients to small tributaries where salmon fry rear (Kan 1975), although limited evidence suggests adults can survive to spawn again (Kostow 2002).

Incubation and Emergence

Eggs typically hatch into ammocoetes in less than 2 weeks; these newly hatched larvae, which are filter feeders, then drift downstream and bury themselves in silt, mud, or fine gravel along the margins and backwaters of streams and rivers (Scott and Crossman 1973; Hammond 1979). Ammocoetes generally spend 5-6 years in freshwater (Scott and Crossman 1973). In the fall of their last year, they metamorphose into macrophthalmia, which resemble the adult form. This transformation process is generally completed by early winter.

Run-timing

Downstream migration of macrophthalmia (pre-adult lamprey smolts) appears to be stimulated by and dependent on late winter and early spring floods (Hammond 1979). Because they are not strong swimmers, lamprey appear to be dependent on spring flows to carry them to the ocean (Kan 1975; Beamish 1980). Passage counts at Bonneville Dam showed median passage dates at the end of July. Out-migrating juvenile lampreys have been sampled in abundance at John Day and Bonneville dams. At John Day Dam, two distinct passage peaks appear to be evident. Martinson et al. (2004) report the following for John Day Dam: “An estimated 21,601 lamprey passed the project through the bypass system May 30. The most noteworthy passage peak occurred over a three day period, from 7-9 June when an estimated 67,700 lamprey passed the project. Approximately 98.7% of the juvenile lamprey were smolted (macropthalmia), while the remaining 1.3% were ammocoetes in various stages of metamorphosis. The total estimated lamprey collection for 2003 was 191,876, about 69% of last year’s estimate of 279,302.”

For Bonneville Dam, Martinson et al. (2004) report: “Pacific lamprey juveniles were found in samples from March through October. Although juvenile lamprey were sampled in every month of the season, there were three distinct peaks; 10 June (6,800), 12 June, (2,500) and 14 June (3,400). These are collection estimates generated from the sample rate and represent the estimated number passing through the bypass system that day. Almost 65% (19,679) of juvenile lamprey passage occurred in June and 97% (30,206) of the run had passed the facility by the end of June. The total collection estimate for the season was 30,333, of which over 99.4% were smolted. This season’s (2003) collection estimate is about 135% of last year’s total of 22,443.”

Habitat Use

Other than upstream and downstream migration, specific habitat use by location, duration, and life stage in mainstem reservoirs is not well known. Current knowledge of habitat use of juvenile Pacific lamprey is mainly limited to tributaries of the Columbia and Snake rivers (Kan 1975; CRITFC 1999.) A recent investigation of substrates in the lower reach of Fifteenmile Creek and its confluence with the Columbia River mainstem identified the presence of larval lamprey at densities up to 117 fish/m2 in depths ranging from 0.5 to 3.2 m (personal communication, J. Smith, InterFluve Company). The fish were well distributed across body lengths, suggesting the presence of multiple year classes.

Changes in temperature clearly dictate both juvenile lamprey outmigration and the timing of spawning migrations by adults. As temperature increases lamprey move more rapidly upstream. However, exceedingly high temperature could be a barrier to lamprey movement. Ocker et al. (2001) reported that significantly fewer lamprey successfully migrated upstream at Bonneville

Dam when temperatures at tagging exceeded 19.5°C. While the effects of high temperature in small streams have not been evaluated, it is possible that lamprey behavior could be altered by thermal barriers.

During both juvenile and adult migrations lamprey may encounter a variety of obstacles to passage. In addition to large hydropower dams discussed below, other less dramatic obstacles to lamprey passage can delay or obstruct adult passage along their migration routes. These include but are not limited to: culverts, irrigation diversion dams, weirs, and other low-head structures (Kostow 2002). The extent to which these structures affect both juvenile and adult movements is not known. However, recent research on lamprey swimming performance and migration behavior at large hydropower dams has provided insights into physical factors that can limit lamprey movements. (See Mesa, Moser, et al. 2004. Passage Considerations for Pacific Lamprey at www.cbfwa.org.)

Population Management

Harvest

Historically Columbia Basin tribes harvested lamprey, which they often call eels, for food, medicine, and trade. Harvested occurred at natural barriers throughout the basin (Wy-Kan-Ush-Mi Wa-Kish Wit 1997). Today, most tribal harvest occurs at Willamette Falls on the Willamette River and at Sherars Falls on the Deschutes River.

Non-Indian harvest lamprey, which does not occur in this subbasin, may be a thing of the past as described above in “Historical Distribution and Abundance.”

In the LMM subbasin there is no significant, if any, harvest of Pacific lamprey.

Hydrosystem

According to the Lower Columbia Subbasin Plan (2004):

> There is substantial evidence indicating that Columbia River dams have had a negative effect on Pacific lamprey populations. Hammond (1979) suggested that construction of the hydroelectric dams have caused a significant decrease in populations. Upstream passage efficiecy of adult lamprey between 1997 and 2000 at Bonneville, The Dalles, and John Day dams have been estimated to be between 38-47%, 50-82%, and 27-55% respectively (Moser et al. 2002).

Research has confirmed that Pacific lamprey are poor swimmers (Mesa et al. 2003; Close et al. 2003). Beamish (1974) showed that the distance (m) sea lampreys could swim declined with an increase in swimming speed between 20-60 cm/s. Swimming speed was positively related to temperature (range 5-15°C).

Mcauley (1996) allowed adult sea lampreys to volitionally swim up a 30-m-long flume at a variety of water velocities and temperatures. At velocities of about 1.5 m/s fish were able to swim for up to 50 s, but at 3 m/s fish could swim for only 2-3 s. Mesa et al. (2003) reported that the mean (+ SD) critical swimming speed of adult Pacific lampreys was 86.2 + 7.5 cm/s at 15°C.

When confronted with rapid current velocities, adult Pacific lamprey use their suctorial disc to hold fast and rest between intervals of burst swimming. They have difficulty navigating fishways at the dams. Swimming over the metal grating in fishway floors and negotiating 90º corners, especially at high velocities are problematic. The sharp edges prevent adult lamprey from staying attached as they move around a corner at the bulkheads adjacent to fish entrances (Moser et al. 2002; W. Kaigle, unpublished data), and instead they fall back down the fish ladder and have to attempt swim up again. Juvenile mortalities, on the other hand, are often the result of turbine entrainment or screen impingement.

Some observations of mainstem habitat use have been made where water surface elevations were rapidly lowered via manipulation of base flows by hydroelectric dams. Several juvenile lamprey were exposed during the test drawdown of Little Goose and Lower Granite dams in March 1992 (Dauble and Geist, 1992).

Hatchery

There are no hatcheries or supplementation programs in the LMM subbasin.

Fish Habitat Conditions

Introduction

The subbasin contains a variety of riverine, riparian, and wetland habitats as well as the rivers and reservoirs themselves. Habitat quality varies, but many habitats have been changed, lost, or degraded by past and present land and water uses such as hydropower development, irrigation and other agricultural activities, fishing, logging, road building, invasion of non-native plants and animals, and other anthropogenic uses.

(Some of the text on the mainstem was taken directly from the Lower Mid-Columbia Mainstem Subbasin Summary produced in 2001 to inform the NPCC's provincial project review process. Principal author of that document was David L. Ward.)

5.6.1 Fish Assessment Methodologies

Ecosystem Diagnosis and Treatment for Rock Creek

This description of the Ecosystem Diagnosis and Treatment (EDT) method is taken from the Draft Wind River Subbasin Plan, authored by the Lower Columbia Fish Recovery Board.

Reach Analysis for fish habitat

Estimation of reach-specific restoration and preservation values is one of several EDT applications. Reach analysis is based on the same fish abundance, productivity, and diversity information derived for population analysis from historic/template and current/patient habitat conditions. Reach analysis provides a greater level of detail as it identifies reaches based on their preservation value and restoration potential.

Preservation value is estimated as the percent decrease in salmon performance if a reach was thoroughly degraded. Reaches with a high preservation value should be protected because of the disproportionately high negative impact on the population that would result from degradation.

Restoration value is estimated as the percent increase in salmon performance if a reach is completely restored. A reach with a high restoration potential would provide a greater benefit to the population than a reach with low restoration potential.

Preservation and restoration are two sides of the same coin. Reaches with excellent habitat conditions have high preservation values but low restoration values. Reaches with poor habitat conditions have high restoration potential but little preservation value. Reach analysis results are specific to each fish species because of the different fish habitat requirements of each. Reach analysis results are typically displayed in a graphical format that is often referred to as a ladder or tornado diagram.

Habitat Factor Analysis

Habitat Factor Analysis is one of several and perhaps the most basic of the EDT applications. Comparing current/patient habitat conditions with optimum conditions in a historic/template baseline identifies key limiting habitat conditions. This analysis illustrates the specific habitat factors that, if restored, would yield the greatest benefit to population abundance. The habitat factor analysis depicts a greater level of detail than the reach analysis in that it looks at the specific habitat factors rather than the aggregate effect of all habitat factors.

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

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

The standard EDT habitat factor output presents the effect of habitat attributes on life stage survival for each life stage and each reach. These outputs are typically referred to as consumer reports or Report 2. While this level of information is useful for salmon biologists, it is too detailed for the scope of this document. Therefore, the attribute analysis presented here summarizes all life stages within a reach. Stage-specific values were then weighted by the impact that restoration of the reach values would have on overall population abundance. In this way, the degree of impact of a particular habitat factor in a particular reach can be compared to other habitat factors in the same reach as well as to habitat factors in other reaches.

Other Fish Assessment Methodologies

Because empirical data is lacking for the other Washington tributaries and Oregon’s Spanish Hollow and Fulton Creek, the habitat assessment is limited and based on the professional judgement of local Yakama Nation, WDFW, ODFW, conservation district, and other agency personnel. The habitat information about the mainstem portion of this subbasin comes from a variety of scientific disciplines and resource agency sources.

5.6.2 Lower Mid-Columbia River Mainstem Assessment Unit

Topography and Climate

The geology of drainage is dominated by extensive basalt flows having a total thickness of up to 5000 feet. The basalt in these flows erupted between 14 and 15.5 million years ago, forming fissures along the Snake River where Washington, Oregon, and Idaho join. The erosion-resistant nature of these flows resulted in the creation of deep (500 to 800 feet) steep-walled canyons with ragged outcrops and in severely constrained floodplain development along substantial portions of the streams within this subbasin (Lautz 2000).

Terrestrial and General Riverine Habitat Conditions

Islands in the Columbia River are of importance to fish. Riverine habitat near islands can provide spawning, rearing, and holding areas for salmonids. In John Day Reservoir, islands occupy approximately 700 ha (USACE 2000).

Embayments, which are shallow water habitats typically connected to the mainstem Columbia River via culverts or small channels, provide special fish values. In most embayments, water fluctuates less than in the river because of the elevation of the culvert or inlet channel. The magnitude of waves is also relatively low in embayments. The reduced water fluctuation and protection from wave action is beneficial to fish directly as potential spawning, rearing and holding habitat, and indirectly, as a result of conditions that promote diverse riparian and wetland vegetative communities that help provide protected areas and food resources.

Abundance of embayments differs among reaches of the Columbia River. McNary Reservoir appeared to have 21 embayments in the mid-1970s (Asherin and Claar 1976). Approximately 17 embayments are connected to John Day Reservoir, with the largest being Paterson Slough in the Umatilla National Wildlife Refuge (approximately 420 ha). The Dalles Pool had 19 embayments in the mid-1970s (Tabor 1976).

River deltas and the usually cooler water occurring at the mouths of the Walla Walla, Deschutes, and most of the other rivers draining into the subbasin’s mainstem provide critical holding habitat for migrating fish, particularly steelhead.

In this portion of the mainstem, some islands are man-made when material from the reservoirs is disposed of material after maintainance dredging. Numerous birds have colonized these islands for nesting, roosting and breeding habitat. Because islands and shallow-water areas attract migrating juvenile salmon, these areas are also often used by predators.

The quantity of riparian and wetland habitat identified in mid-1970s inventories was small (Tabor 1976). An example is John Day Reservoir, where only 230 ha of riparian habitat and 925 ha of wetland habitat remain (USACE 2000). The implications of riparian area degradation and alteration are significant for fish populations that utilize these habitats for rearing and resting (Lautz 2000).

In the Lower Mid-Columbia Mainstem Subbasin, the construction of The Dalles, John Day, and McNary dams and resulting impoundments of the Columbia River have inundated mainstem spawning and rearing areas in the mainstem as well as in the lower reaches of tributaries in this subbasin. Built for hydroelectric power, and variously for navigation, flood control, irrigation and storage, dams (including those constructed upstream of this subbasin) and the resulting impoundments altered water flows. Physical blockages and flow fluctuations caused by large and small dams, tidegates, and warm water limited access to spawning habitat. Dams and impoundments have scoured vegetation and flooded riparian and flatland areas. The river now exhibits steepshore lines and sparse riparian plant communities. The change in the river ecosystem has been systemic.

The dominant shoreline type within the impoundments is usually rip-rap, followed by smaller rock or sand (Hjort et al. 1981). Shoreline gradient in rip-rapped areas is often very steep (>45^{o}). In the relatively common backwaters, banks are often eroded, and substrate is often smaller than in main reservoirs. There is almost no functioning riparian habitat along the mainstem itself; most of the floodplains that provided favorable hydrologic conditions have been inundated.

Small, relatively slow swimming juvenile salmonids such as fall chinook salmon, may use portions of reservoirs for rearing. Rearing salmonids do not prefer the rip-rap habitats that constitute a high proportion of the shoreline and nearshore areas of all reservoirs in the current planning area of the LMM subbasin (Ward 2001a).

The operation of the hydropower system also has large effects on the spawning habitat of white sturgeon (Parsley and Beckman 1994). Impoundment has increased water depths upstream from the dams; thus, because young sturgeon use the deeper water, the physical rearing habitat has increased. However, during years of reduced river runoff, the lack of high-quality spawning habitat in impounded reaches may preclude successful reproduction by white sturgeon (Ward 2001a). (See 7.3.1 White Sturgeon Key Findings.)

Extant Aquatic Habitats and Aquatic Conditions

In 2004 the multi-agency Northwest Area Committee, a spill response-planning group, identified much of the important remaining aquatic and riparian (and wildlife) habitats in the mid-Columbia mainstem. (The river's general migratory habitat is not described.) The identified aquatic habitats in the LMM subbasin, by reservoir, are in the table below. See Figures x-x for general locations (not all islands are shown). To review the documents, view them or download them from the Internet:

http://www.rrt10nwac.com/files/grp/mid_columbia/dalles-pool-new.pdf

http://www.rrt10nwac.com/files/grp/mid_columbia/johnday-pool-new.pdf

http://www.rrt10nwac.com/files/grp/mid_columbia/johnday-pool-new.pdf

Table 29 Extant aquatic and riparian habitats in the lower mid-Columbia mainstem

Fish Habitat in Mid-Columbia River Mainstem*		
River miles**	**Area**	**Type of Habitat**
The Dalles Pool		
RM 192	The Dalles Dam	Downstream passage resources
RM 193	Lake Celilo pool above The Dalles Dam	Sturgeon spawning area
RM 197.3-197.7	Islands south and SW of Browns Island	Salmonid concentrations and habitat, warm water rearing, fishing
RM 201	NE Celilo, riverbend; Celilo Park (OR) and west of Wishram (WA)	Salmonid concentrations and habitat
RM 205.1	Deschutes River mouth	Salmonid concentrations and habitat
RM 209.3	Spanish Hollow Creek mouth near Biggs Junction (OR)	Riparian habitat
RM 211.25-213.85	West of Rufus (OR)-Oregon side, SE of Maryhill (WA), including three small islands	Salmonid concentrations and habitat, resident warm water fish
John Day Pool		
RM 216.6	John Day Dam (WA side)	Fish ladder
RM 218.7	John Day River mouth (OR)	Salmonid concentrations and habitat, resident warm water fish
RM 230	Rock Creek (WA)	Salmonid concentrations and habitat, resident fish
RM 240.5	Inlet near Roosevelt boat ramp	Salmonid concentrations and habitat, resident fish - warm water rearing, and adult fishery
RM 242.87-243.8	East to west of Roosevelt (WA)	Salmonid concentrations and habitat, resident fish – warm water rearing, and adult fishery
RM 250	Pine Creek (WA)	Salmonid concentrations and habitat
RM 253.5	Willow Creek (OR)	Shallow water habitat-salmonid concentrations and habitat (no tribal fishing zones) resident fish
RM 255.7	Third inlet entrance to Threemile Canyon	Salmonid concentrations and habitat
RM 255.8	Shallow water habitat (WA)	Salmonid concentrations and habitat, resident fish, warm water rearing
RM 255.9	Second inlet entrance to Threemile Canyon	Salmonid concentrations and habitat
RM 256.6	First inlet entrance to Threemile Canyon (OR)	Salmonid concentrations and habitat
RM 258.1	Alder Creek (WA)	Salmonid concentrations and habitat

Fish Habitat in Mid-Columbia River Mainstem*		
River miles**	**Area**	**Type of Habitat**
RM 261.3-263.97	NE, west, east, Crow Island Butte (Crow Butte State Park, WA)	Salmonid concentrations and habitat, prime small mouth fishing west of Crow Butte Island
RM 264.8-265.55	West end of Whitcomb Island (WA) (Umatilla National Wildlife Refuge)	Salmonid concentrations and habitat
RM 272.3	Glade Creek mouth (WA)	Salmonid presence and habitat
RM 273.9	SE point of Sand Island	Salmonid concentrations and habitat, nursery for warm and cool water fish
RM 273.95	Between Sand Island and island to the west (WA)	Salmonid concentrations and habitat, nursery for warm and cool water fish
RM 274.1	South end of Long Walk Island	Salmonid concentrations and habitat, nursery for warm and cool water fish
RM 274.2-275.3	Abandoned railroad trestle, NW of Big Blalock Island	Salmonid concentrations and habitat, nursery for warm and cool water fish
RM 275.15-275. 9	Big Blalock Island, NW corner (WA)	Salmonid concentrations and habitat, nursery for warm and cool water fish
RM 276.5	First set of small islands east of Long Walk Island (OR)	Salmonid concentrations and habitat, nursery for warm and cool water fish
RM 277.7	Paterson Slough (WA)	Salmonid concentrations and habitat, resident fish in Paterson Slough
RM 278.1-278.18	Washington side, east end of abandoned railroad tracks	Salmonid concentrations and habitat, resident fish in Paterson Slough
RM 282.2-282.3	Washington side, north of Irrigon, Oregon	Island, shallow water habitat
RM 285.8-286.1	Island between Irrigon and Umatilla, east and north entrances	Shallow water habitat
RM 286.2	Second inlet west of Plymouth (WA)	Shallow water habitat
RM 288.6	Near Umatilla River mouth	Salmonid concentrations and habitat, sturgeon spawning, freshwater fish habitat
RM 289.1	Plymouth Park, south side, boat ramp opening (WA)	Island resources
McNary Pool		
RM 291.6	McNary Dam fish ladder (OR)	Adult fish passage
RM 297.6	Inlet at Hat Rock State Park (OR)	Inlet waters
RM 298.3-299.05	The two largest islands east of Hat Rock State Park and passageways between them (OR)	Shallow water habitat
RM 299.4-299.8	First island north of Cold Springs Junction to NE point of peninsula jutting north of Cold Springs Junction	Shallow water habitat

Fish Habitat in Mid-Columbia River Mainstem*		
River miles**	**Area**	**Type of Habitat**
RM 300.05-300.28	Point on south shore opposite Spukshowski Canyon to Point NE of Cold Springs Junction (OR)	Shallow water habitat
RM 304.6	Wetlands area of Juniper Canyon; Corps Habitat Management Area (OR)	Marsh, shallow water, wetland habitat
RM 313.8-314.3	Walla Walla River mouth; near Wallula State Park (OR)	Fish and wildlife resources at the mouth of the Walla Walla River
RM 316.75	Inlet south Hover and Hover Park (WA) across the river from Walla Walla River mouth	Salmonid concentrations and habitat

*General mainstem migratory habitat not described. Not all potentially significant habitat has been identified. ** River miles are based on either the booming or skimming strategies intended to protect riverine resources; in the case of booming strategies, the river miles are slightly upstream of the habitat areas. Where known, some river miles have been adjusted to more closely approximate exact location.

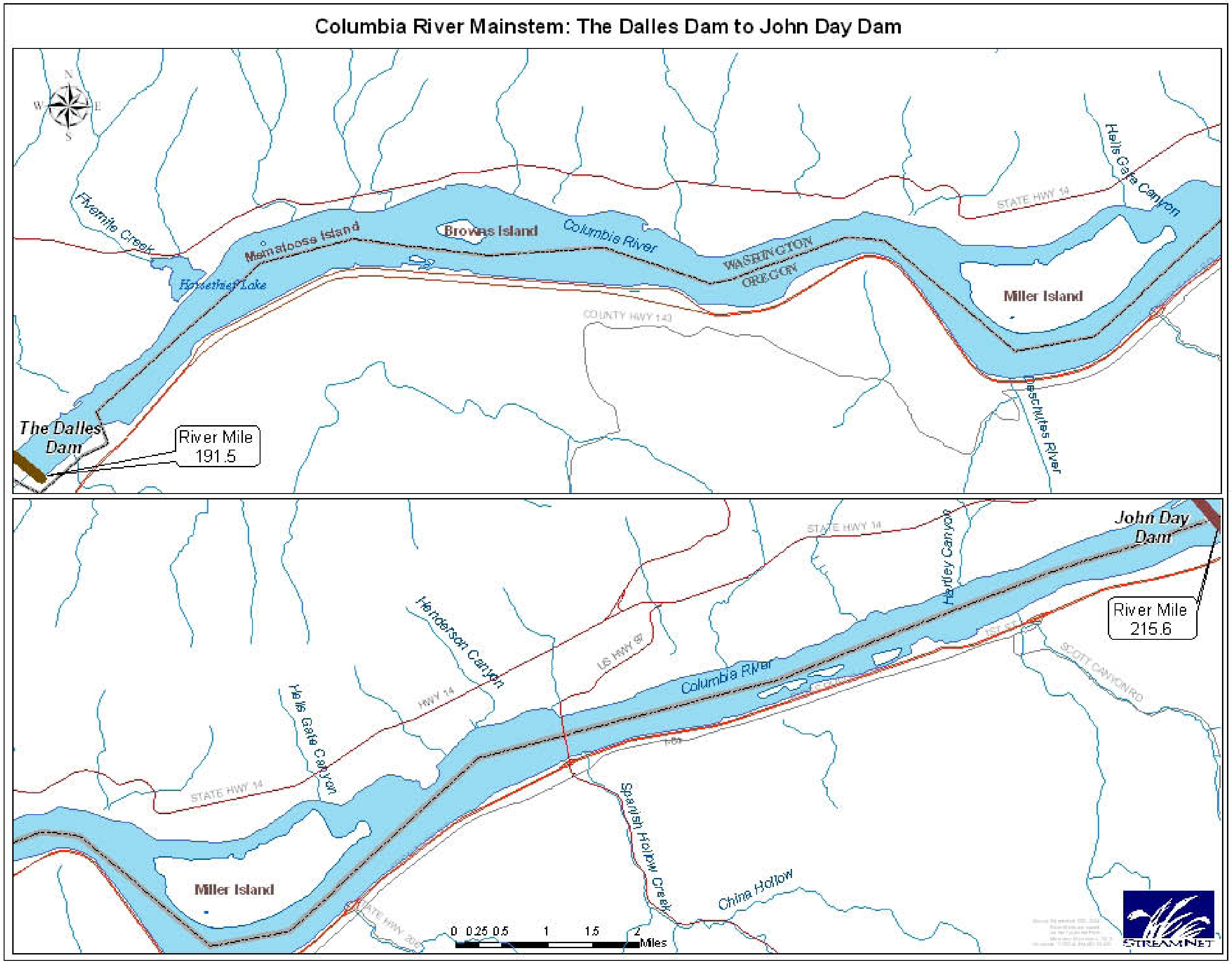


Figure 33 Mainstem Columbia from The Dalles Dam to John Day Dam

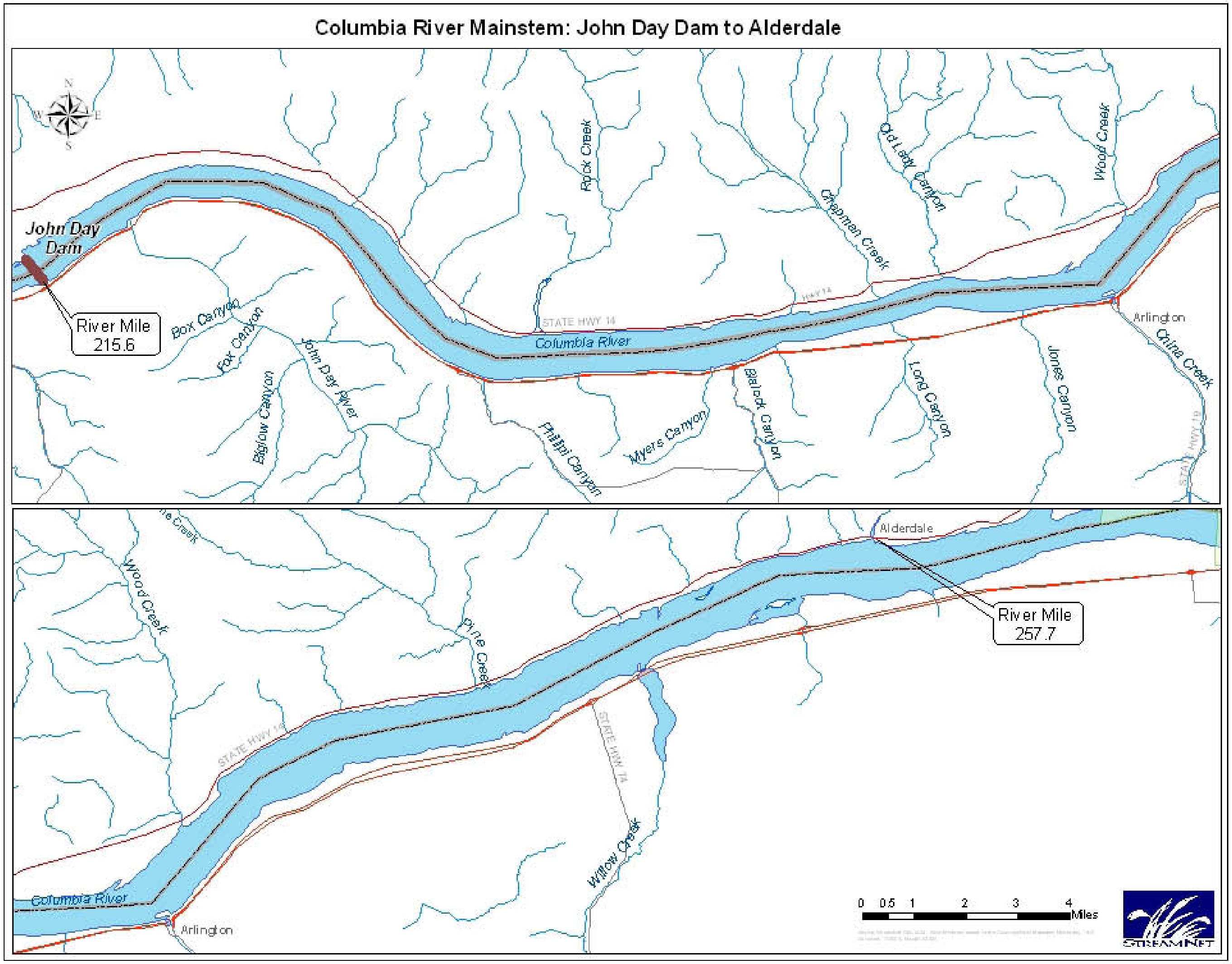


Figure 34 Mainstem Columbia from John Day Dam to Alderdale

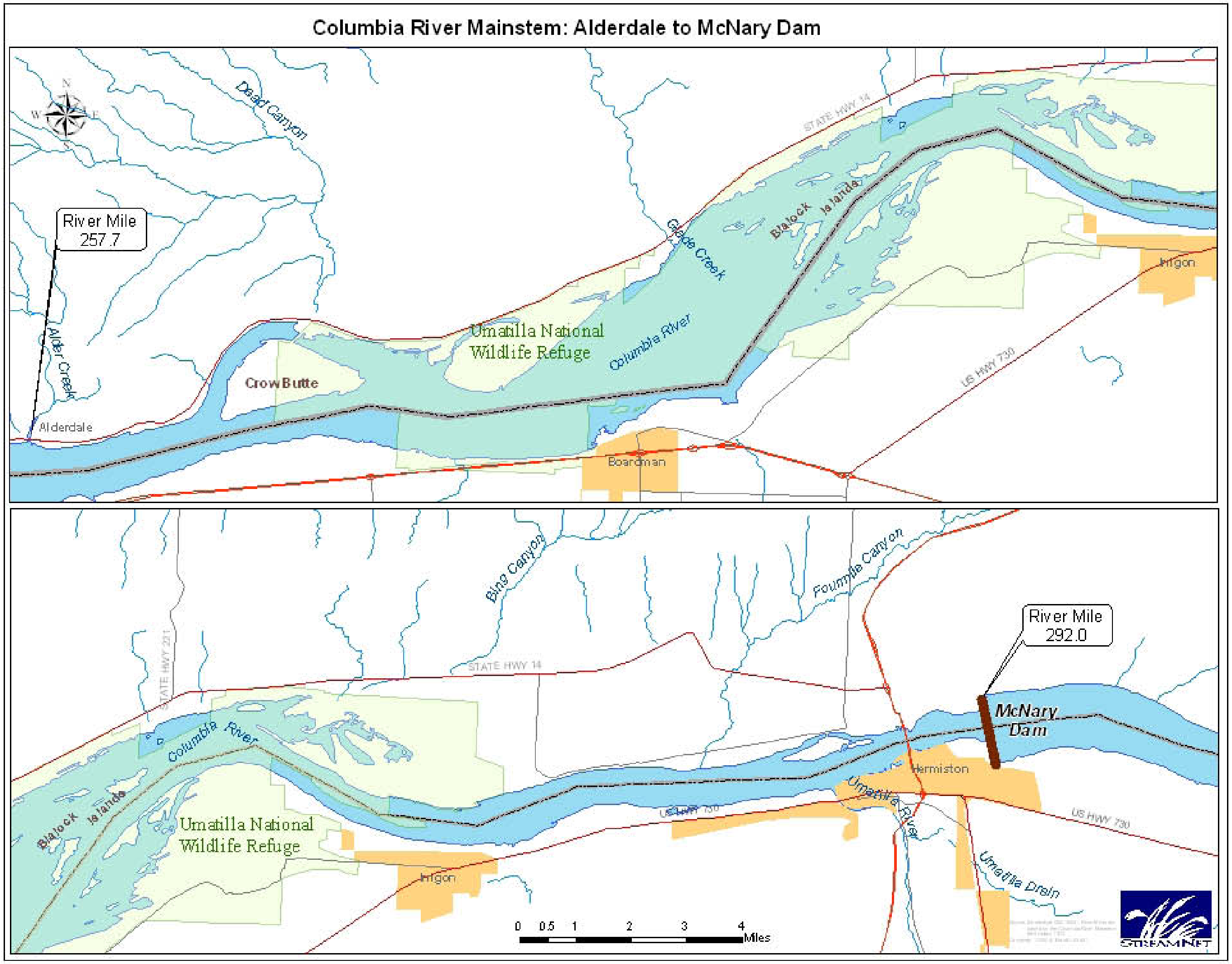


Figure 35 Mainstem Columbia from Alderdale to McNary Dam

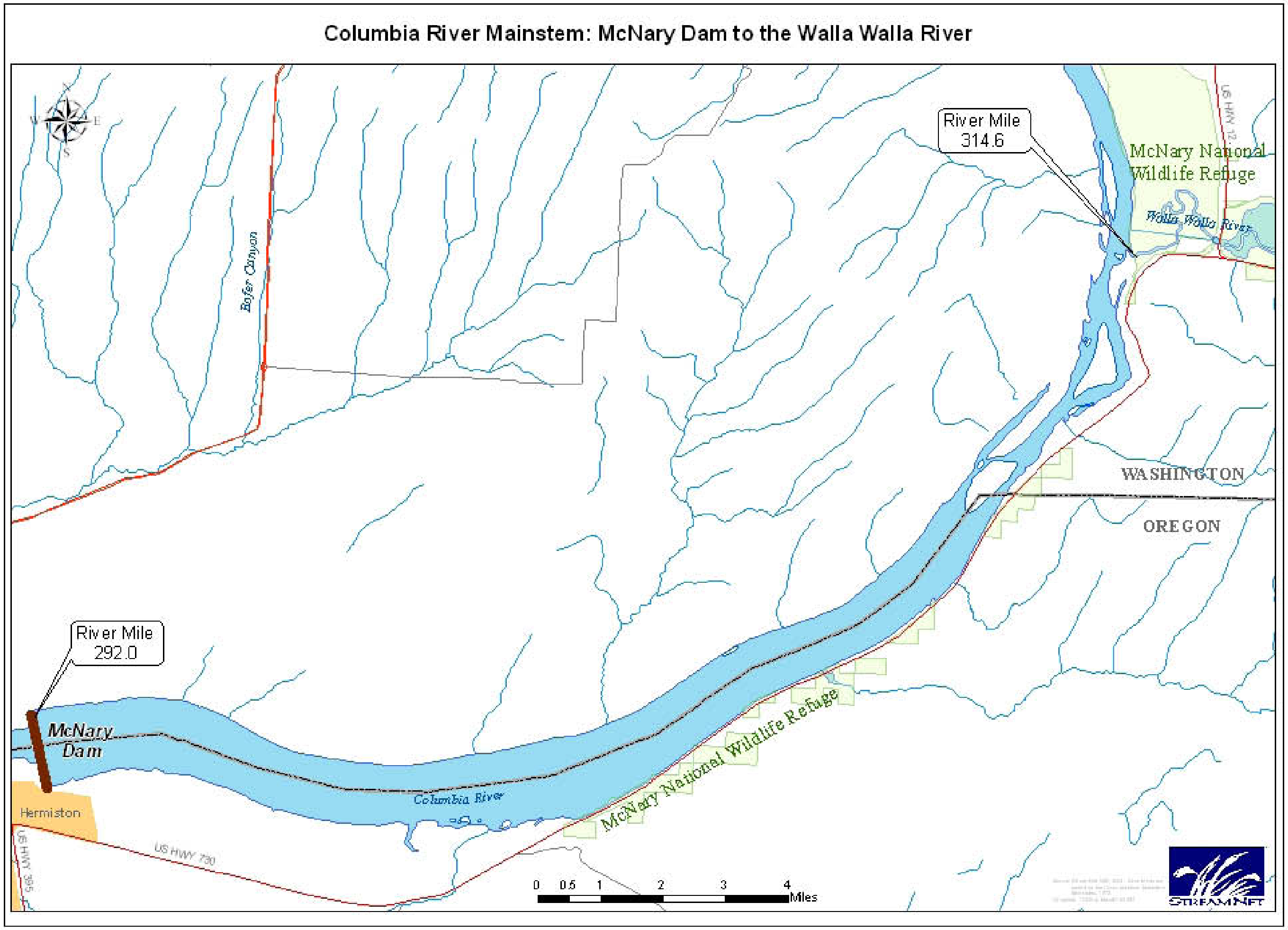


Figure 36 Mainstem Columbia from McNary Dam to the Walla Walla River

Environmental Contaminants

Environmental contaminants enter the lower mid-Columbia mainstem ecosystem through a variety of point and non-point sources. Point sources include outfalls at a variety of agricultural, military, and industrial facilities along the river and major non-point sources including agricultural applications of pesticides, insecticides, and herbicides. Salmonids may uptake contaminants through direct contact or biomagnification through the food chain. The USFWS conducted a study (USFWS 2004d) of environmental contaminants in the Columbia River, with sediment, invertebrate, fish, and egg (piscivorous and non-piscivorous birds) samples collected in the lower Columbia River below Bonneville Dam (four river segments including three NWRs), at Umatilla NWR, above McNary Dam, and in the lower Willamette River near Portland. They found most organochlorine (OC) pesticides were below detection in sediment and biota. However, similar to previous and concurrent studies, the pesticide transformation products DDE and DDD were the most commonly detected and most elevated compounds in biota from both rivers. DDE was detected in all fish samples during both years of the study, and in nearly all samples of bird eggs.

Polychlorinated biphenyls (PCBs) were commonly found in fish and bird egg samples, but were rarely detected in sediment or invertebrates. PCBs and DDE in most fish samples exceeded mean concentrations reported in nationwide comparison studies, and exceeded estimated guidance values for the protection of avian predators.

Mercury was detected in all invertebrates and birds eggs, and in most fish sampled. In invertebrates, mercury was below estimated guidance values for the protection of avian invertebrate predators, but some fish samples exceeded these guidance values. Mercury in eggs of some piscivorous birds in the lower river segments exceeded values associated with impaired reproduction in sensitive individuals.

Most dioxin and furan congeners were near or below detection in sediment and invertebrates, but were commonly detected in fish and bird eggs. Nearly all fish sampled contained 2,3,7,8-tetrachlorodibenzo-pdioxin (TCDD) and 2,3,7,8-tetrachlorodibenzofuran (TCDF) in excess of guideline values derived in this study or other studies for the protection of bald eagles or other avian predators. TCDD and TCDF exceeded estimated NOAELs in eggs of some piscivorous birds.

BMFs derived based on data from Columbia River fish and bald eagle eggs were fairly consistent among river Segments 1 to 3 in the lower river, and the combined BMFs for the three segments were 113 for total PCBs, 75 for DDE, 2.8 for mercury, 16 for TCDD, and 2 for TCDF. The TFC values derived from the BMFs were 0.06 µg/g for total PCBs, 0.04 µg/g for DDE, 0.20 µg/g for mercury, 0.9 pg/g for TCDD, and 7.5 pg/g for TCDF.

Although bioaccumulative contaminants were near or below detection limits in sediment and invertebrates, results document biomagnification of some OC compounds to concentrations likely resulting in adverse impacts to piscivorous birds.

Results did not indicate that individual river segments differed in their contribution to the contaminant concentrations observed in biota. This trend indicates that the river receives contaminants from numerous widespread sources, and that contaminants were evenly distributed in biota.

The extent to which sediments are re-mobilized and transported out of a designated site and their subsequent effects to habitat in areas receiving the sediments is not well understood. USFWS Biological Opinion (1999 predicted contaminants mobilize during the dredging of fine sediments. The USFWS recommends a basin-wide strategy to better control release of bioaccumulative contaminants to the river and minimize impacts to fish-eating birds, to monitor changes in OC contaminants over time, and to better address contaminant uptake from sediment sources.

The lower Umatilla basin is now a Groundwater Management Area. A recent DEQ comprehensive study of the wells within a 352,000-acre portion Umatilla and Morrow counties found elevated levels of nitrate groundwater contamination. Possible source included Umatilla Chemical Depot washout lagoons, confined animal feeding operations, irrigated agriculture, land application of food processing water, and speptic systems. While positive actions have been taken to reduce the contamination, continued work is necessary, according to DEQ (2003).

Lost fishing gear

Commerical gillnets are used in The Dalles and John Day reservoirs. When gear is lost during commercial fishing seasons because of river traffic, vandalism, or water and weather conditions, they sink and sometimes trap fish, including white sturgeon and occasionally salmon. Because a project to retrieve lost gear is relatively new, there are many years worth of the lost synthetic net and buoys to recover (WCT 2003).

Hydrosystem Conditions

Once anadromous fish species and a rugged terrain of fast moving water dominated Columbia River. Since completion of the federal hydrosystem, the lower mid-Columbia River mainstem is dominated by a regulated series of reservoirs and dams, serving multiple and useful purposes. Once the river was important to all stages of the anadromous life cycle; now salmon and other anadromous fish use the mid-Columbia mainstem almost exclusively as a migratory corridor. A migration corridor challenged by juvenile and adult passage through warm, slow moving reservoirs and around/by/through dams by various means.

The focus of mainstem subbasin plans, however, is primarily on habitat rather than system-wide mainstem issues such as passage. Hydropower and storage dams are, of course, major factors in determining the productivity, mortality, and survival of fish in mainstem subbasins. However these issues are intentionally not the focus of subbasin planning and most issues related to passage of anadromous salmonids have been left to be addressed other forums. Major passage and other habitat issues are discussed briefly here and addressed in 8. Management Plan.

Water Quantity

The extent to which hydropower development and flow management practices and their alteration of physical habitat and species assemblages have affected key trophic relationships between species is unknown. It is well established that stream flow quantity and timing are critical components of water supply, water quality, and the ecological integrity of river systems

(Poff et al. 1997). Flow regimes, geology of surrounding landscapes, and longitudinal slope are important controlling variables in salmon habitats and operate at both the watershed and reach scale (Imhof et al. 1996). In the Columbia River, flow regimes are highly regulated by the hydroelectric complex and seasonal discharge is influenced by water storage and water use practices (Ebel et al. 1989). Flow regulation also affects connections among groundwater, floodplains, and surface water (Stanford et al. 1996), or convergence zones (hyporheic habitats) where biodiversity and bioproduction are frequently high (Stanford and Ward 1993). The relative magnitude and frequency of high flow events also acts to modify channel form, but only within constraints of existing geological features. For example, major floods are less frequent because of upstream flood-control projects constructed since the 1940s. This change is significant because rivers that flood frequently maintain different species and food webs from systems that are more ecologically benign (Stanford et al. 1996).

Flows and Flow Augmentation

Dams upstream of this subbasin hold back water for flood control and other uses, interrupting the seasonal river flow patterns. Seasonal releases of water from the dams, called flow augmentation, can aid salmon migration. Flow augmentation for migrating juvenile salmon is called for in the 2000 Biological Opinion. Water is released in spring and summer months to improve flows in the Columbia and Snake rivers. The Corps and the BPA coordinate and plan the flow augmentation with the region through a Technical Management Team for fish.

•

Stream flow quantity and timing are critical components of water supply, water quality, the ecological integrity of river systems (Poff et al. 1997) and the ability of anadromous fish to successfully make their timely annual migrations. Flow regimes, geology of surrounding landscapes, and longitudinal slope are important controlling variables in salmon habitats and operate at both the watershed and reach scale (Imhof et al. 1996). Flow regulation also affects connections among groundwater, floodplains, and surface water (Stanford et al. 1996), or convergence zones (hyporheic habitats) where biodiversity and bioproduction are frequently high (Stanford and Ward 1993). The relative magnitude and frequency of high flow events also acts to modify channel form, but only within constraints of existing geological features. For example, major floods are less frequent because of upstream flood-control projects constructed since the 1940s. This change is significant because rivers that flood frequently maintain different species and food webs from systems that are more ecologically benign (Stanford et al. 1996).

The regions fishery agencies have long been working in with the NOAA/Fisheries to ensure that, at a minimum, the flow levels specified in the 2000 Biological Opinion are provided during the juvenile fish migration (State, Federal, and Tribal Fishery Agencies Joint Technical Staff. 2003). These levels of flow were originally selected based on existing data that suggested juvenile survival below these flows would be severely impacted, according to the Joint Technical Staff. Others have recommended alternatives: the Columbia River Inter-Tribal Fish Commission has recommended a normative flow regime that more nearly resembles a natural hydrograph under various runoff conditions, and generally provides spring flows that are significantly greater than the existing targets (2003). (See “Natural Hydrograph and Altered Control” below.)

The preponderance of scientific evidence is that increased flow during migration increases survival of juvenile salmonids by decreasing travel times and that mortality over spillways is lower than mortalities through other routes at dams. Determining the relationship of flow with smolt survival requires, however, more than simply a flow-related variable (DeHart 2003). In a letter of response to the ISAB, DeHart wrote:

> NMFS in published papers has utilized several predictor variables in the regression models. In studies of smolt travel time in the past we have utilized several predictor variables in regression models. In the present application to smolt reach survival, the predictor variables were water transit time, proportion of spill, and water temperature. Because each of these predictor variables are linked to conditions at can influence survival, the model that contained the most predictor variables that each had slope parameter significantly different than zero was chosen as the best model with explanatory capability. Even when spill proportion did not remain in a model in the presence of water transit time, we acknowledged that its influence was still present *because the spillway route is a dam's highest survival route based on past NMFS studies* (emphasis added).
>
> …[A] trend in increasing survival in the lower Columbia River in 2001 was coincident with the increase in spill be provided at dams within the reach. Flows were only moderately changing in 2001 and water temperatures followed the normal course of increasing over time, which links well with increasing predation activity over time. Under these conditions, one would expect reach survival to decrease over the season had spill never been used in the lower Columbia River.
>
> Spill also influences the smolt survival in the reach by providing the route of highest survival ateach dam to the proportion of smolts that utilize that route. Therefore, in every reach survival estimate there are contributions of both spill passage at the dams and flow related variables in the reservoirs to the overall smolt survival estimates. We have been successful in demonstrating that analyses of survival data must include a series of years in order to get a wide enough range of environmental and biotic conditions to show statistically significant relations between smolt survival and a joint set of predictor variables which include a flow-related variable.
>
> The fact that among year flow, water transit time, fish transit time relations can beestablished provides significant reasons to achieve, at a minimum, [2000] Biological Opinion flow objectives in any given year. The proposed NWPPC Program measures would move water from the fish migration period, back to the winter period, affecting flow during the fish migration period. This would be contrary to the intent of the [2000] Biological Opinion. Seasonal flow targets were derived in order to meet minimal hydrosystem survival rates in conjunction with harvest, hatchery and habitat measures, which are required to achieve overall population survival and recovery. Flows should be met throughout the migration period because of differences in passage timing for individual populations. Within populations there are different out migration timing for various lifehistory strategies (e.g. differing overwintering locations within a tributary). The importance of providing protection measures across populations and life-history types has been thoroughly documented, such as ISG *Return to the River* (1996, 2000) and NMFS Viable Salmonid Populations (McElhany et al. 2000). In addition, in river survival

estimates represent only one component of the life cycle, which flows can effect. Other effects of flow include the additional direct mortality that occurs down stream of reach studies and the indirect or delayed mortality that occurs as a result of fish condition, arrival timing and estuary and plume conditions.

The tribes and fish agencies (including NMFS as of 2000), support the flow targets in the unamended 2000 Columbia River Basin Fish and Wildlife Program. At that time in a white paper (2000), NMFS agreed that, especially when base flows are low, continued flow augmentation is consistent with a spread the risk strategy.

Natural Hydrograph and Altered Flood Control

Development of the hydropower system has eliminated most mainstem riverine habitat available for spawning anadromous salmonids and altered the water flows that juvenile anadromous salmonids encounter as they migrate to the ocean. Before construction of the dams, the highest flows occurred in the spring and early summer, and the migration of juvenile salmonids coincided with those high flows (Park 1969). Operation of the hydropower system has resulted in regulated flows that are lower in spring and summer relative to the historic hydrograph (Ebel et al. 1989). Increases in cross-sectional area of the river associated with impoundments further reduced water velocities in spring and summer. The Columbia, once a narrower, fast-moving river, is a now a series of broad, slow-moving reservoirs, effecting wildlife as well as fish (Ward 2001a).

The four Columbia River treaty tribes, who fish and, among others, care for the natural resources in the lower mid-Columbia mainstem, recommend a return to a more natural hydrograph or flow regime. A natural river reservoir operation promotes environmental conditions that are in harmony with the salmon's biological timing (Independent Science Group. 2000. http://www.nwcouncil.org/library/return/2000-12.htm 12.htm

It would require altered flood control and earlier reservoir refill at upstream storage dams. The results, according to the GENESYS model plan, would be more natural river peaks, which would improve salmon survival by increasing turbidity and habitat, decreased travel time, cooler water, less predation, reactivate flood-plain habitats, higher river estuary productivity, and better coincident timing with salmon migration (Martin 2004). Altered flood control uses less reservoir drafts during winter and early spring. More water is shifted from winter to spring, which is more akin to the natural hydrograph than the Corps' current flood contol system.

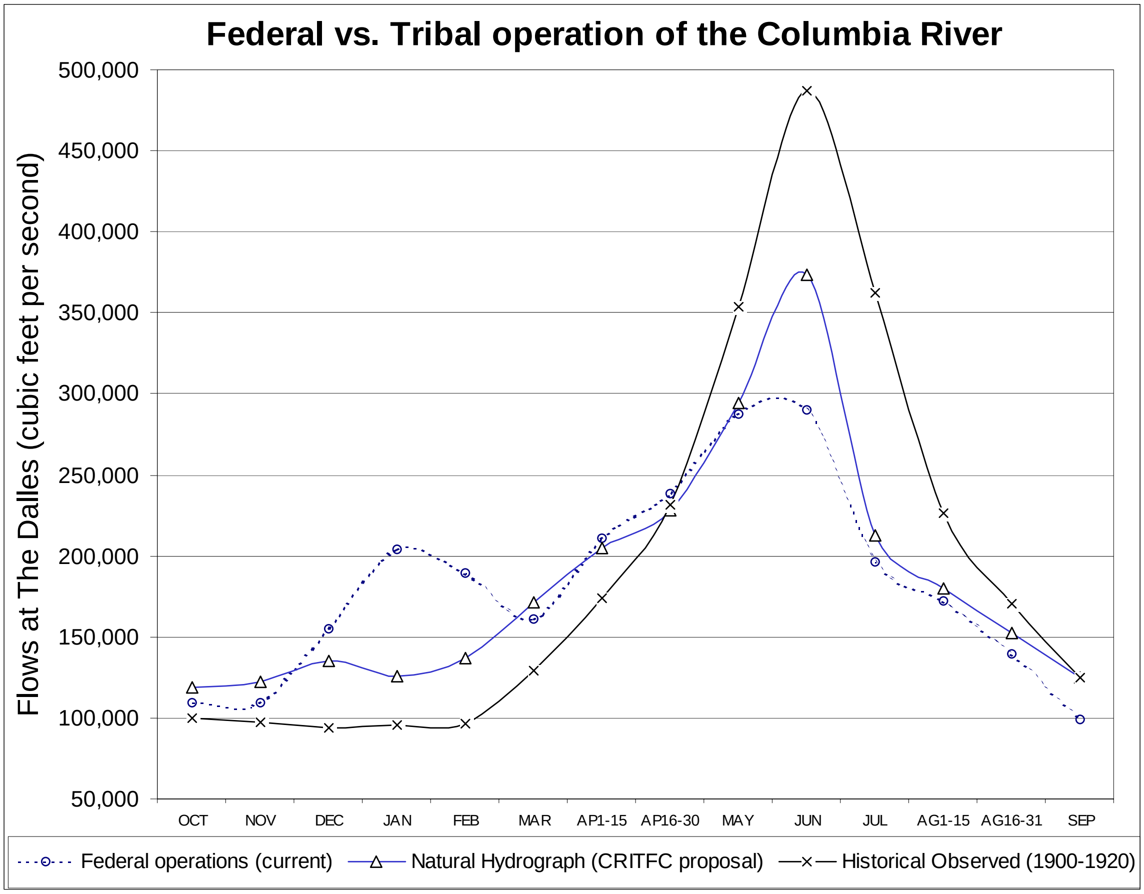


Figure 37 Historical, proposed natural, and current hydrograph

The modeled results shown in the chart above are for the Columbia at The Dalles using the average of 50 water years with the GENESYS hydro model (CRITFC 2001).

Martin makes the case that global warming will reduce winer snow packs, thus reducing the need to store water for spring flood control. New forecast tools, e.g., from the University of Washintgon, CRITFC, and NOAA can reduce premature flood control drafts (2004).

Specific recommendations are proposed for reservoir storage at all the Columbia Basin's major storage dams. Under the proposed scenario generation increases in summer and decreases in winter. Winter demand is offset, in part, by global warming and other non-hydro energy sources (CRITFC 2003) http://www.critfc.org/legal/energy_fin.html

Annual generation from the Federal Columbia River Power System Hydropower would be 162,650 MW or 1,754 MW less than 2000 Biological Opinion annual generation of 162,650 MW.

Note: For other points of view on flow augmentation issues, see Giorig et al. 2002. Giorgi, A., M. Miller, J. Sevenson 2002. Mainstem Passage Strategies in the Columbia River System: Transportation, Spill, and Flow Augmentation. Prepared for the Northwest Power Planning Council, Portland, OR.; and ISAB. 2002. Review of Flow Augmentation: Update and Clarification, Prepared for the Northwest Power Planning Council, Portland, Oregon.

Water fluctuations and rapid flow alterations

Rapid water level fluctuations associated with hydropower peak operations may reduce habitat availability for fish and alter migration patterns. Threats to salmon from altered flows include disruption of natural diurnal and seasonal flow patterns, loss of water-driven access to off-channel habitat, decreased habitat availability for mainstem spawning and rearing stocks, decreased foodweb productivity, altered juvenile migrations and stranding through both direct and indirect effects, and disrupted turbidity patterns (decreased predator avoidance) (LCSSRSP 2004). Rapid changes in flow and spill may also increase problems with upstream passage of adults at dams as fish may have a more difficult time locating the entrances to fishways and may be more likely to fall back after exiting the fish ladder.

Juvenile and adult migration behavior and travel rates are closely related to river flow. Flow fluctuations may stimulate or delay juvenile emigration or adult migration, thereby affecting synchrony of juvenile arrival in the estuary or adult arrival at the spawning grounds. Juvenile and adult salmon have to adjust their habitat distribution and migration timing during these rapid changes in water levels (LCSSRSP 2004).

In response, federal operating agencies have agreed to stabilize daily flow fluctuations from hydropower facilities, including The Dalles, John Day, and McNary dams. Since 1999, the Corps has maintained the John Day reservoir at minimum operating pool year round, with a flow variation within plus or minus one foot, and operate McNary reservoir within the same specifications. Irrigation pumps will be extended in the three reservoirs and will be designed to accommodate spillway crest operation levels as well as minimum operating pools (LCSSRSP 2004). These actions, called for in the regional, federal, and tribal salmon plans, are likely to reduce juvenile travel time, prevent dangerous river conditions for tribal fishers, and may have other habitat benefits.

Peak power flows

Among the reasons for sudden fluctuations and alterations in river flows, is the hydroelectric system responding to peak power demands. The Tribal Energy Vision (Foley and Lothrop 2003), which describes the conflict between peak demand flows and fish among other issues, is the source of most of the following information.

Hydropower is used to serve peak loads because dams can react to demand by quickly putting more or less water through generating turbines. Serving peak loads with hydropower, however, kills millions of juvenile salmon every year. During certain times of the year, so much water is drawn down to generate electricity that salmon redds (gravel nests where salmon lay eggs) are uncovered or dewatered and their eggs die. Juvenile salmon also become stranded in pools or other entrapments and are vulnerable to predation. (This is particularly a problem at Hanford Reach where most of the mainstem spawning is occurring; but also at risk are other potential and documented areas where limited lower mid-Columbia mainstem spawning is occurring or attempted.) There are other adverse flow effects caused by accommodating peak loads. Additionally, the water held behind storage dams for future power generation—for summer air conditioning, for example—would, under natural conditions, be in the river aiding the swift and timely downstream migration of young salmon. Power peaking is an important example of

Columbia River hydrosystem operations that do not provide the natural (or normative) river conditions needed to restore fish to harvestable and sustainable levels.

The tribes envision the development of a more diverse energy resource portfolio to spread the risk between numerous electric power production means. Diverse production sources and other proposals from conservation to major energy effeciencies can be used to make up for losses in power output at federal hydro projects.

Water withdrawals

Flow objectives of NOAA/Fisheries' Biological Opinions for the mainstem Columbia River are rarely met during the summer, especially in moderate to low water years. The summer is a critcal time for migrating salmon, for steelhead and especially fall chinook. Diversion of water for agricultural production, also at its peak during the summer, contributes significantly to this shortage. Low flows, resulting in part from water withdrawals contribute to higher water temperatures and delays in salmon migration, both harmful to fish.

Numerous pumping facilities remove water from the Columbia River mostly for irrigation purposes. Most of the system's water withdrawals are upstream of the John Day Dam, the largest being the Columbia Basin Project in Washington (outside of this subbasin). One of the largest is part of the U.S. Bureau of Reclamation's Umatilla Basin Project. This project includes facilities to pump a maximum of 240 cfs from McNary Reservoir, and to divert an additional 3.9 m3/s from the Oregon-bank fish ladder at McNary Dam to irrigation districts in the Umatilla River subbasin. This project was designed to decrease irrigation withdrawals from the Umatilla River (Ward 2001a).

Another large pumping facility is in John Day Reservoir at the mouth of Willow Creek. A maximum of approximately 449 cfs is withdrawn as part of a permit issued in 1971 by the USACE to irrigate a portion of the land leased originally by the Boeing subsidiary. Various groups have opposed proposed increases to the amount of water withdrawn (Ward 2001a). Most others are small projects. Yet in total large volumes of surface water and groundwater within 1 mile of the Columbia River are being extracted primarily for irrigation (National Research Council 2004; BOR 2002).

Despite efforts to loosen restrictions by the Oregon legislature, it's been very difficult to obtain new water permits in the State of Oregon since 1994, when the state tried to bring its water permitting system in sync with the NPCC's Columbia River Basin Fish and Wildlife Program (Lies 2003). A Bureau of Reclamation study found that water withdrawals from the Columbia and Snake rivers were likely having a significant impact on salmon (BOR 2002). At McNary Dam water diversions take about 20% of the average flow in dry years during the irrigation season which coincides with salmon migations. The study showed that target flows for salmon at McNary were met 74% of the time when there were no withdrawals for irrigation and only 26% with irrigation withdrawals (2002). As of 2003, only two new Oregon water rights were issued since 1994 for Columbia River withdrawals for irrigation (Lies 2003).

In 2004 the National Academy of Sciences, working on behalf of the State of Washington, recently released a report recommending no additional permits be issued for water withdrawals on the Columbia River during the samon critical months of July and August (2004).

Irrigation screening

The irrigation devices used to deflect or pump water from the Columbia River are required by to be screened at the point where water is diverted from the river. The wire mesh screens keep fish from being sucked into the diversion channel or pipe. In 1992 over 44,000 fall chinook salmon in the Umatilla River were killed by a powerful irrigation pump. Then again in 1994, on the same river, 44, 400-88,800 fall chinook were killed when screens failed on a hydroelectric project (BPA 1998).

According to the 1998 BPA report, following a 1993 and a 1994 survey of water intakes on the shores of the Columbia River between Bonneville and McNary Dams, 83% of the Oregon, and 77% of the Washington intakes were out of compliance with screening standards. In 1996 Reynolds, project investigator, did an initial survey of Lower Columbia River (Washington shoreline) water diversion and discovered a noncompliance rate of 62.5%. Reynolds estimated that between 576,000 and 1.1 million juvenile salmon could be lost instantaneously due to inadequately screened water diversions (1998).

The Fisheries Restoration and Irrigation Mitigation Act of 2000 (PL 106-502) created a new federal partnership fish screening and passage program in Idaho, Oregon, Washington and western Montana administered by the U.S. Fish and Wildlife Service. The Congress appropriated $4 million in 2002 to match federal funds with local, state, and tribal water use programs to increase fish survival, reduce entrainment in water distribution systems, and increase access to fish habitats. Since then many irrigation withdrawals have been screened to modern standards. But the authors of this report were unable to locate information regarding the extent of the screening accomplished in the subbasin and how many additional irrigation intakes need to be brought into compliance.

Water Quality

Throughout McNary, John Day, and The Dalles reservoirs, pH, and dissolved oxygen, and conductivity generally meet both Washington and Oregon standards (Ward 2001a). However, standards for dissolved oxygen, sediment bioassay and water temperatures exceed state water quality standards. The Dalles, John Day, and McNary pools are listed as impaired [303(d)] waterways. (See above “Environmental Contaminants” for discussion of sediment problems.)

Tanner, et al. (1996) noted 56 temperature excursions beyond the state criterion out of 170 samples (33%), and the EPA shows 26% of samples collected between 1991 and 1997 have excursions at the John Day Dam forebay. The Corps (1991) also documented numerous temperature excursions at station 814 (below McNary Dam). Numerous TDG excursions were noted at several Corps sites: 25 excursions at the North Pacific Division station JDA in 1993; 14 excursions at the Walla Walla District station MCNTW in 1994; and 33 and 28 excursions at the North Pacific Division station MCN-S in 1993 and 1994, respectively, during times without approved short term modifications to the standards. Sediment levels also exceeded criterion at several locations. Conbere (1994) showed a significant response with sediment bioassay collected Nov. 4, 1993 at 3 locations in the segment and Johnson and Heffner (1994) sediment samples showed substantial toxicity in 10-day Hyelalla bioassays at Badger Island (62%), the Old Outfall (62%), Port Kelly (60%) and Hat Rock (71%) in 1992 (WDE 2000).

Temperature

Impoundments have generally decreased the diversity and quality of habitats. Nearshore and backwater areas, which are more important to the early life history stages of most fish species, suffer from high water temperatures during summer and freezing temperatures during the winter (Hjort et al. 1981). This may preclude year-around use by many species (USFWS 1980). Summer water temperatures often exceed the state and federal standard of 65^{o}F (20^{o} C) that has been established for the Columbia River. EPA is doing work to assess possible PCB releases associated with hydroelectric sources (Ward 2001a).

While construction and operation of dams and reservoirs within the subbasin have not produced a significant change in average water temperature, upstream storage projects have resulted in a temperature phase shift (Jaske and Goebel 1967). Recent studies have hypothesized that the phase shift has resulted in earlier arrival of adult sockeye salmon in the upper Columbia River (Quinn et al. 1997). The migratory and spawning timing of fall chinook salmon returning to the Hanford Reach is also responsive to water temperatures (Dauble and Watson 1997). Historical records indicate that fall chinook salmon returning to the mid-Columbia River may spawn as much as one month later than populations did at the beginning of the nineteenth century (DeVoto 1953). The effects of a later spawning time on the emergence timing and availability of aquatic food web resources is unknown (Ward 2001a).

The upper incipient lethal temperature for juvenile chinook salmon is 24^{o}C (Brett 1952). Temperature affects swimming performance (Brett 1967), growth and energetics (Brett 1952; Elliott 1982), movement behavior (Bjornn 1971), physiological development (Ewing et al. 1979), disease susceptibility (Fryer and Pilcher 1974), and vulnerability of fish to predation (Sylvester 1972; Coutant 1973; Yocom and Edsall 1974; Deacutis 1978). The long-term consequences to fall chinook from chronic exposures to sublethal temperatures that exist in the Columbia River during the summer are unknown, but may be manifested in high mortality at dams due to increased physical stress during passage. This is evidenced by the subyearling chinook salmon kills at McNary Dam in 1994 and 1998, which were temperature related. Studies have also shown that late-migrating juvenile fall chinook salmon exposed to high water temperatures have poorer survival than earlier migrants (Connor et al. 1998; Muir et al. 1998). Considering the life history of fall chinook salmon along with the environmental conditions that exist during their freshwater life cycle, high water temperatures may limit this population by reducing fish performance and long-term survival (Ward 2001a).

Total Dissolved Gas

Because increased flow during migration is thought to increase survival of juvenile salmonids by decreasing travel times, and mortality over spillways is lower than mortalities through other routes at dams, a spill program during juvenile salmonid migration has been specified at Columbia and Snake River dams. Although spill is a relatively safe route to pass dams, it poses risks to fish because it can result in elevated levels of total dissolved gas (TDG) in their bloodstreams. The Environmental Protection Agency's recommended limit and Oregon and Washington's criterion is 110% TDG saturation; however, no general agreement exists as to maximum allowable TDG, or to acceptable long-term exposures to levels over 110%. Evaluations of the effects of TDG levels are further confused by the ability of fish to avoid high levels by moving to deeper water. CRITFC and state fish agencies found that because juveniles *are* able to quickly move away from areas of superstatured gas, juvenile exposure to 125% TDG for short periods of time was a better alternative with higher survival rates than moving downstream through generating turbines (Backman and Evans 2002). Nevertheless, fish may be impaired by the sublethal effects of dissolved gas (Ward 2001a).

All reaches making up the Lower-Mid Columbia Mainstem subbasin (the Dalles Dam to John Day Dam, John Day Dam to McNary Dam, and Mcnary Dam to the Washington border) are considered impaired for TDG. Elevated TDG levels are caused by spill events at The Dalles, John Day, and McNary dams. Some spill events, such as those to meet juvenile fish passage goals, are "voluntary." Others are "involuntary" and are caused by lack of powerhouse capacity for river flows. Involuntary spills can result from turbine maintenance or breakdown, lack of power load demand, or high river flows. Elevated TDG levels also enter the TMDL area at the upstream boundary from sources outside the TMDL area. Dams on the Lower Mid-Columbia Mainstem are run-of-the-river dams with very little storage capacity. Therefore, spills are often forced due to operational decisions at upstream storage reservoirs, such as Washington's Grand Coulee Dam or Dworshak Dam (ODEQ and WDE 2002).

Involuntary spills caused by river flows above powerhouse capacity are most likely to occur from late fall to early summer, depending on rainfall or snowmelt in the tributary watersheds. At times of involuntary spill, exceedances above the standard can rise dramatically, peaking above 130% of saturation, and even 140%. These levels do not meet the 110% criterion of either state (ODEQ and WDE 2002).

Adult and Juvenile Passage

Spill

The fish agencies recommend the spill levels in the 2000 Biological Opinion are the minium acceptable levels in most instances for the three mid-Columbia subbasin dams; CRITFC generally recommends more aggressive spill regimes than called for in the Biological Opinion. The dam operators, the Corps and BPA challenged the Bi Op spill plan, arguing that BPA needed to sell more electricity to California, thus saving an extra 10 cents off Northwest ratepayers' bill. Federal Judge James Redden of the Oregon District rejected the power operators' alternative plan on July 28, 2004.

This is from The Biological Benefits of Spill (Heinith and Lothrop 2004):

> The fish agencies and tribes made the case for the federal spill plan: Spill has the lowest rate of direct mortality for juvenile fish passage, ranging generally from 0-2% for spillbays with deflectors, while turbine passage ranges from 2.3-19%. For screen passage, direct morality ranges from 0.4-7.6% (Whitney et al. 1997). Spill has other direct benefits. It reduces passage delay, "speeding juveniles to the ocean" (Heinith and Lothrop 2004). Spill provides higher velocity, decreasing fish delay in dam forbays and trailraces where predator populations are high. (Venditti et al. 2000; Jones et al. 1996; Beamesderfer and Rieman 1991). Spill prevents juveniles from holding in poor quality water conditions in dam passage facilities. (In 1994 an estimated 100,00 fall chinook died because water temperatures were too high.)

In 2003 an estimated 1 million subyearling chinook passed McNary Dam during August. Over the past twelve years the estimated population size at McNary Dam in August has been as high as 2.6 million. The median travel time of subyearling chinook from McNary Dam to Bonneville Dam was estimated to average 8.0 days during August for the years 1997 to 2003. The travel times would likely be longer without spill at John Day and The Dalles and Bonneville dams.

FPC passage data indicates that the average 95% passage date at McNary Dam (1997-2003) of unclipped sub yearling mid-Columbia and Hanford fall chinook marked at Rock Island Dam at McNary is September 16. Long travel time through the John Day pool at summer low flows places these fish in the lower Columbia through September, well beyond the present August 31 end date of BiOp summer spill.

It is estimated that on average, 700,000 and 600,000 subyearling chinook pass John Day and Bonneville dams during August, respectively. The maximum over the past twelve years was 3.5 million and 1.75 million subyearling chinook for John Day and Bonneville dams during the month.

The median travel time of subyearling chinook from McNary Dam to Bonneville Dam was estimated to average 8.0 days during August for the years 1997 to 2003. The travel times would likely be longer without spill at John Day and The Dalles and Bonneville dams.

Survival for many other stocks would be also affected under a no spill operation, including Pacific lamprey. As indicated in radio-telemetry studies by Bjornn and colleagues (2000), spill provides a safer passage route for adult migrants that fallback over dams than turbines or screen systems. Loss of summer spill would select against important stock life history diversity. Tiffan et al. (2000) found that middle and late migraing segments of the Hanford fall chinook were the primary contributors to harvest and to spawning grounds.

The weight of biological evidence indicates that summer spill is critical to the direct and indirect anadromous fish survival, life history diversity and recovery.

The historic passage data demonstrates that a significant proportion of the juvenile and adult summer migration for many diverse stocks is present in the lower Columbia River in late July-August and is benefited by summer spill.

The BiOp August 31 summer spill end date does not provide protection to 95% of the mid-Columbia and Hanford fall chinook passage distribution or adult fallbacks. To protect these migrants, summer spill needs to be extended.

The fish agencies, tribes, environmental and fishing groups argue that barge transportation is not an acceptable substitute for meeting spill and flow targets, because fish mortalities associated with transport can be high. They explain their preference for a spread the risk strategy: use other means, in addition to barging, to aid juvenile fish passage and migration.

Weir Technology

In November 2004 NOAA/ Fisheries announced a revised plan, the 2004 Biological Opinion, which relies heavily on the installation of removable fish weirs at federal Columbia and Snake rivers dams. Fish agencies, tribes, and environmental organizations have criticized the plan saying that it must not be a substitute for other measures called for in the 2000 Biological Opinion. Critics have characterized it as another in a series of federal actions weakening protection for the basin,s salmon. The matter is expected to be taken by Federal District Judge James Redden.

Most Columbia River Basin juvenile anadromous salmon and steelhead tend to stay in the upper 10 to 20 feet of the water column as they migrate downstream to the ocean. However, dam configurations at the Corps, lower Columbia River and Snake River dams cause juvenile fish to dive to depths of 50 to 60 feet to find the passage routes. Engineers and biologists are pursuing new technologies that would provide more surface-oriented, less stressful, passage routes for juvenile fish. Two of these are the removable spillway weir and the Bonneville Dam Second Powerhouse Corner Collector (NOAA/Fisheries 2004).

A prototype removable spillway weir, was installed at Lower Granite Dam on the lower Snake River in 2001. The weir passes juvenile salmon and steelhead over a raised spillway crest (similar to a waterslide), near the water surface, under lower velocities and lower pressures than conventional spill. Juvenile fish are safely and efficiently passed over the weir with less stress and reduced migration delays at the dam. The weir is also designed to be "removable" by controlled descent to the bottom of the dam forebay. This capability permits returning the spillway to original flow capacity during major flood events. The weir has the potential to provide not only fish benefits but also power savings to the region, since less water is used to pass similar numbers of fish, Additional removable spillway weirs are being considered for McNary and John Day dams among others (NOAA/Fisheries 2004).

Adult Fallback and Passage

Spill also provides safer downstream passage for steelhead kelts and adults that fallback over dams than powerhouse routes (Wagner and Hilson 1993). Fallback rates are significant ant range from 5-10% (Henith and Lothrop 2004). Currently, adults that fallback over dams such as John Day and McNary dams can spend extended periods of time in the juvenile system since there is no way to move them from the channel. Several hundred adults are removed each time the fishway system is dewatered. Such dewatering is stressful to adults and has led to mortality. At McNary Dam alone, fallback of steelhead was over 11,000 adults in 1991 (2004). Lamprey are also subject to fallback and impingement on screen bypass systems (Heinith and Lothrop). Adult direct turbine mortality rates are estimated at 22-51% (Wagner and Ingram 1973) and injury rates from screen bypass at 40-50% (Wagner and Hillson 1993).

Adult fish passage criteria for the three lower mid-Columbia dams are established in the Corps' Fish Passage Plan. Fish agency personnel inspect passage facilities at the three dams as they do at other hydroelectric dams on the Columbia and Snake rivers. Since 2001, Basham noted in his 2003 annual inspections report, security conditions prevent unannounced inspections. Although adult fish passage operations and maintainance are routine activities at the dams, some improvements are still needed to meet the established passage critera. Different types of problems from the three dams include: During numerous inspections at The Dalles Dam in 2003, inspectors found fishway traskracks were not being cleared of debris and sticks, which are hazards for salmon trying to swim though the fishways. Gates along the powerhouse collection channel at NcNary need repair as they are at times overtopped with water (2003).The calibrations of gages and other mechical instruments have been an issue of concern at The Dalles and John Day dams. In 1999 the ISAB called for the installation of automated fishway control systems at the dams, which has yet to be accomplished. At John Day a high percentage of fish fall back continues to be a problem: "During the past few seasons, there has been a large fish count differential between The Dalles Dam, John Day Dam, and Mcnary Dam 2003 appears to be no different, with more steelhead counted at John Day thatn The Dalles Dam (+23,000) and about (+58,000) more at John Day than at McNary Dam."

In a positive development, an important modification was made in 2002-03 at John Day Dam in the exit section of the fish ladder. Many lamprey and steelhead tended either to hold or jump in this "serpentine-like" section of the ladder. Biologists observed that the structural modification appeared to have resolved the problem. Despite this success storty, for more than five years, the Fish Passage Center inspection reports, the tribes, and the ISAB have called for a series of more than a dozen recommendations to improve compliance with the adult fishway criteria.

Predation

Primary predators of juvenile salmonids in the Columbia River include northern pikeminnow, smallmouth bass, and walleye. Predator-prey relations have been altered by development of the hydropower system in many ways. Although northern pikeminnow are a native species and have always preyed on juvenile salmonids, development of the hydropower system has increased the level of predation. Dams have slowed water velocity and decreased turbidity, effects that have increased exposure time of juvenile salmonids to predators and increased predation success. Development of the hydropower system has also resulted in extended periods of warm water, and therefore increased predator activity and consumption. Dams concentrate juvenile salmonids in forebays and tailraces, and fish in tailraces are disoriented from passage through or around turbines, spillways, or bypass systems, further increasing their vulnerability to predation. Warm water in the reservoirs have created favorable conditions for exotic warm water species, some of them competing with salmon for food and habitat and preying on juvenile salmon.

Bird predation on juvenile salmonids at the lower mid-Columbia dams is also be a problem. Although estimates for bird predation have been 2% or less of salmonids passing a single dam, it is not known what proportion taken by birds were already dead or seriously or mortally injured (Bayer 2003). In words, it has not been determined what portion of the juveniles would have otherwise survived. Avian predators include Caspian terns, various gull species, double-crested cormorants, American white pelicans among others. While bird predation on juvenile fish is natural part of the food web, dams have made it easier for the birds to select their prey, e.g., by concentrating juvenile salmon at the dams. Some birds have built their nest on the dams; others nest on fish barges and wait for juvenile salmonids to be released en masse from the barges (Collins et al. 2003). After a finding on no significant impact regarding the NMFS 2000 Biological Opinion, the Corps began a new program to deter avian predation at federal dams on the Columbia, including dams in the lower mid-Columbia mainstem. The program is re-evaluating previous deterents strategies, including the wires above the water at tailraces, various forms of lethal and nonlethal harassment as well as studying avain predator behaviors and avain predation mortality numbers.

Environmental/Population Relationships/Limiting Factors

Shallow water habitats can be very productive for fish species. Shallow water habitats comprise approximately 3,600 ha in John Day Reservoir (USACE 2000). The productivity of shallow water habitats, however, is limited in the Columbia River portion of the subbasin because of fluctuating water levels that are caused by power production at the dams.

Islands composed of dredged material have created nesting, roosting and breeding areas for avian predators that prey on juvenile salmon.

Fluctuating water levels along McNary reservoir, the mouth of the Walla Walla River and other areas and river mouths, which provide resting or holding areas for adult salmon, can stress the fish and compromise their upstream migration.

5.6.3 Rock Creek Assessment Unit

Assessment Approach

Available information was summarized on a reach basis. Reaches were delineated using the basic EDT methodology initiating new reaches at each tributary confluence. Great detailed reach breaks may be possible in the future but the time available for planning did not allow an extensive specification based on geomorphology. Generally, the reach breaks are useful and not misleading in the presentation of conditions.

An EDT framework was also used in summarizing the habitat conditions of the reaches. In other words, definitions of ‘pools’, ‘glides’ and other habitat features were considered within the definitions of EDT. Because information on Rock Creek is sparse and sporadic, much of the characterizations are based on best professional judgement. However, orthophotos, field observations, and unpublished Yakama Nation data were incorporated into this summary by reach.

Topography and Climate

Elevations range from 200 feet at the confluence of Rock Creek and the Columbia River to 4,721 feet at Lone Pine Butte. Often the period between volcanic eruptions was long enough to allow development of lakes and streams on the down-warping basalt surface. These bodies of water deposited layers of sand, silt, clay, and volcanic ash forming sedimentary beds between some of the basalt flows. Also present are a variety of forbs indicative of lithic soils (continuous, shallow soils, usually bedrock). Sediment beds form local aquifers and are seen on the hillsides as light colored bands of soil, or bands of trees and brush running along the open grassy slopes.

The drainages in the Rock Creek assessment unit originate in the Simcoe Mountains along Bickleton Ridge, which forms the northern boundary of the subbasin and the southern boundary of the Yakama Indian Reservation. Most of the streams flow in a southerly to southeasterly direction to Lake Umatilla, the portion of the Columbia River impounded by the John Day Lock and Dam. The major streams include Badger Gulch, Harrison, Luna Gulch, Quartz and Squaw creeks as well as Rock Creek. (See Aquatic Habitat Conditions.)

The Rock Creek drainage lies within the eastside Cascades ecological province. Winter conditions in this area tend to be colder with more frequent snow accumulation. Annual precipitation ranges from 20 to 25 inches in the headwaters of Rock Creek to less than 10 inches over most of the eastern half of the subbasin (Lautz 2000).

Vegetation Patterns

The assessment unit lies within a vegetation zone in transition from arid shrub-steppe to the south and forest vegetation to the north. Within the zone, there is a mosaic of meadow-steppe communities and forest communities dominated by Oregon white oak and ponderosa pine (WDNR 1998).

The forest communities are generally found on north-facing slopes and in riparian zones, while the steppe communities populate drier areas. The meadow steppe communities also occupy drier areas in the subbasin. Bluebunch wheatgrass (*Agropyron spicatum*) and Sandberg's bluegrass (*Poa suandbergii*) generally dominate this plant community type (WDNR 1998).

In the headwaters, land cover is primarily coniferous forest. (This area is mostly above known anadromous fish use, although rainbow trout and non-salmonids such as dace use available fish habitat.) Coming off the plateau, land cover is conifer forest or mixed conifer-deciduous forest in the vicinity of streams, transitioning to shrub-steppe in the uplands. Below the canyon reaches, land cover is primarily shrub-steppe in the uplands, with riparian areas transitioning downstream from mixed conifer-deciduous forest to deciduous forest to shrub-grassland.

The riparian zones are made up of primarily the white alder plant community. The subbasin contains some of the few known high-quality occurrences of the white alder community type within Washington, where it is limited to riparian zones in the eastern portion of the state. Most of the riparian zone community has an overstory of Oregon white oak (Quercus garryana), bigleaf maple (Acer macrophyllum), white alder (Alnus rhombifolia), black cottonwood (Populus trichocarpa), and water birch (Betula occidentalis), while shrubs are dense in places and include mock orange (Philadelphus lewisii), ocean spray (Holodiscus discolor), currant (Ribes aureum), and occasionally willow (Salix sp.) (WDNR 1998).

Forested Habitat Function and Process

Oregon White Oak (Quercus garryana)

Oregon white oak (Quercus garryana) is Washington's only native oak. Although limited and declining, oaks and their associated floras comprise distinct woodland ecosystems.

The Rock Creek drainage is the easternmost extent of the largest assemblage of white oak habitat remaining in the state of Washington. Oregon white oak is considered a state priority habitat that is determined to be of significance because it is used by an abundance of mammals, birds, reptiles and amphibians. Many invertebrates, including a variety of moths, butterflies, gall wasps and spiders are found exclusively in association with this oak species. Oak/conifer associations provide contiguous aerial pathways for animals such as the state-threatened western gray squirrel, and they provide important roosting, nesting and feeding habitat for wild turkeys and other birds and mammals. Dead oaks and dead portions of live oaks harbor insect populations and provide nesting cavities. Acorns, oak leaves, fungi and insects provide food. Some birds, such as the Nashville warbler, exhibit unusually high breeding densities in oak. Oaks in Washington may play a critical role in the conservation of neotropical migrant birds that migrate through or nest in Oregon.

Late-successional Forest

Little forestland occurs in the Rock Creek drainage. However logging practices have altered the late successional habitats that do occur within the subbasin. In the past, timber harvest removed important components of older forests, such as large diameter trees, snags, multi-layered canopies and dead, downed wood. Components of these habitats are important to the viability of species such as spotted owls, white-headed woodpeckers, black-backed woodpeckers, pileated woodpeckers, and pine marten. Large, intact tracts of closed canopy and late succession forest habitat are in short supply within the forest stands of the basin.

Deer Winter Range

The Rock Creek drainage lies within the eastside Cascades ecological province. Winter conditions in this area tend to be colder with more frequent snow accumulation. Therefore the importance of low elevation winter range has importance disproportionate to its size. Development of hydropower reduced available big game winter range from historic levels, limiting carrying capacity for big game.

Research has indicated that the low elevation oak woodland and oak/pine mixed forest found in Rock Creek are important wintering habitats, especially where these cover types occur in a mosaic with openings and topographically diverse terrain with abundant south-facing slopes. Such areas are most commonly found associated with the breaks in the upper Rock Creek canyon.

Meadows

Meadow habitats provide for a unique assemblage of plant and wildlife species. Fire suppression has allowed trees to encroach into meadows, resulting in a decrease in size or total loss of meadows. Over-grazing has changed species composition of grasses and herbs, introduced non-native plants that out-compete native vegetation, and reduced species diversity. The construction of roads through meadows has altered water flow patterns, effectively draining them and drastically changing the species composition.

Meadow Steppe

The meadow steppe community is found in the “transition area” between forested uplands and true shrub-steppe. In the subbasin, the meadow steppe community is found in drier areas. Bluebunch wheatgrass and Sandberg's bluegrass generally dominate. Also present are a variety of forbs indicative of lithic soils. In the south central Klickitat area, heavily grazed stands are dominated by cheatgrass, gray rabbitbrush, broom snakeweed, and/or lupines (WDNR 1998).

Areas in the uplands that produce the best herbaceous forage are the riparian habitats that are consequently heavily used by cattle. Bitterbrush (Purshia tridentata) stands on south-facing slopes are heavily browsed by deer and many are decadent and under-productive. Grazing management, particularly in the upper riparian zones and deer winter ranges, is a primary concern.

Conservation Designations

Badger Gulch Natural Area Preserve

The Washington Department of Natural Resources (WDNR) established the 180-acre Badger Gulch Natural Area Preserve in 1982 to protect four important native plant communities and three rare plants. The Natural Area Preserve lies within Klickitat County about 6.8 miles north of the Columbia River and 13 miles east of Goldendale on the Goldendale-Bickleton road. The preserve includes a 2-mile long portion of Badger Gulch, a narrow, steep-walled canyon. Running west to east through the canyon bottom, Badger Creek empties into Rock Creek near river mile 15.

The four protected native plant communities are Idaho fescue-houndstongue hawkweed, Oregon white oak-ponderosa pine, bluebunch wheatgrass-Sandberg's bluegrass and white alder riparian. The three rare plant species are porcupine sedge, shining flatsedge, and beaked cryptantha. These plant communities play an important ecological role in protecting the subbasin's water quality and many vertebrate and invertebrate species.

The Badger Gulch NAP serves as an educational laboratory that provides opportunities for outdoor research and provides baselines for comparison against the effects of human manipulations in similar ecosystems. Additionally, this Natural Area Preserve is valuable as gene pools for native organisms, including species designated as sensitive, threatened or endangered in region.

In 1998 Washington Department of Natural Resources' Southeast Region developed the "Badger Gulch Natural Area Preserve Management Plan." The purpose of the management plan is "to permit natural ecological and physical processes to predominate, while controlling activities that directly or indirectly modify these processes" on the preserve. The plan defines all aspects of management for the site from public use to monitoring and research activities.

Klickitat Oaks Preserve

Adjoining the Badger Gulch NAP is The Nature Conservancy of Washington's Klickitat Oaks Preserve. The currently 414-acre site is preserving native habitats and significant plant and animal species as a functional ecosystem within the upper Rock Creek watershed. This area has been a major conservation site for the Conservancy since the ecological significance of the area was identified in the 1980s. The Conservancy is currently negotiating the purchase of an additional 120-acre plot and, with another private landowner, a 1500-acre limited development conservation easement. Working with federal, state and private adjoining landowners, the Conservancy's purpose is to protect all of the native habitats and significant plant and animal species of the site as a functional ecosystem within the upper Rock Creek watershed.

The Nature Conservancy has developed an initial preserve design and an in-depth Site Conservation Plan for the area. It is a cooperative management strategy for the upper Rock Creek watershed involving a U.S. Bureau of Land Management, WDNR, and resident private landowners. The Nature Conservancy has made a long-term commitment to the site and is currently involved in restoration and management work on the ground, including exotic species control, plant and animal inventory and assessment, and long-term restoration planning.

Physical/Habitat Structure and Composition

Little late successional forest occurs in the Rock Creek drainage and logging practices have altered those that do exist. In the past, timber harvest removed important components of older forests, such as large diameter trees, snags, multi-layered canopies and dead, downed wood. Large, intact tracts of closed canopy and late succession forest habitat are in short supply within the basin.

Forest practices, including logging and roads, have also adversely impacted functional quality of riparian areas in some portions of the headwater and canyon reaches (e.g. upper Rock Creek, Box Canyon, Quartz Creek). Types of impacts include removal of or damage to riparian vegetation, fine sediment delivery from roads and ground disturbance, and compaction and erosion of stream banks and adjacent floodplain areas. Roads and timber harvest may also be elevating the efficiency of storm and snowmelt runoff; thereby affecting peak flows in the drainage. Other timber harvest activities such as skid trails, landings, and tree skidding near streams have caused ground disturbance and erosion.

Development of hydropower reduced available big game winter range from historic levels, limiting carrying capacity for big game.

Vegetative/Habitat Structure and Composition

Riparian hardwood, dominated by white alder, cottonwood, and willow, has an abundance of snags and downed logs that are critical to many cavity birds, mammals, reptiles, and amphibians. Riparian habitats may also contain important subcomponents such as marshes and ponds that provide critical habitat for a number of species (e.g., Virginia rail, sora rail, marsh wren).

The importance of low elevation winter range (for deer) has importance disproportionate to its size. Research has indicated that the low elevation oak woodland and oak/pine mixed forest found in Rock Creek are important wintering habitats, especially where these cover types occur in a mosaic with openings and topographically diverse terrain with abundant south-facing slopes. Such areas are most commonly found associated with the breaks in the upper Rock Creek canyon.

Little forestland occurs in the Rock Creek drainage. However logging practices have altered the late successional habitats that do occur within the subbasin. In the past, timber harvest removed important components of older forests, such as large diameter trees, snags, multi-layered canopies and dead, downed wood. Components of these habitats are important to the viability of species such as spotted owls, white-headed woodpeckers, black-backed woodpeckers, pileated woodpeckers, and pine marten. Large, intact tracts of closed canopy and late succession forest habitat are in short supply within the forest stands of the basin.

Areas of Special Concern

The subbasin contains some of the few known high-quality occurrences of the white alder community type within Washington, where it is limited to riparian zones in the eastern portion of the state. [Please see Vegetation Patterns.]

Oregon white oak (Quercus garryana) is Washington's only native oak. Although limited and declining, oaks and their associated floras comprise distinct woodland ecosystems. The Rock

Creek drainage is the easternmost extent of the largest assemblage of white oak habitat remaining in the state of Washington. [Please see Vegetation Patterns.]

Aquatic Habitat Conditions

Water Quality

Rock Creek was identified as a candidate for the state 303(d) (water quality impaired) list for temperature based on multiple excursions of the standard (18oC/64.4oF) measured in 1990 and 1991 (WDE, 1998).

After further monitoring and stream survey work, Ehinger (1996) concluded that Rock Creek showed "little impact from current forestry or agricultural activities", but also indicated that "impacts from past grazing activity and episodic flood events, including lack of riparian cover and a shallow, braided stream channel" were evident. Ehlinger suggested that high stream temperatures observed in upper Rock Creek "may be natural for a small creek in a hot, sunny summer climate", while temperatures in lower Rock Creek were "affected by the exposed rocky substrate (channel bed) and lack of riparian cover."

Based on this assessment, a memorandum of agreement (Memorandum of Agreement between the Washington State Department of Ecology and Eastern Klickitat Conservation District regarding the delisting of Rock Creek form Section 303(d) list of the Clean Water Act. Signed July 9, 1996) was developed which allowed Rock Creek to be excluded from the 303(d) list subject to the following conditions, to be implemented jointly by the Department of Ecology and Eastern Klickitat Conservation District in cooperation with landowners:

- Identify riparian zones which can be successfully revegetated. Assist landowners to implement Best Management Practices which would enhance canopy cover and encourage channel rehabilitation.
- Monitor grazing and forestry practices.
- Advise landowners in the upper watershed of Best Management Practices for road stability and riparian corridor harvesting.
- Continue water quality monitoring to obtain data for long range planning and for landowners participation with Best Management Practices
- Seek funds to assist with monitoring and rehabilitation efforts.
- Submit a yearly progress report. Implementation of this agreement is ongoing and will continue at least through 2001.

The temperature situation identified in the Rock Creek watershed is likely for all streams in the WRIA; stream monitoring by the Eastern Klickitat Conservation District (1997) has confirmed exceedances of the standard at most of the 27 sites where thermographs have been installed. Based on temperature data through 1997, it appears that exceedances of the standard at higher elevations (plateau and upper canyon reaches) are relatively minor and of short duration; some thermal stressing of juvenile salmonids may occur, but may be avoided if there is access to cool water refuges (areas of spring outflow or groundwater upwelling). In lower canyon and alluvial reaches, exceedances extend well into the sub-lethal or lethal ranges for salmonids and are of long duration. It is unknown to what extent cool water refuges exist in these reaches (Lautz 2000).

Stream-adjacent roads exist along portions of Rock Creek. Generally, the road occurs either along the edge of the floodplain or on a terrace immediately above the floodplain; observed impacts of these roads on floodplain connectivity appears to be minimal. Roads have adversely impacted functional quality of riparian and instream areas in some portions of the headwater, canyon, and alluvial reaches. Types of impacts include removal of or damage to riparian vegetation, fine sediment delivery from roads, ground disturbance, and compaction and erosion of stream banks and adjacent floodplain areas. Roads and timber harvest may also be elevating the efficiency of storm and snowmelt runoff; thereby affecting peak flows in the drainage.

Roads located in the headwaters have also affected instream conditions in the lower Rock Creek. The streams in this subbasin are considered "flashy" (i.e. flows rise and fall rapidly in response to precipitation and/or snowmelt) in the canyon and alluvial reaches. It is likely that road construction in the headwaters has increased drainage density and intensified any natural flashiness. Fish habitat quality in the headwaters is generally considered fair to poor due to the extensive road network.

Further, the construction of roads through meadows has altered water flow patterns, effectively draining them and drastically changing the species composition.

From the mountain headwaters in Rock Creek across the relatively flat basalt plateau, channels are moderately confined to unconfined. As streams enter steep-walled canyons, channels become highly confined. Fish habitat quality is generally fair to poor, due mostly or entirely to the higher stream power in these reaches (Lautz 2000). The subbasin contains a number of springs or seeps including some located in small depressions close to stream channels in the bottom of canyons. In the alluvial valleys below the canyon reaches, channels are moderately confined to unconfined (although there may be locally confined reaches caused by channel incision).

The streams in Rock Creek are considered flashy (i.e. flows rise and fall rapidly in response to precipitation and/or snowmelt) in the canyon and alluvial reaches. It is likely that road construction in the headwaters has increased drainage density and intensified any natural flashiness. Degradation in riparian areas and wetlands has also likely decreased retention capacity. These impacts are most likely to have altered the natural regimen.

Headwaters and Upper Plateau

Grazing, timber harvest near streams and the recent wildfire have also reduced vegetation needed for stream temperature moderation. Loss of riparian vegetation has opened the stream channel to greater summer heating and winter cooling.

Canyon Reaches

Water temperature in the upper canyon reaches is not a significant problem as temperatures exceeding the standard (18 C/64.4 F) are infrequent and of short duration (Lautz 2000). Some thermal stressing of juvenile salmonids may occur, but may be avoided if there is access to cool water refuges (areas of spring outflow or groundwater upwelling).

Alluvial Valley

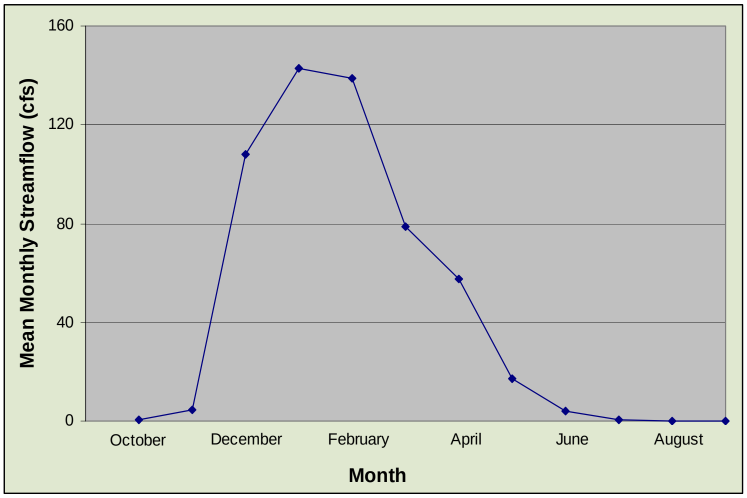
Subbasin streams are classified as Class A streams. Water temperature is, however, a problem affecting habitat quality in the alluvial and lower canyon reaches. In these areas, temperatures above the standard extend well into the sublethal or lethal ranges for salmonids for extended periods. Some springs and seeps exist in these reaches and can provide critical cool water refuges.

The juvenile fall chinook emerge from the gravel from March through May and rear along the shoreline and backwaters for a short period before migrating seaward during the summer (Becker 1973; Key et al. 1994; Key et al. 1996). Fall chinook salmon are the dominant salmonid during spring in nearshore areas of the Lower Mid-Columbia Mainstem Columbia River. Fall chinook salmon also use the upper portions of McNary and John Day reservoirs for rearing, but do not prefer riprap habitats that constitute a large portion of reservoir shorelines (USGS, unpublished data).

Water Quantity

In Rock Creek the limiting factor is flow. When flows reconnect the lower miles of Rock Creek and provide access, fall chinook enter and distribute themselves upstream. In Rock Creek, timing of the spawning run has consistently been in October and November, when flow allows access. Flow likely dictates run-timing in terms of out-migration as well. For Rock Creek, the loss of perennial wetted area in the lower mainstem, loss in overall Columbia River populations, and habitat degradation within the watershed, fall chinook are likely to have diminished in abundance.

Streamflow data is very limited for Rock Creek. The USGS maintained a gage near Roosevelt, WA (Gage # 14036600) for water years (WY; October 1 through September 30) 1963-1968. Mean streamflow over the period of record was 45.8 cfs. The maximum mean annual discharge was 113 cfs and occurred in water year 1965, which encompassed the Christmas floods of 1964 when Rock Creek peaked at 4800 cfs on Dec. 22 and 23. The minimum mean annual flow of 25 cfs occurred during water year 1964. However, annual and even monthly streamflow values do not adequately communicate the seasonally episodic flow distribution pattern. Much of the runoff generally occurred in two or three discreet events.



Major flood events occur when winter rains (or rain-on-snow) falls on frozen soils. Channels and riparian areas were damaged by such flooding early in 1996. Below the plateau, upland soils are thin and rocky; relatively narrow floodplain areas limit storage of runoff during the winter for later release in the summer. These landscape factors, combined with the virtual lack of precipitation from July through September, cause summer flows to go subsurface in some portions of the stream network. This situation is exacerbated in areas where channel widening has occurred, channel downcutting is taking place or flow is distributed over several smaller, shallower channels. Channel dewatering has obvious impacts to fish, including reduction in juvenile mobility, limiting or precluding access for spawning, and mortality due to stranding.

Headwaters and Upper Plateau

Additionally, reductions in vegetation across the watershed may also be increasing peak flow discharges and reducing ground water storage.

Canyon Reaches

Stream flows in the canyons currently rise and fall rapidly in response to precipitation and/or snow. The relatively narrow floodplain in the canyon area limits storage of runoff during the winter for later release in the summer when precipitation is negligible. During normal or drier-than-normal years some areas may go dry during the summer. At the same time, heavy rains and snowmelt can result in extremely high stream flows and flooding conditions. The floods of 1996 further reduced habitat quality in some areas of the watershed.

Alluvial Valley

Dewatering is also a problem [in alluvial valleys], particularly in areas where channel widening has occurred and flow is distributed over several small, shallower channels. Channel dewatering has obvious impacts on fish, including reduction in juvenile mobility, limiting or precluding access for spawning, and mortality due to stranding.

Historical Conditions (Trends)

Historically, peak flows [from the headwaters] may have been somewhat moderated due to greater infiltration and groundwater storage from beaver ponds and vegetation in the headwaters. Further evaluation of historic conditions is needed.

Riparian/Floodplain Condition and Function

There are some areas at the lower end of the Rock Creek canyon reach where flooding and resulting channel widening has damaged or obliterated riparian vegetation over several hundred feet of stream (Lautz 2000).

Headwaters and Upper Plateau

Fish habitat quality in the headwaters is generally considered fair to poor due to effects from past grazing and riparian harvest activities, recent fires on the east side of Rock Creek, and the extensive road network. This area is above currently known anadromous fish use. Rainbow trout and non-salmonids such as dace use the available fish habitat.

Alluvial Valley

Grazing activities, which tend to be concentrated along streams, have degraded riparian habitat (Lautz 2000). These impacts are both direct (browsing, trampling, soil compaction) and indirect (channel incision, bank instability and resulting channel widening). Historically, intensive land uses such as overgrazing adversely altered riparian species composition and habitat characteristics. Continued use of degraded areas in conjunction with greater storm flow intensity is likely impeding natural recovery mechanisms. In incised channels, habitat quality is reduced due to several factors, including high fine sediment levels (associated with bed and bank erosion, runoff from agricultural lands), reduced shade from riparian vegetation, and higher storm flows. In all areas where incision has been reported, grazing is prevalent and is likely a primary accelerating factor.

Steam-adjacent roads exist along portions of Rock Creek. Generally, these roads occur either at the edge of the floodplain, or on a terrace immediately above the floodplain; observed impacts of these roads on floodplain connectivity appears to be minimal (Lautz 2000).

Stream Channel Conditions and Function

The streams in the Rock Creek assessment unit subbasin appear to have similar geomorphic characteristics. Headwater tributaries flow out of the mountains and across the relatively flat basalt plateau at gradients of generally less than 1 %. This area is above known anadromous use.

Coming off the plateau, streams enter steep-walled canyons where gradients increase to 2-4% or more. In steep-walled canyons, substrate is characterized by a mix of cobbles and boulders. Little suitable spawning gravel occurs, and rearing areas (pools) are minimal in extent and quality and are limited to protected areas behind boulders and along stream margins (Lautz 2000).

Below the canyon reaches, streams enter alluvial valleys; gradients range between 1% and 2% near the upper end, diminishing to less than 1% as streams approach the Columbia River (Lautz 2000). Substrate is variable, with particle sizes ranging from cobble to silt.

There are no known natural barriers, such as falls or cascades that block anadromous fish access within the Rock Creek subbasin. Such barriers may exist in unsurveyed canyon reaches of the area.

Geomorphic features of the Rock Creek subbasin have a significant impact on habitat availability and quality. The principal streams of the subbasin share similar features, allowing discussion of three general habitat sub-areas: (1) headwaters and upstream plateau, (2) mid-stream canyons and (3) lower stream alluvial reaches.

Overall [in alluvial valleys], fish habitat quality is highly variable, ranging from poor where degraded riparian zones and channel widening and incision occurs, to excellent where complex habitat elements (deep pools, suitable spawning gravel, large wood debris, riparian cove) exist in the vicinity of spring inflow or groundwater upwelling areas.

There are some areas at the lower end of the Rock Creek canyon reach where flooding and resulting channel widening has damaged or obliterated riparian vegetation. Much of the observed disruption occurred as a result of the 100-year flood event that occurred in 1996. Riparian quality is highly variable in the downstream reaches; the riparian zone is non-existent over significant portions of the alluvial reaches, while elsewhere, it occurs as a strip varying in width from 15 feet to over 150 feet. Continued use of degraded areas in conjunction with greater storm flow intensity is likely impeding natural recovery mechanisms. In incised channels, habitat quality is reduced due to several factors, including high fine sediment levels (associated with bed and bank erosion, runoff from agricultural lands), reduced shade from riparian vegetation, and higher storm flows.

In-channel condition and function

Headwaters and Upper Plateau

In-channel fine sediment is a problem in some areas of Rock Creek, particularly in the headwaters and lower alluvial areas. Primary contributors of fine sediment in the watershed include roads, riparian grazing, timber harvest activities, and recent wildfires.

A number of roads in the headwaters are primarily built of native material with a high fine sediment component. Some of these roads parallel or are in close proximity to streams. Additionally, the roads typically have had infrequent maintenance. Where these roads are poorly maintained and near streams they deliver substantial sediment to the stream system.

Grazing practices in riparian areas have also elevated fine sediment in some areas. Heavy livestock use in springs, seeps and on stream banks has caused erosion and channel downcutting. Loss of vegetation from grazing in these areas has also contributed to bank erosion through a reduction in rooting strength. Other timber harvest activities such as skid trails, landings and tree skidding near streams have caused ground disturbance and erosion. Finally, the recent forest and range fire on the east side of the Rock Creek drainage has removed substantial vegetation and escalated the erosion process.

Canyon Reaches

Fish habitat quality is generally fair due primarily to the higher stream power that can be experienced in these reaches. Spawning gravel and rearing areas are typically associated with boulders and limited woody debris in the canyon reach (Berg 2001).

Alluvial Valleys

Overall, fish habitat quality is highly variable, ranging from poor where degraded riparian zones and channel widening and incision occurs, to excellent where complex habitat elements (deep pools, suitable spawning gravel, large wood debris, riparian cove) exist in the vicinity of spring inflow or groundwater upwelling areas.

Stream channel form and complexity

Headwaters and Upper Plateau

Headwater tributaries flow out of the mountains and across a relatively flat basalt plateau. Channels are moderately confined to unconfined (although there may be locally confined reached caused by channel incision) with gradients generally less than 1% on the plateau. Land cover is primarily coniferous forest.

Loss of riparian vegetation due to grazing, road building, timber harvest and wildfires has limited future recruitment of woody debris to the stream channel. Woody debris is a key element for forming pool habitat, providing overhead cover, sorting spawning gravels, and maintaining channel and bank stability.

Canyon Reaches

Coming off of the plateau, streams enter steep-walled canyons. Channels are highly confined, gradients increase to 2-4%, and substrate is characterized by a mix of cobbles and boulders. Riparian vegetation consists primarily of white alder, willows and water birch. Although limited by the narrow floodplain area, existing riparian vegetation is of relatively good quality and is less effected by grazing and forest management activities as the steep terrain limits accessibility. There are some areas at the lower end of the Rock Creek canyon reach where flooding and resulting channel widening has damaged or obliterated riparian vegetation. Much of the observed disruption occurred as a result of the 100-year flood event that occurred in 1996.

Alluvial Valleys

Below the canyon reaches, streams enter alluvial valleys. Channels are moderately confined to unconfined (although there may be locally confined reaches caused by channel incision), with gradients generally between 1% and 2% near the upper end, diminishing to less than 1% near the Columbia River (Lautz 2000).

Current channel conditions have been significantly impacted by a 100-year flood event, which occurred in early 1996 (Lautz 2000). A number of reaches exhibit extensive bank erosion, migration, widening, deposition, braiding and uprooting of riparian vegetation. While these large flood events are commonly viewed as destructive to habitat, their occasional occurrences can produce long-term habitat benefits through increases in habitat quantity and complexity. Potential benefits can be enhanced if complemented by channel and riparian restoration activities that serve to create habitat, cover, and bank and channel stability against smaller, more frequent flood events.

Ecological Conditions

After further monitoring and stream survey work, Ehinger (1996) concluded that Rock Creek showed “little impact from current forestry or agricultural activities”, but also indicated that “impacts from past grazing activity and episodic flood events, including lack of riparian cover and a shallow, braided stream channel” were evident (Lautz 2000).

Environmental/Population Relationships/Limiting Factors

Human and Natural Factors

The primary limiting factors affecting fish productivity are seasonally low to non-existent stream flows and high summer temperatures. These conditions are most prevalent in the lower portions of the watersheds, but also occur in some sections of the headwaters and canyon reaches. Low or non-existent flows in all streams during the late summer, fall, and early winter will limit or preclude utilization by fall spawning adults (chinook, coho), and limit mobility of juveniles of all species and may result in mortality due to stranding. High stream temperatures during the summer and early fall limit mobility of juveniles of all salmonid species and may result in mortality due to thermal stress. The high stream temperatures can also restrict or delay upstream migration and access for fall spawning fish.

The secondary limiting factors are channel incision and channel widening which have resulted in a reduction in the quality and amount of available fish habitat. In the headwaters and alluvial reaches of the watershed, the combined effects of overgrazing on soils, vegetation and hydrology is the principal contributor to downcutting and channel widening. Channel incision and channel widening may also be causing a reduction or loss of summer base flows. Cattle watering at, or in the vicinity of, spring areas can also have an adverse impact on water quality and riparian function. Spring outflow into fish-bearing waters may provide important cool water refuges for juvenile salmonids during the summer and early fall, even when stream temperatures are high.

Forest practices including logging and roads have also adversely impacted functional quality of riparian areas in some portions of the headwater and canyon reaches (e.g. upper Rock Creek, Box Canyon, Quartz Creek). Types of impacts include removal of or damage to riparian vegetation, fine sediment delivery from roads and ground disturbance, and compaction and erosion of stream banks and adjacent floodplain areas. Roads and timber harvest may also be elevating the efficiency of storm and snowmelt runoff; thereby affecting peak flows in the drainage.

Limiting factors vary for each species of wildlife. However, the degradation and loss of habitat is a common theme for all species. Degradation and loss of habitat has been the result of land use activities such as logging, agriculture, road building, hydropower development, invasion of non-native plants, and expansion of human activities.

Functional Relationship of Assessment Unit with Subbasin

Anadromous fish production within the assessment unit is almost exclusively natural. There are no fish production hatcheries or other facilities located in the subbasin. However, to mitigate for the loss of fall chinook spawning and rearing habitat, the U.S. Fish and Wildlife Service tested net pen rearing of bright fall chinook near the mouth of Rock Creek from 1984 through 1987 (Nelson 1987; Beeman 1994). The program was discontinued because of exposure to infectious hemetopietic necrorsis among the source populations from the Little White Salmon hatchery (Nelson 1987).

Table 30 Rock Creek reach assessments

REACH	DESCRIPTION	Assessment Unit
Rock Creek 1	Columbia River Mainstem to Army Corps of Engineers Park	Rock Creek
FOCAL SPECIES	Steelhead, Coho, Fall Chinook	
PHYSICAL HABITAT CONDITIONS		
decrease in glides increase in pools decrease in pool tailouts loss of backwater pools decrease in woody debris		
WATER QUALITY CONDITIONS		
elevated temperature multiple listings for 303(d) (Columbia River)		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		
decreased riparian function increased nutrient enrichment increased hatchery outplants increased fish species introduction increased fish community richness increased fish pathology increased harassment decrease in benthic community richness		
COMMENTS		
Reach 1 is a one mile of creek inundated by the John Day Dam. Rock and Columbia River are 303(d) listed for temperature.		

REACH	DESCRIPTION	Assessment Unit
Rock Creek 2	Army Corps of Engineers Park to Squaw Creek	Rock Creek
FOCAL SPECIES	Steelhead, Coho, Fall Chinook	
PHYSICAL HABITAT CONDITIONS		
increase in hydro-confinement increase in embeddedness decrease in glides decrease in pools decrease in pool tailouts loss of backwater pools decrease in woody debris		
WATER QUALITY CONDITIONS		
increased fine sediment increase in turbidity decrease in temperature spatial variation increase in mean monthly temperature		
WATER QUANTITY CONDITIONS		
low flow		
ECOLOGICAL HABITAT CONDITIONS		
decreased riparian function increased hatchery outplants increased fish species introduction increased fish community richness increased fish pathology increased harassment increased nutrient enrichment decrease in benthic community richness		
COMMENTS		
Army Corps of Engineers park confines new mouth; it buries approximately 40 acres with fill, asphalt, and exotic landscaping. Old Highway 8 bridge and road grade bisect floodplain, confine stream. Riparian cover constitutes less than 5%of channel migration zone. Rock Creek Band has documented declining well depths. Groundwater analysis reveals possible link between upper watershed well water withdrawals and lower watershed surface flows. Small mouth bass observed preying on steelhead fry. Stream 303(d) listed for temperature. Road parallels stream for entire reach. Clipped steelhead morts observed. Extensive invasive species(Himalayan blackberry, walnut, etc). Grazing has impacted channel morphology and has direct impact on steelhead redds/spawning. Steelhead spawning in bottom 5 miles averaged between 36 and 45 redds in 2002 and 2003.		

REACH	DESCRIPTION	Assessment Unit
Rock Creek 3	Squaw Creek to Luna Gulch	Rock Creek
FOCAL species	Steelhead, Coho, Fall Chinook	
PHYSICAL HABITAT CONDITIONS		
increase in hydro-confinement decrease in pools decrease in pool tailouts increase in embeddedness decrease in woody debris		
WATER QUALITY CONDITIONS		
increased fine sediment increase in turbidity decrease in temperature spatial variation increase in mean monthly temperature		
WATER QUANTITY CONDITIONS		
low flow		
ECOLOGICAL HABITAT CONDITIONS		
decreased riparian function increased fish pathology increased harassment decrease in benthic community richness		
COMMENTS		
Stream has been significantly confined by dikes, channelization, and bridge. Riparian growth is severely limited. Road parallels stream for entire reach. Stream 303(d) listed for temperature. Extensive invasive species (Himalayan blackberry, walnut, etc.). Springs have been impaired by roads and/or grazing.		

REACH	DESCRIPTION	Assessment Unit
Rock Creek 4	Luna Gulch to Badger Gulch	Rock Creek
FOCAL SPECIES	Steelhead, Fall Chinook	
PHYSICAL HABITAT CONDITIONS		
increase in hydro-confinement decrease in pools decrease in pool tailouts decrease in woody debris		
WATER QUALITY CONDITIONS		
increased fine sediment increase in turbidity decrease in temperature spatial variation increase in mean monthly temperature		
WATER QUANTITY CONDITIONS		
low flow		
ECOLOGICAL HABITAT CONDITIONS		
decrease in benthic community richness increased fish pathology increased harassment decreased riparian function		
COMMENTS		
Diking of channel. Lack of any riparian vegetation through half of reach. Road parallels entire reach. Stream is 303(d) listed for temperature. Extensive invasive species (Himalayan blackberry, walnut, etc.). Springs have been impaired by roads.		

REACH	DESCRIPTION	Assessment Unit
Rock Creek 5	Badger Gulch to Quartz Creek	Rock Creek
FOCAL SPECIES	Steelhead	
PHYSICAL HABITAT CONDITIONS		
decrease in woody debris		
WATER QUALITY CONDITIONS		
increased fine sediment increase in turbidity		
WATER QUANTITY CONDITIONS		
low flow		
ECOLOGICAL HABITAT CONDITIONS		
decrease in benthic community richness decreased riparian function		
COMMENTS		
Mostly naturally confined reach. Most of reach is remote. Loss of stream structure.		

REACH	DESCRIPTION	Assessment Unit
Rock Creek 6	Above Quartz Creek	Rock Creek
FOCAL SPECIES	Steelhead	
PHYSICAL HABITAT CONDITIONS		
WATER QUALITY CONDITIONS		
increased fine sediment increase in turbidity		
WATER QUANTITY CONDITIONS		
low flow		
ECOLOGICAL HABITAT CONDITIONS		
decrease presence of beaver ponds decreased riparian function decrease in salmon carcasses		
COMMENTS		
Long reach, two probable low flow barriers. Anecdotal evidence suggests beaver were highly present in past; no beaver observed in past 3 years.		

REACH	DESCRIPTION	Assessment Unit
Squaw Creek 1	Rock Creek to Harrison Creek	Rock Creek
FOCAL SPECIES	Steelhead	
PHYSICAL HABITAT CONDITIONS		
increase in hydro-confinement increase in embeddedness decrease in woody debris		
WATER QUALITY CONDITIONS		
increased fine sediment increase in turbidity increase in mean monthly temperature		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		
decrease in salmon carcasses decrease presence of beaver ponds decreased riparian function decrease in benthic community richness		
COMMENTS		
Rock Creek Road and bridge bisect floodplain. Subwatershed is dominated by agricultural and forest uses. Riparian vegetation is extremely limited.		

REACH	DESCRIPTION	Assessment Unit
Squaw Creek 2	Above Harrison Creek	Rock Creek
FOCAL SPECIES	Steelhead	
PHYSICAL HABITAT CONDITIONS		
decrease in woody debris		
WATER QUALITY CONDITIONS		
increased fine sediment increase in turbidity decrease in temperature spatial variation increase in mean monthly temperature		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		
decreased riparian function		
COMMENTS		
Lack of riparian cover. Subwatershed is predominantly agricultural and forest.		

REACH	DESCRIPTION	Assessment Unit
Luna Gulch	Above Rock Creek	Rock Creek
FOCAL SPECIES	Steelhead	
PHYSICAL HABITAT CONDITIONS		
decrease in woody debris		
WATER QUALITY CONDITIONS		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		
decreased riparian function		
COMMENTS		
Stream is unknown except by orthophoto interpretation and road intersections.		

REACH	DESCRIPTION	Assessment Unit
Badger Gulch	Above Rock Creek	Rock Creek
FOCAL SPECIES	Steelhead	
PHYSICAL HABITAT CONDITIONS		
increase in hydro-confinement		
WATER QUALITY CONDITIONS		
increased fine sediment increase in turbidity		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		
decrease presence of beaver ponds		
COMMENTS		
Slight road and bridge encroachment in upper watershed. Active channelization observed. No beaver observed. Steelhead observed.		

<table>
<tr><th>REACH</th><th>DESCRIPTION</th><th>Assessment Unit</th></tr>
<tr><td>Quartz Creek 1</td><td>Rock Creek to Box Canyon</td><td>Rock Creek</td></tr>
<tr><td>FOCAL SPECIES</td><td colspan="2">Steelhead</td></tr>
<tr><td colspan="3">PHYSICAL HABITAT CONDITIONS</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td colspan="3">WATER QUALITY CONDITIONS</td></tr>
<tr><td colspan="3">increased fine sediment
increase in turbidity</td></tr>
<tr><td colspan="3">WATER QUANTITY CONDITIONS</td></tr>
<tr><td colspan="3">low flow</td></tr>
<tr><td colspan="3">ECOLOGICAL HABITAT CONDITIONS</td></tr>
<tr><td colspan="3">decrease in salmon carcasses
decrease presence of beaver ponds</td></tr>
<tr><td colspan="3">COMMENTS</td></tr>
<tr><td colspan="3">Upper watershed dominated by timber harvest and grazing. Roads previously identified as contribution to increase sediment delivery. No beaver observed; anecdotal evidence suggests previous presence; habitat suitable.</td></tr>
</table>

REACH	DESCRIPTION	Assessment Unit
Quartz Creek 2	Above Box Canyon	Rock Creek
FOCAL SPECIES	Steelhead	
PHYSICAL HABITAT CONDITIONS		
decrease in woody debris		
WATER QUALITY CONDITIONS		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		
decrease in salmon carcasses decrease presence of beaver ponds decreased riparian function		
COMMENTS		
Upper watershed dominated by timber harvest and grazing. Roads previously identified as contribution to increase sediment delivery. No beaver observed; anecdotal evidence suggests previous presence; habitat suitable. Orthophotos show lack of riparian cover.		

REACH	DESCRIPTION	Assessment Unit
Box Canyon 1	Quartz Creek to Falls	Rock Creek
FOCAL SPECIES	Steelhead	
PHYSICAL HABITAT CONDITIONS		
decrease in woody debris		
WATER QUALITY CONDITIONS		
increased fine sediment increase in turbidity increase in mean monthly temperature		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		
decrease presence of beaver ponds decreased riparian function decrease in salmon carcasses		
COMMENTS		
Short reach(less than 1 mile); 16' waterfall marks end. Lack of large woody debris and opportunity for recruitment. No beaver presence. Upper watershed dominated by timber harvest and grazing. Roads previously identified as contribution to increase sediment delivery.		

REACH	DESCRIPTION	Assessment Unit
Pine Creek	Above Columbia River	Lower Mid-Columbia Mainstem
FOCAL SPECIES	Steelhead, Fall Chinook	
PHYSICAL HABITAT CONDITIONS		
increase in hydro-confinement increase in embeddedness decrease in glides decrease in pools decrease in pool tailouts loss of backwater pools decrease in woody debris		
WATER QUALITY CONDITIONS		
increased fine sediment increase in turbidity decrease in temperature spatial variation increase in mean monthly temperature		
WATER QUANTITY CONDITIONS		
low flow		
ECOLOGICAL HABITAT CONDITIONS		
decreased riparian function increased fish species introduction increased fish community richness increased fish pathology increased harassment decrease in benthic community richness		
COMMENTS		
Steelhead and Fall Chinook have been observed spawning in limited numbers. State highway and railroad create difficult barrier to passage. How fish pass is unknown; some reports of sunken culvert(now buried). Anecdotal information suggests greater populations historically, better habitat. Habitat has been simplified. Upper watershed is primarily in agriculture. Stream needs more study and passage solution.		

5.6.4 Washington Tributaries Other Than Rock Creek Assessment Unit

Vegetation Patterns

Less than 10% of the WRIA is forested, primarily in the headwaters of Rock Creek and Pine Creek; much of the forested land also has active grazing allotments (Lautz 2000).

Environmental/Population Relationships/Limiting Factors

Access

Barrier culverts at SR 14 on Pine Creek preclude access to potential steelhead habitat.

Low or non-existent flows in all streams during the late summer, fall, and early winter will limit or preclude utilization by fall spawning adults (chinook, coho), and limit mobility of juveniles of all species.

High stream temperatures in the lower portions of all streams during the summer and early fall will limit mobility of juveniles of all salmonid species (Lautz 2000).

Floodplains/Wetlands/Riparian Areas

Grazing and trampling by cattle in and near stream banks has caused accelerated channel incision (entrenchment, downcutting) and resulted in a reduction in the quality and amount of available existing or potential fish habitat; continued grazing activity in these areas may delay recovery where functional floodplains and riparian areas are becoming reestablished (Lautz 2000).

Channel widening and obliteration of riparian zones caused by a 75 to 100 yearflood event in 1996 has resulted in locally poor habitat quality and riparian condition. While there may be long term benefits (LWD recruitment, creation of complex habitat) as a result of this event, there may be opportunity to accelerate habitat recovery and improve stability against smaller, more frequent floods through channel and riparian restoration activities (Lautz 2000).

Cattle watering at, or in the vicinity of, spring areas may have adverse impacts on water quality. Spring outflow into fish-bearing waters may provide important cool water refuges for juvenile salmonids during the summer and early fall (Lautz 2000).

Functional quality of riparian areas has been adversely impacted by grazing and forest practices in many locations throughout the watershed. Types of impacts include removal of or damage to riparian vegetation and compaction and erosion of stream banks and adjacent floodplain areas (Lautz 2000).

Water Quantity and Quality

Low or non-existent flows in all streams during the late summer, fall, and early winter will limit or preclude utilization by fall spawning adults (chinook, coho), limit mobility of juveniles of all species, and may result in mortality due to stranding (Lautz 2000).

High stream temperatures in the lower portions of all streams during the summer and early fall will limit mobility of juveniles of all salmonid species, and may result in mortality due to thermal stress (Lautz 2000).

Information Gaps

The limiting factors described above were identified based upon a very limited amount of information that was available for this WRIA. More detailed information should be collected to more precisely define these factors, and to identify specific areas where restoration activities will best redress them. The information to be collected includes the following:

- Further investigstion of fish utilization and habitat availability and quality, to be conducted on all accessible or potentially accessible streams.
- Further investigation of potential barriers should be conducted on all fish bearing streams, using an approved assessment and inventory protocol.
- More detailed evaluations of the condition of channels, floodplains, wetlands, and riparian areas.
- Identification of sediment sources, sinks, and sediment related impacts to habitat.
- A stream temperature study to provide a better understanding of the causative factors of high stream temperatures.

A watershed assessment, funded by the Columbia River Basin Fish and Wildlife Authority and administered by the Yakama Nation, will be initiated in the next year. It is anticipated that most, if not all, of the information needs described above will be accounted for as part of this assessment (Lautz 2000).

Aquatic Habitat Conditions

Water Quality

All streams in this assessment unit are classified as Class A streams (excellent water quality). Identified water quality problems include high water temperatures recorded during the summer. Alder Creek, Six Prong Creek, Wood Gulch, Pine Creek were found to exceed the WDE standard (18oC/64.4oF) (BLM 1986, EKCD 1997, Lautz 2000).

The temperature situation identified in the Rock Creek watershed is likely for all streams in the subbasin. Stream monitoring by the Eastern Klickitat Conservation District (1997) has confirmed exceedances of the standard at most of the 27 sites where thermographs have been installed. Based on temperature data through 1997, it appears that exceedances of the standard at higher elevations (plateau and upper canyon reaches) are relatively minor and of short duration; some thermal stressing of juvenile salmonids may occur, but may be avoided if there is access to cool water refuges (areas of spring outflow or groundwater upwelling). In lower canyon and alluvial reaches, exceedances extend well into the sub-lethal or lethal ranges for salmonids and are of long duration. It is unknown to what extent cool water refuges exist in these reaches (Lautz 2000).

Riparian/Floodplain Condition and Function

Riparian areas have been extensively impacted within the Columbia basin such that undisturbed riparian systems are rare (Knutson and Naef 1997). Impacts have been greatest at low elevations and in valleys where agricultural conversion, altered stream channel morphology, water impoundment, and water withdrawal have played significant roles in changing the character of streams and associated riparian areas. Losses in lower elevations include large areas once dominated by cottonwoods that contributed considerable structure to riparian habitats (Lautz 2000).

Steam-adjacent roads exist along portions of Wood Gulch, Chapman Creek, and Glade Creek. Generally, these roads occur either at the edge of the floodplain, or on a terrace immediately above the floodplain; observed impacts of these roads on floodplain connectivity appears to be minimal (Lautz 2000).

Stream Channel Conditions and Function

No systematic, evaluation of sediment sources and impacts has been conducted in the subbasin. Generally speaking, land-use related sediment sources in this watershed occur as a result of forest practices (e.g. streamside harvesting and construction and use of gravel and native surface roads and skid trails), grazing practices (e.g. streamside grazing), and from stream-adjacent county and private roads not associated with forest practices. Informal assessments suggest that in-channel fine sediment is not a problem, except in the upper reaches of Pine Creek (Lautz 2000).

Areas of Special Concern

WDFW has identified potential coho habitat in the lower portion of Glade Creek (LaRiviere, pers. comm.; Lautz 2000).

Environmental/Population Relationships/Limiting Factors

The barrier culverts at SR 14 on Pine Creek preclude access to potential steelhead habitat. This barrier occurs at the mouth of Pine Creek, and consists of a single 120” concrete-encased corrugated metal pipe located on line with the creek, and three 120” concrete-encased corrugated metal pipes offset approximately 150 feet to the east of the creek. All culverts are perched approximately 6 feet relative to the creek bed at the upstream end. Flow (and fish passage) in the culverts occurs only when high flows in Pine Creek create a backwater, or when the John Day pool in the Columbia River rises above the inlet elevation of the culverts; at other times, flow in either direction passes through the roadbed, effectively precluding passage. These culverts have been identified by WDFW as a total barrier to all anadromous species. Approximately three miles of potential steelhead habitat have been surveyed above this culvert (Lautz 2000).

Functional Relationship of Assessment Unit with Subbasin

Pine and Glade creeks do not have confirmed anadromous fish use, but have been identified as having potential use because of available habitat (Lautz 2000).

5.6.5 Oregon Tributaries Assessment Unit

The two streams with anadromy in this subbasin are Frank Fulton Canyon and Spanish Hollow creeks. East of these two watersheds are small intermittent streams such as Helm, Blalock, Long, and Jones canyons, which are near but not part of the John Day River Subbasin. Neither ODFW or Sherman County SWCD have habitat surveys of Spanish Hollow or Fulton Canyon Creek watersheds or the other canyon areas, and they do not know of any that have been conducted.

A 2003 map produced by StreamNet apparently with data from DEQ and EPA shows salmonid use of Spanish Hollow and Fulton Canyon watersheds. (See Appendix E Figures 160A&B in LMM Appendices folder.)

Aquatic Habitat Conditions

Water Quality and Quantity

Low flows throughout these watershed during the late summer, fall will limit or preclude utilization by fall spawning adults (chinook, coho), limit mobility of juveniles of all species, and may result in mortality due to stranding (French 2004). Groundwater withdrawals are likely to have lowered base flows decreasing perennial flow area (NOAA/Fisheries 2004).

Temperatures near and above lethal limits for salmonids for much longer duration than during pre-settlement times due to reduction in summer low flow (French 2004). High stream temperatures in the lower portions of all streams during the summer and early fall will limit mobility of juveniles of all salmonid species, and may result in mortality due to thermal stress.

Increased percentages of fine sediment from background levels in spawning gravels and interstitial spaces is occurring and can severely decrease egg incubation survival, decrease interstitial space affecting inactive rearing stages of juveniles and or entomb juveniles (NOAA/Fisheries). The NOAA/Fisheries recommendation is to decrease sources of fine sediment from erosion, especially on sloping soils, where cover crops and residue are lacking.

Riparian/Floodplain Condition and Function

Altered hydrology and removal of vegetation from landscape and riparian areas, uncontrolled grazing, and mechanized agriculture have resulted in soil erosion and reduced infiltration capacity of the soils, and increased peak or flashier runoff is also likely to be occurring (NOAA/Fisheries 2004).

Stream Channel Conditions and Function

In general, habitat conditions in Fulton Canyon and Spanish Hollow streams are confined by roads and are affected by sedimentation likely from agricultural practices and, in some places, from livestock grazing (French, pers. comm. 2004; Stradley, pers. comm. 2004). Both sediment and temperature limit fish production in these two streams (French, pers. comm. 2004).

Environmental/Population Relationships/Limiting Factors

Lower mid-Columbia River and other mainstem dams have reduced anadromous fish numbers, including potential spawners in Fulton Canyon and Spanish Hollow Poor passage and migratory conditions (including temperature) for anadromous fish have reduced abundance, productivity, and spatial diversity. Summer/early fall habitat availability diminished in comparison with pre-settlement environment.

Functional Relationship of Assessment Unit with Subbasin

Columbia River dams have reduced anadromous fish numbers, including potential spawners in Fulton Canyon and Spanish Hollow Poor passage and migratory conditions (including temperature) for anadromous fish have reduced abundance, productivity, and spatial diversity. Spanish Hollow and Fulton Canyon watersheds are used by steelhead (French 2004), but whether other anadromous species use the watershed and the extent of that use is unknown.

5.7 Key Findings

5.7.1 Mainstem: Steelhead, Coho, Fall Chinook

Table 31 Mainstem key findings and working hypotheses: steelhead, fall chinook, coho

Key Findings	Cause/Working Hypothesis	Confidence Effect Is Actually Occurring	Confidence Level in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate, Improve/Maintain or Mitigate
Hydropower system has altered the historic hydrograph, which has a negative impact on juvenile salmon, including steelhead, coho, and fall chinook.	For juvenile salmon, migration time is greatly extended and has decreased juvenile and subsequent adult survival	High	High	High	Restore normative hydrograph	Employ alternative flood control strategies to help recapture to historical timing of flows Augment flows
	Increased water velocities will reduce travel time and improve juvenile and subsequent survival of adult returns	High	High	High	Improve juvenile passage conditions in the subbain's mainstem	Augment flows to increase water velocities. Provide spill beyond August 31, which is the 2000 BiOp rule
Downsteam passage conditions at dams can result in high mortalities	Increased spill diverts fish from turbines and increases survival	High	High	High	Improve juvenile passage conditions in the subbain's mainstem	Provide appropriately timed and sufficient spill at The Dalles, John Day, and McNary Dams
Peak flows and frequent water fluctations have a deleterious and sometimes fatal effect on juvenile salmon	More uniform flow will keep more juveniles away from turbines and improve travel time.	High	Medium	Medium	Improve juvenile passage conditions in the subbain's mainstem	Operate hydrosystem to minimize peak demand flows and develop new appropriate energy sources to minimize peak flows to meet peak demand

Key Findings	Cause/Working Hypothesis	Confidence Effect Is Actually Occurring	Confidence Level in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate, Improve/Maintain or Mitigate
Weir technology is new and has been installed only at Lower Granite Dam. Not all dams and reservoirs have the same passage conditions.	New weir technology directs fish to safer passage routes; hower, technology must be tested before it is presumed to be effective for juvenile salmon survival.	Medium	Medium	Unknown	Improve juvenile passage conditions at The Dalles, John Day, and McNary Dams.	Investigate the efficacy of the planned installation of removable spillway weirs to aid in directing migrants to safer passage routes
Fluctuations in flow can delay adult salmon migration	Adult salmon migration is imperiled by alterated hydrology.	High	High	Medium	Restore features of the normative hydrograph to improve migration conditions.	Minimize flow fluctuations and continue investigation of adult migration patterns.
Prolonged exposure to elevated water temperatures is stressful for upstream migrants and can delay migration. Steelhead seek cold water refuges, including tributary mouths.	Adult salmon migration is imperiled by alterated hydrology and subsequent high water temperatures can be lethal.	High	High	Medium	Reduce exposure to elevated water temperatures.	Develop a temperature TMDL for the subbasin and implement specific actions (to reduce exposure to elevated water temperatures).
When monitored, adult fish passage perfomance criteria are not often in compliance.	Compliance with fish passage criteria will improve upstream adult returns.	Medium	Medium	Low	Improve adult migration conditions	Monitor fishways regularly at the dams for compliance with adult fish passage criteria.
Adult steelhead fallback is occurring at the dams.	Hydro operations alter flow patterns, creating various conditions conducive to fall back.	Medium	High	Medium	Improve adult migration	Identify and correct adult steelhead fallback conditions at eacn dams.

Key Findings	Cause/Working Hypothesis	Confidence Effect Is Actually Occurring	Confidence Level in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate, Improve/Maintain or Mitigate
Construction of the hydrosystem reduced the survival of steelhead kelts. (BPA, CRITFC)	Collecting and reconditioning the kelts improves the chances of repeat spawning.	High	High	High	Improve chances of return migration to the ocean and to spawning areas.	Continue research on kelt reconditioning to identify conditions that improve survival.
Contaminants input from upstream land-use activities are often trapped in the reservoirs behind dams. Dredging suspends contaminants accumulated in sediments.	Dredging can lead to direct mortalities of juveniles (and adults).	Medium	Medium	Medium	Improve water quality	Reduce exposure to contaminants.
Same as above	Same as above		Medium	Medium	Improve water quality	Eliminate dredging.
Same as above	Same as above		Medium	Unknown	Improve water quality	Identify contaminants in the sediment and water and the effects of the contaminants on salmon migrants.
Same as above	Same as above		Medium	Unknonw	Improve water quality	Develop TMDLs for contaminants, including identifying remedial actions.
Rapid changes in reservoir levels occur frequently, e.g., levels in The Dalles Pool can change several feet in one day.	Rapid changes in reservoir levels can isolate or dewater rearing areas and lead to juvenile mortalities.	Medium	Low	Unknonw	Minimize juvenile stranding	Identify flow conditions creating areas vulnerable to stranding.

Key Findings	Cause/Working Hypothesis	Confidence Effect Is Actually Occurring	Confidence Level in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate, Improve/Maintain or Mitigate
Juveniles can be entrained into irrigation pumps.	Screening irrigation pumps will prevent entrainment.	High	Medium	Medium	Protect rearing habitat	Screen all irrigation pumps.
Irrigation withdrawals contribute to stranding of rearing juveniles.	Irrigation withdrawals can affect water quantity and create conditions that can result in stranded juveniles.	Medium	Medium	Unknown	Protect rearing habitat	Enact a moratorium on additional mainstem water withdrawals and quantify the effects of irrigation withdrawals.
Commercial and recreational fisheries occur in the subbasin. Commercial gillnets used in The Dalles and John Day pools may break free and get lost.	Under certain conditions the lost fishing gear will continue to trap fish.	High	Medium	Low	Protect migrating adult salmon.	Identify locations of lost gear and remove. Quantify the impact of lost fishing gear on salmon.
Juvenile salmon are being harvested by bird and fish predators at higher rates than prior to hydro operations.	Controlling avian and piscivorous predators will increase juvenile salmon survival.	HIgh	High	High	Protect juvenile salmon migrants.	Remove exotic species and control native predators.

5.7.2 Mainstem: Sturgeon

Table 32 Mainstem key findings and working hypotheses: white sturgeon

Key Finding	Cause/Working Hypothesis	Confidence Effect Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate or Improve/Maintain
Spawning occurs in the mainstem but can be limited by hydrograph and water temperatures	Modification of the historic hydrograph due to dam operation can result in peak flows that do not coincide with optimal spawning temperatures and can result in year class failure	High	High	High	Increase spawning success of white sturgeon in the LMM Columbia River	Operate hydrosystem so that peak flows occur when water temperature is suitable for white sturgeon spawning
Impounded WS populations incur periodic year-class failures	Inadequate spawning ground water velocities, lack of multi-day uniformity in flow, turbulence, and turbidity produce year class failures	High	High	High	Increase first-year survival of naturally spawned WS in the LMM Columbia River	Operate hydrosystem for multi-day uniform peak flow (no excessive hourly or daily variation) when water temperature is suitable for white sturgeon spawning
Egg, larval stage, and YOY WS are susceptible to predation	Indigenous and introduced predators cause mortality in pre-juvenile white sturgeon	High	High	High	Reduce predation in LMM Columbia River, especially on egg and larval stage WS, but also sub-yearling WS	Develop predator control studies for the LMM Columbia River. Identify predator population densities and dynamics. Develop experimental predator removal programs. Establish predator removal M&E including predator population exploitation, WS egg, larvae, and YOY consumption rates, and pre-yearling WS survival rates.

Key Finding	Cause/Working Hypothesis	Confidence Effect Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate or Improve/Maintain
Impounded WS populations are less productive than the unimpounded lower Columbia River population	Construction and operation of Mainstem hydroelectric dams has reduced WS population productivity especially in The Dalles and John Day pools	High	High	High	Restore LMM Columbia River population abundance and productivity	Supplement less productive impounded WS populations through capture of juvenile WS from below Bonneville Dam and transporting them into The Dalles and John Day reservoirs to compensate for year class failures.
The health of WS populations show up in density, condition factor, reproductive potential, age structure, and fish growth rates	Construction and operation of Mainstem hydroelectric dams has reduced or eliminated WS population productivity resulting in reduced or negated sustainable WS harvest	High	High	High	Restore LMM Columbia River population abundance and productivity to levels that can sustain reasonable harvest	Identify the need for and evaluate the success of LMM WS population recovery activities. Sustainable tribal and sport harvest is dependent upon periodic population status updates. Expand the periodic stock assessment program into McNary pool, the Hanford Reach, and into Priest Rapids Pool.

Key Finding	Cause/Working Hypothesis	Confidence Effect Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate or Improve/Maintain
Reservoir specific intensive harvest management can influence WS abundance levels	Population over harvest has been mitigated by WDFW, ODFW, and CRITFC through many years of adapted reservoir specific harvest management involving in-season harvest monitoring linked to periodic population assessment and harvest regulation modeling	Medium	Medium	Medium	Increase LMM Columbia River WS populations to levels supporting reasonable harvest opportunities	Continue to monitor harvest levels and adjust fishing regulations as necessary between Bonneville and McNary Dams. Expand annual angler survey program to McNary pool, the Hanford Reach, and eventually to Priest Rapids Pool.

5.7.3 Mainstem: Pacific Lamprey

Table 33 Mainstem key findings and working hypotheses: Pacific lamprey

Key Findings	Cause/Working Hypothesis	Confidence Effect Is Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate Improve/Maintain or Mitigate
Recent counts of Pacific lamprey at The Dalles, John Day and McNary dams indicate a serious decline in abundance. Pacific lamprey serve an important role in the ecological function of the area by contributing to nutrient budgets and transporting marine nutrients to freshwater systems. Pacific lamprey are important part of the natural food web. Pacific lamprey are an important tribal cultural food source. Low abundances preclude fishing opportunities in upstream tributaries.	Populations are below historical levels because of anthropogenic activities, including hydropower operations.	High	High	HIgh	Restore Pacific lamprey populations. Attain self-sustaining natural production of Pacific lamprey that provides for fishing opportunities at traditional locations.	

Key Findings	Cause/Working Hypothesis	Confidence Effect Is Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate Improve/Maintain or Mitigate
Adult fishways are difficult for lamprey to negotiate. Research indicates that rounding corners and alternative substrates improve passage efficiency.	Changes in fishways will improve passage.	HIgh	High	High		Improve adult passage at dams.
Same as above and, in addition, alternative passage routes may be more effective.	Auxiliary passage systems will increase survival.	HIgh	Medium	Medium	Investigate auxiliary passage systems, similar to those being researched at Bonneville Dam.	
Juvenile lamprey suffer from high impingement rates on bypass screens because they are relatively poor swimmers. John Day Dam, in particular, impinges large numbers of lamprey.	Modifications to and avoidance of screens will increase survival.	HIgh	HIgh	Medium	Identify areas for passage improvements.	Make improvements in juvenile passage that do not conflict with salmonid passage needs.

Key Findings	Cause/Working Hypothesis	Confidence Effect Is Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate Improve/Maintain or Mitigate
Contaminants input from upstream land-use activities are often trapped in the reservoirs behind dams. Dredging suspends contaminants accumulated in sediments. Dredging can also lead to direct mortalities. Dredging should be minimized and limited to periods outside of the active migration period.	Eliminating dredging will reduce exposure to contaminants and reduce mortalities.	Medium	Low	Low		Identify contaminants and the effects on lamprey
Same as above	Same as above	Medium	Medium	Low	Reduce exposure to contaminants.	
Rapid changes in reservoir levels can isolate or dewater rearing areas and lead to mortalities of juveniles. Reservoir levels in The Dalles Pool can change several feet in one day.	Change in flow fluctuations minimizes stranding	Medium	Medium	Low	Minimize stranding.	
Data gap. To remediate it is important to know where stranding occurs.	Identifying habitat usage will indicate where actions need to take place.	Low	Unknown	Unknown		Identify areas vulnerable to stranding.

Key Findings	Cause/Working Hypothesis	Confidence Effect Is Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate Improve/Maintain or Mitigate
Data gap. Essential for efforts to restore Pacific lamprey.	Acquiring basic information about species will increase likelihood of developing successful restoration strategies.	High	Unknown	Unknown		Determine abundance, distribution, and habitat use of rearing juveniles

5.7.4 Rock Creek

Table 34 Rock Creek key findings and working hypotheses

Key Findings	Cause/Working Hypothesis	Confidence that Effect Is Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate or Improve/Maintain	Strategy to Mitigate Effect
Altered thermal regimes have affected fish life histories (such as natural spawn timing, incubation, rearing etc), decreased quantity of suitable habitat	Management activities affecting riparian areas and channel morphology have produced greater summer maxima, and lower winter minima	High	High	High	Increase winter minima temperature and decrease summer maxima temperatures	Restore riparian conditions and channel morphology.	

Key Findings	Cause/Working Hypothesis	Confidence that Effect Is Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate or Improve/Maintain	Strategy to Mitigate Effect
Juveniles redistribute themselves downstream in the summer and fall after emergence, with highest densities in fall being found well below the major spawning areas	Natural expression of some life histories	High	High	High			
	Decreased areas of perennial flow in tributaries	Medium	Medium	Medium	Increase extent and distribution of perennial habitat	Restore riparian conditions and channel morphology. Increase floodplain connectivity. Improve upland management practices to mimic natural runoff and sediment production.	
Steelhead populations have been dramatically reduced from pre-settlement abundance levels	Habitat loss and alteration and changes in the biotic community have reduced habitat suitability, which in turn has reduced productivity, abundance, and spatial distribution of the species.	High	High	High	Restore steelhead population abundance, productivity and spatial distribution to viable, harvestable and sustainable levels over the next 30 years.	Coordinated management of populations and habitat improvements including: Ongoing research, Habitat restoration, Population management activities such as harvest management and hatchery supplementation	

Key Findings	Cause/Working Hypothesis	Confidence that Effect Is Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate or Improve/Maintain	Strategy to Mitigate Effect
Population levels of Lamprey have been dramatically reduced from pre-settlement levels.	Poor passage for anadromous forms through the mainstem Columbia River (and possibly in the Subbasin) have severed life history pathways and reduced population abundance, productivity and spatial diversity.	High	High	Medium			
	Changes in habitat conditions and reduction in salmon populations within the subbasin have reduced habitat suitability and reduced abundance, productivity and life history diversity. Improvement in habitat conditions for salmonids will improve lamprey populations as well.	Medium	Medium	Medium	Study specific habitat relationships for lamprey. Implement habitat restoration actions under Subbasin Plan.		

Key Findings	Cause/Working Hypothesis	Confidence that Effect Is Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate or Improve/Maintain	Strategy to Mitigate Effect
Tributary Summer/Early Fall Habitat availability lower in comparison with pre-settlement environment	Temperatures near and above lethal limits for salmonids for much longer duration than during pre-settlement times due to reduction in summer low flow.	High	High	High	Reduce Temp to near pre-settlement conditions	Increase flows to satisfy depth thresholds, Reconnect Side Channels; improve Riparian Zone; investigate areas of groundwater connection; improve floodplain connectivity	
Loss of Habitat Diversity/ thermal refugia by loss of off-channel habitat	Numerous examples of confinement by roads, bridges, dikes.	Med	High	High	Reconnect 100% of floodplain side channels in this Assessment Unit	Relocate infrastructure where possible to allow natural processes to operate. Re-establish native vegetation on floodplain.	Reconnect side channels. Artificially confined reaches limit side channel habitat, more importantly though, removal of rd and rip rap may reduce bed shear and increase margin habitat complexity

Key Findings	Cause/Working Hypothesis	Confidence that Effect Is Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate or Improve/Maintain	Strategy to Mitigate Effect
Hydrology has been altered to increase peak flows; loss of storage	Groundwater withdrawals may lower base flows decreasing perennial flow area	Medium	Medium	Medium		Study and monitor groundwater withdrawals in area	
	Increased peak runoff	High	Medium	Medium	Restore historical hydrologic regime	Compare to 1860s GLO maps, restore physical and riparian characteristics	
Tributary Lack of Habitat diversity (pools with cover)/Lack of Large Woody Debris(Decreased Abundance of LWD)	Logging practices, general agricultural/forest and floodplain developments increased peak flows	Medium	Low to Medium	High	Implement sustainable agricultural and forest practices, improve road management. Improve watershed management	Implement practices which leave sources of LWD to naturally enter system	
	Lack of LWD Recruitment Due to riparian harvest, stream cleaning, and Change in upstream Riparian Zone	High	High	Medium	Restore viable P. Pine populations to upstream Riparian Zones over the next 20 years (upper forest)	Implement practices to naturally supply sources of LWD	Artificially introduce LWD

Key Findings	Cause/Working Hypothesis	Confidence that Effect Is Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate or Improve/Maintain	Strategy to Mitigate Effect
Food web in lower river has been altered/reduced.	Fluctuations in water quality parameters (Temp, DO, Nutrients) and toxics have reduced native aquatic vegetation and faunal (insect, zooplankton, vertebrates) communities and productivity	Low	High	High		Study/Characterize productivity. Characterize within framework of Sediment load. Restore riparian conditions and channel morphology. Increase floodplain connectivity. Improve upland management practices to mimic natural runoff and sediment production.	
Predation Risk to salmonids from native fish (northern pike minnow) is high in vicinity of Rock Creek Mouth-	Loss of abundance of native salmonids has resulted in a greater proportional impact from native predation.	High	High	Medium	Increase abundance of salmonid populations to reduce proportion of predation due to native sp	1) Implement Subbasin planning and other habitat and population restoration programs	Bounty Programs, creation of artificial off-channel habitats.
	Increased habitat for native predators in Col. Mainstem leads to increased pops in lower tribs.	High	High	Medium	Reduce population levels in Mainstem Col	Further control and actions on predator populations in mainstem reservoirs	
Predation risk to salmonids from non- native fish (walleye, Smallmouth bass etc) is high	Increased Temps in lower river increase habitat for non-native predators, temps also trigger increase in feeding levels	High	High	Medium	Reduced non-native predators	Reduce Habitat suitability	Bounty and increased harvest measures on non-native predators

Key Findings	Cause/Working Hypothesis	Confidence that Effect Is Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate or Improve/Maintain	Strategy to Mitigate Effect
Predation risk to salmonids from bird populations is elevated	Loss of abundance of native salmonids has resulted in a greater proportional impact from native predation	Med	Low	High	Increase abundance of salmonid populations to reduce proportion of predation due to native sp.	Improve flow, cover, available habitat, and habitat diversity to reduce potential for predation by native birds.	
Survival of steelhead kelts (mature spawned out fish with the potential to spawn again) migrating out of the Rock Creek Subbasin and through the mainstem Columbia to the ocean is believed to be at or near zero.	Lack of facilities for downstream passage through the dams for large bodied adults, habitat conditions in the mainstem Columbia.	Med	High	High	Increased adult survival at mainstem Columbia dams for repeat spawners.	Support Corps studies of fish passage at mainstem Columbia dams. Evaluate habitat conditions for survival in the mainstem Columbia habitat.	Implement Kelt Reconditioning. Implement improved passage at Mainstem Columbia dams.
Hatchery Fish compete with Natural Origin fish for space and food resources	Clipped fish morts have been observed in lower river; competition with natural origin fish,	Low	Low	High	Evaluate genetics of Rock Creek steelhead		

Key Findings	Cause/Working Hypothesis	Confidence that Effect Is Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate or Improve/Maintain	Strategy to Mitigate Effect
Tributary High Temperatures have resulted in increased susceptibility of native salmonids to pathogens.	Increased temperature stresses the fish and increases chances of initial infection Where current or Historic fish stocking exists	Low	High	Medium	Reduce Summer High Temperatures	Study presence of pathogens in juveniles and adults during high temperatures. Restore riparian conditions and channel morphology.	
Loss of Habitat Diversity/ thermal refugia by loss of off-channel habitat	Rock Creek Road and other infrastructure in watershed have altered floodplain negatively, confined river and tributaries	Med	High	High	Reconnect 100% of floodplain side channels in this Assessment Unit	Relocate infrastructure where possible to allow natural processes to operate. Re-establish native vegetation on floodplain.	Reconnect side channels. Artificially confined reaches limit side channel habitat, more importantly though, removal of rd and rip rap may reduce bed shear and increase margin habitat complexity

Key Findings	Cause/Working Hypothesis	Confidence that Effect Is Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate or Improve/Maintain	Strategy to Mitigate Effect
Population and ecological effect of Beavers have been significantly reduced and altered	Reduction of habitat, conflict with water infrastructure results in removal of dams and beavers, current trapping and historic population reduction and fragmentation. Other effects: Loss of fine sediment storage capacity, beaver dams also created grade control structures which resulted in off channel habitat and increased channel stability and maintained channel planform	High	High	High	Increase available habitat in mainstem floodplains, especially urbanized floodplains. Reduce conflicts with infrastructure, set population targets based on desired functions and population connectivity.	Restore “unmanaged” or natural floodplain habitats. Encourage beaver colonization of these areas. Inventory existing and potential habitat, include reintroduction of beaver into restoration actions.	

Key Findings	Cause/Working Hypothesis	Confidence that Effect Is Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate or Improve/Maintain	Strategy to Mitigate Effect
Increased percentages of fine sediment from background levels in spawning gravels and interstitial spaces	Can severely decrease egg incubation survival, decrease interstitial space affecting inactive rearing stages of Juveniles and or entomb juveniles				Decrease sources of fine sediment	Employ road management actions that reduce fine sediment inputs. Study fine sediment inputs. Characterize. Restore riparian conditions and channel morphology. Increase floodplain connectivity. Improve upland management practices to mimic natural runoff and sediment production.	

5.7.5 Fulton Canyon and Spanish Hollow

Table 35 Fulton Canyon and Spanish Hollow key findings and working hypotheses

Key Finding – Observed Effect or Phenomenon	Cause/Working Hypothesis	Confidence Effect Is Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate, Improve/Maintain or Mitigate
Altered hydrology	Removal of vegetation from landscape and riparian areas, uncontrolled grazing, and mechanized agriculture resulted in soil erosion and reduced infiltration capacity of the soils	High	Undetermined	Unknown		Implement Dry Cropland or Range and Pastureland Resource Management Systems (RMS) in Gilliam and Sherman counties in conjunction with the Natural Resources Conservation Service (NRCS) as per the April 2004 Biological Opinion
	Increased peak or flashier runoff is occurring	High	Undetermined	Unknown	Restore historical hydrologic regime	Same as above Restore physical and riparian characteristics
	Groundwater withdrawals lower base flows decreasing perennial flow area	High	Undetermined	Unknown	Restore historical hydrologic regime and Increase extent and distribution of perennial habitat	Implement dry cropland or range and pastureland RMS plans in conjunction with NRCS, specifically, study and monitor groundwater withdrawals in area

Key Finding – Observed Effect or Phenomenon	Cause/Working Hypothesis	Confidence Effect Is Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate, Improve/Maintain or Mitigate
Columbia River dams have reduced anadromous fish numbers, including potential spawners in Fulton Canyon and Spanish Hollow	Poor passage and migratory conditions (including temperature) for anadromous fish have reduced abundance, productivity, and spatial diversity.	High	Undetermined	Unknown	Improve passage rates	Support efforts to improve passage survival rates
Summer/early fall habitat availability diminished in comparison with pre-settlement environment	Temperatures near and above lethal limits for salmonids for much longer duration than during pre-settlement times due to reduction in summer low flow	High	Undetermined	Unknown	Reduce temperatures to near pre-settlement conditions	Implement dry cropland or range and pastureland RMS plans in conjunction with NRCS, specifically: Increase flows to satisfy depth thresholds Reconnect side channels Improve riparian zone Investigate areas of groundwater connection Improve floodplain connectivity

Key Finding – Observed Effect or Phenomenon	Cause/Working Hypothesis	Confidence Effect Is Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate, Improve/Maintain or Mitigate
Increased percentages of fine sediment from background levels in spawning gravels and interstitial spaces	Can severely decrease egg incubation survival, decrease interstitial space affecting inactive rearing stages of juveniles and or entomb juveniles	High	HIgh	Unknown	Decrease sources of fine sediment from erosion, especially on sloping soils, where cover crops and residue are lacking	Implement dry cropland or range and pastureland RMS plans in conjunction with NRCS, specifically: Study and characterize fine sediment inputs. Improve agricultural management practices to mimic natural runoff and sediment production Restore riparian conditions and channel morphology. Increase floodplain connectivity. Employ road management actions that reduce fine sediment inputs.
Basic hydrological, habitat, and population information is lacking	Scientific information and analysis is the foundation of natural system and species conservation and restoration	—	High	—	Restore ecological functioning and biological integrity to these two watersheds	Use funds available from a variety of sources, including federal and ratepayer sources

6 Inventory

6.1 Introduction, Purpose, and Scope

The inventory attempts to summarize the fish and wildlife protection, restoration, and artificial production projects and programs that have occurred over the past five years or are about to be implemented. The inventory identifies existing legal protections, management plans, management programs, and projects that target fish and wildlife or otherwise provide substantial benefit to fish and wildlife. The timeframe of this inventory is the last five years and where possible, such activities that are about to be implemented.

Compilation of this information helps demonstrate the current management directions, existing and imminent protections, and current strategies implemented through specific projects. The inventory information illustrates current effort. This alone is not the purpose of an inventory of fish and wildlife programs and projects in the Lower Mid-Columbia Mainstem Subbasin. The Council's "Technical Guide for Subbasin Planners" (Council Document 2001-02), states that the inventory will have its greatest value when it is reviewed in conjunction with the limiting factors resulting from the assessment. Such a project review helps to identify gaps between: 1) what is actually happening and 2) what needs to happen to achieve the Council's vision and the subbasin's vision. However, such a gap analysis for the Lower Mid-Columbia Mainstem Subbasin is only partially constructed in this 2004 draft. Elements of a gap analysis are in:

- 4. Wildlife Assessment/4.3.4 - 4.5.3 Key Findings
- 5. Fish Assessment/5.8 Key Fish Findings
- 7. Synthesis and Interpretation
- 8. Management Plan/Wildlife 8.2.1 - 8.2.6 and Fish 8.3.1 - 8.3.5

The inventory information gathered for this subbasin was derived from interviews, fish and wildlife project managers, Internet websites, and databases. The Yakama Indian Nation, WDFW, ODFW, the Department of Ecology, and Klickitat, Sherman, and Gilliam counties provided information used in this plan. Also, the Eastern Klickitat Conservation District is actively pursuing bridge replacement, riparian restoration and channel stabilization projects, which have been identified, but not yet funded. Yet it is still incomplete. Summaries of existing legal protections, management plans, management programs, and conservation and restoration projects are compiled in the following tables: **Table 36**, **Table 37**, **Table 38**, **Table 39**.

6.1.1 Existing Legal Protection

Table 36 Summary of existing legal protections

Federal	Endangered Species Act
	Clean Water Act
	Fish and Wildlife Coordination Act
	Magnuson-Stevens Fishery Conservation and Management Act
	Migratory Bird Treaty Act
	Columbia River Gorge National Scenic Area Act
	Rivers and Harbors Act
	Bald Eagle Protection Act
	Federal Non-indigenous Aquatic Nuisance Prevention and Control Act
	National Invasive Species Act
State (Oregon/Washington)	Oregon Forest Practices Act
	Washington Forest Practices Act
	Oregon Removal-Fill Law
	Fishing and Harvest Regulations
	Washington Growth Management Act
	Washington Shoreline Management Act
	Washington Bald Eagle Habitat Buffer Rule
	Washington Fish and Wildlife Commission 1986 Bald Eagle Habitat Protection Rule
	Oregon Water Resource Protections
	Oregon Department of Fish and Wildlife Integrity Rules
	Washington Salmon Recovery Planning Act
	Washington Wild Stock Restoration Initiative
	Washington Watershed Management Act
Local	Klickitat County Zoning Ordinances
	Washington Critical Area Ordinances

Federal

Endangered Species Act – The 1973 Endangered Species Act provides broad protection for species of fish, wildlife and plants that are listed as threatened or endangered in the U.S. or elsewhere. Provisions are made for listing species, as well as for recovery plans and the designation of critical habitat for listed species. The Act outlines procedures for federal agencies to follow when taking actions that may jeopardize listed species, and contains exceptions and exemptions. The Endangered Species Act also is the enabling legislation for the Convention on International Trade in Endangered Species of Wild Fauna and Flora, commonly known as CITES. Criminal and civil penalties are provided for violations of the Act and the Convention.

Clean Water Act - The Clean Water Act established the basic structure for regulating discharges of pollutants into the waters of the United States. It gave the Environmental Protection Agency the authority to implement pollution control programs such as setting wastewater standards for industry. The Clean Water Act also continued requirements to set water quality standards for all contaminants in surface waters. The Act made it unlawful for any person to discharge any pollutant from a point source into navigable waters, unless a permit was obtained under its provisions. It also funded the construction of sewage treatment plants under the construction grants program and recognized the need for planning to address the critical problems posed by nonpoint source pollution.

Section 404 of the Act regulates the discharge of dredged or fill material into all waters of the United States, including wetlands, both adjacent and isolated. The USACE presides over permitting, mitigation, and enforcement of Section 404.

Fish and Wildlife Coordination Act - The Act provides that whenever the waters or channel of a body of water are modified by a department or agency of the U.S., the department or agency first shall consult with the U.S. Fish and Wildlife Service and with the head of the agency exercising administration over the wildlife resources of the state where construction will occur, with a view to the conservation of wildlife resources. The Act provides that land, water and interests may be acquired by federal construction agencies for wildlife conservation and development. In addition, real property under jurisdiction or control of a federal agency and no longer required by that agency can be utilized for wildlife conservation by the state agency exercising administration over wildlife resources upon that property.

Magnuson-Stevens Fishery Conservation and Management Act – The U.S. Congress passed the Magnuson-Stevens Fishery Conservation and Management Act in 1976. It created a 200-mile limit of U.S. control over waters once heavily fished by foreign fleets. It also set up a federal management system for fishing between three and 200 nautical miles. States continue to manage fishing out to three miles but now they must coordinate what they do with federal management. The Sustainable Fisheries Act amended the Magnuson-Stevens Act in 1996. The Sustainable Fisheries Act is a landmark piece of legislation containing strict new mandates to stop overfishing, rebuild all overfished stocks, minimize bycatch, and protect essential fish habitat.

The Magnuson Act involves power-sharing arrangements between regional management councils and the U.S. Department of Commerce. The councils write and revise fishery management plans (FMPs) and also make decisions as required by those FMPs. NOAA Fisheries provides scientific advice and reviews the plans to make sure that they meet the legal obligations of the Act. The Department of Commerce has the final say on plan approval. Approved plans are implemented by NOAA Fisheries and enforced by the U.S. Coast Guard. Congress oversees the process by regular reauthorization of the Magnuson Act and designating funding for the Councils, NOAA Fisheries, and the Coast Guard.

Migratory Bird Treaty Act - The Migratory Bird Treaty Act implements various treaties and conventions between the U.S. and Canada, Japan, Mexico and the former Soviet Union for the protection of migratory birds. Under the Act, taking, killing or possessing migratory birds is unlawful.

Columbia River Gorge National Scenic Area Act - The Columbia River Gorge National Scenic Area was created on November 17, 1986 when President Reagan signed into effect Public Law 99-663. One of the purposes of the Act is to protect and enhance natural resources including fish and wildlife. The entire Columbia Gorge Subbasin is within the Scenic Area and proposed land use is subject to review by the Forest Service to ensure consistency with the Scenic Area Management Plan.

Rivers and Harbors Act – Section 10 of the Rivers and Harbors Act requires authorization for the construction of any structure in or over any navigable water of the United States. This law applies to any dredging or disposal of dredged materials, excavation, filling, rechannelization, or any other modification of navigable water of the United States, and applies to all structures. The USACE presides over permitting, mitigation, and enforcement of Sections 10 and 13 of the Act.

Bald Eagle Protection Act - Prohibits the taking or possession of and commerce in bald and golden eagles, with limited exceptions.

Federal Non-indigenous Aquatic Nuisance Prevention and Control Act - The Non-indigenous Aquatic Nuisance Prevention and Control Act was passed on November 29, 1990, and subsequently amended by the National Invasive Species Act of 1996 (P.L. 101-646, 11/29/90, as amended through 10/26/96). It established a broad new Federal program to prevent introduction of, and to control the spread of, introduced aquatic nuisance species (Zebra mussels, mitten crab, brown mussel, ruffe, Eurasian watermilfoil, and hydrilla) and the brown tree snake. The purposes of the Nonindigenous Aquatic Nuisance Prevention and Control Act are to (ANS Task Force 1990, USFWS 1990):

- prevent unintentional introduction and dispersal of nonindigenous species into waters of the United States through ballast water management and other requirements;
- coordinate federally conducted, funded or authorized research, prevention control, information dissemination, and other activities regarding the zebra mussel and other aquatic nuisance species;
- develop and carry out environmentally sound control methods to prevent, monitor and control unintentional introductions of nonindigenous species from pathways other than ballast water exchange;
- understand and minimize economic and ecological impacts of nonindigenous aquatic nuisance species that become established, including the zebra mussel; and
- establish a program of research and technology development and assistance to States in the management and removal of zebra mussels.

The U.S. Fish and Wildlife Service, the U.S. Coast Guard, the Environmental Protection Agency, the Army Corps of Engineers, and the National Oceanic and Atmospheric Administration all were assigned major, new responsibilities, including membership on an Aquatic Nuisance Species Task Force established to develop and implement a program of prevention, monitoring, control, and study to prevent the introduction and dispersal of nonindigenous species in waters of the U.S.

National Invasive Species Act (P.L. 104-332) - This 1996 Act reauthorizes and amends the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (P.L. 101-646) (NMI 2001). The purposes of the Act are to:

- reauthorize the Great Lakes ballast management program and expands applicability to vessels with ballast tanks (as opposed to vessels which carry ballast water);
- direct vessels that enter U.S. waters after operating beyond the exclusive economic zone to undertake ballast exchange in the high seas;
- conduct ecological and ballast discharge surveys in waters highly susceptible to invasion or requiring further study and determine effectiveness of ballast management;
- consult and negotiate with foreign governments, examine ballast discharge and types of ballast practices, develop guidelines in abating invasions, and test compliance with and effectiveness of the guidelines;
- develop and maintain a clearinghouse of national data on ballasting practices, compliance with the national ballast management guidelines, and other information and to report data collected to the Task Force and Congress on a biannual basis;
- issue guidelines developed by the Task Force to control the spread of zebra mussels and other aquatic nuisance species via recreational activities, such as boating and fishing;
- implement a ballast water management program for seagoing vessels of the Department of Defense and Coast Guard;
- undertake a demonstration of technologies and practices which may prevent introduction and spread of nonindigenous species through ballast discharge;
- provide research grants to fund research on aquatic nuisance species prevention and control; and
- encourage the formation of regional panels to participate in activities to control introduction of aquatic nuisance species and to encourage and fund the development and implementation of state, interstate, or tribal invasive species management plans.

State

Oregon Forest Practices Act - The Oregon Department of Forestry enforces the Oregon Forest Practices Act (OAR 629-Division 600 to 680 and ORS 527) regulating commercial timber production and harvest on state and private lands. The Act contains guidelines to protect forests and streams in forest management activities including road maintenance, road construction, chemical application, slash burning, timber harvest, and reforestation.

Washington Forest Practices Act – The Forest Practices Act defines a plan to protect public resources while assuring that Washington continues to be a productive timber growing area. The Act regulates activities related to growing, harvesting, or processing timber on all local government, state, and private forestlands. The Act provides for a riparian space program that includes acquisition and conservation easement on lands within unconfined avulsing channel migration zones.

Oregon Removal-Fill Law - Oregon Division of State Lands, under Removal-Fill Law (ORS 196.795-990) and the U.S. Army Corps of Engineers, under Section 404 of the Clean Water Act, regulate the removal and filling of materials in wetlands and waterways. Under state law, permits are required for projects involving 50 or more cubic yards of material in wetlands and streams. Permit applications are reviewed by ODFW and may be modified or denied based on project impacts to fish. Projects that may affect ESA-listed species require consultation with NOAA Fisheries or the U.S. Fish and Wildlife Service to insure compliance with the Endangered Species Act. The Oregon Removal-Fill Law requires a permit for most removal and fill activities in areas designated by the state as essential indigenous salmonid habitat. Essential salmonid habitat is defined as the habitat necessary to prevent the depletion of native salmon and trout species during their life history stages of spawning and rearing. The designation applies to species listed as Sensitive, Threatened or Endangered by a state or federal authority.

Fishing and Harvest Regulations – Commercial fishing seasons in the mainstem Columbia River (concurrent jurisdictional waters) are established by the Columbia River Compact while Select Area commercial fishing seasons occurring in state waters are established by the regulating state. The Columbia treaty tribes regulate treaty Indian Ceremonial and Subsistence fisheries in the mainstem Columbia and tributaries. Recreational fishing regulations for the Columbia River are established separately by the management agencies of Washington and Oregon. Recreational regulations set by each state in the concurrent Columbia River waters are usually identical. All fisheries of the Columbia River are established within the guidelines and constraints of the Columbia River Fish Management Plan (CRFMP), the Endangered Species Act (ESA), and management agreements negotiated between the Parties to U.S. v. Oregon. The Columbia River Inter-Tribal Fisheries Enforcement (CRITFE) monitors tribal fisheries and enforces fishing regulations in the Columbia River between Bonneville and McNary Dams, including closures around the mouth of the Hood River.

Washington Growth Management Act – The Growth Management Act requires cities and counties to plan for growth and development through a comprehensive, coordinated, and proactive land use planning approach. The Act is adopted and implemented at the local government level.

Washington Shoreline Management Act - Provides for some tree retention within 61 m (200 ft) of the shorelines of rivers and marine waters.

Washington Bald Eagle Habitat Buffer Rule - State Legislature’s 1984 RCW 77.12.655: Habitat buffer zones for bald eagles.

Washington Fish and Wildlife Commission 1986 Bald Eagle Habitat Protection Rule - (WAC 232-12-292) provides for development of a Site Management Plan whenever activities that alter habitat are proposed near a verified nest territory or communal roost.

Oregon Water Resource Protections

- allocation of conserved water program ORS 537.470
- delivery and use of water under water exchange ORS 540.541-543

- delivery of stored water ORS 540.410
- regulation of water by watermaster ORS 540.045 to protect existing rights including instream water rights
- lease of water rights instream ORS 537.348
- transfer of water rights instream ORS 540.510;
- transfer of a surface water point of diversion to a ground water well ORS 540.53.
- public interest standards for new water withdrawals from the Columbia River under OAR Chapter 690, Division 33

Oregon Department of Fish and Wildlife Integrity Rules - Nonnative, introduced species (sometimes called "exotics"), which are brought into Oregon for a variety of reasons (e.g. commercial, recreational, domestication), are a major concern of the ODFW because of negative impacts to native fish and wildlife: competition, diseases, destruction of habitat, interbreeding, and mortality. Under state law #ORS 496.012, which prevents the serious depletion of any indigenous species, ODFW drafted rules (Oregon Administrative Rules, Division 056) to protect the integrity of Oregon's native wildlife. These rules regulate the importation, purchase, sale, exchange, transportation, holding, and confinement of prohibited and controlled nonnative wildlife (ODFW 2004f).

Washington Salmon Recovery Planning Act (SRPA, ESHB 2496) -The SRPA provides the framework for developing restoration projects. It requires a limiting factors analysis and establishes a funding program for local habitat restoration projects. It also creates the Governor's Salmon Recovery Office. As a result of this bill, an Independent Scientific Panel was created to provide scientific review for salmon recovery projects.

Washington Wild Stock Restoration Initiative (WSRI), ESHB 1309 - In 1993, Washington State adopted the WSRI and initiated a commitment to salmonid protection and recovery that has led to more recent salmon recovery legislation. Recently enacted state legislation (1998-1999) designed to guide salmon recovery in the state of Washington includes the SRPA (ESHB 2496), Watershed Planning Act (ESHB 2514), and Salmon Recovery Funding Act (2E2SSB 5595). Stock inventories were the initial commitment of state and tribal fishery managers to the WSRI that complemented and strengthened ongoing programs to protect salmonid stocks and habitats. The Salmon and Steelhead Inventory and Assessment Program (SSHIAP), an integral part of WSRI, is a partnership-based information system that characterizes freshwater and estuary habitat conditions and distribution of salmonid stocks in Washington. SSHIAP is designed to support regulatory, conservation, and analysis efforts such as Washington State Watershed Analysis, State Salmon Recovery, Habitat Conservation Planning, and EDT.

Watershed Management Act (WMA, ESHB 2514) - The 1998 Washington State Legislature passed the WMA (Chapter 90.82 RCW) to provide a framework for local citizens, interest groups, and government organizations to collaboratively identify and solve water-related issues in each of the 62 Water Resource Inventory Areas (WRIAs) in the state. The WMA enables local groups called "Planning Units" to form for the purpose of conducting watershed planning. Under the law, citizens, local governments, tribes, and other members of the Planning Unit must assess water resources and needs and recommend management strategies for the watershed. The

Planning Unit may also assess habitat, water quality and instream flow requirements. Ecology oversees the WMA (Kaputa and Woodward 2002).

Local

Klickitat County Zoning- Klickitat County zoning is guided by Ordinance No. 62678, which includes the Klickitat County Shoreline Master Plan and the Flood Plain Management Ordinance. http://www.klickitatcounty.org/Planning

Washington Critical Area Ordinances – As part of the Growth Management Act, cities and counties are required to adopt policies and regulations that protect critical areas, such as fish and wildlife habitat conservation areas, wetlands, frequently flooded areas, aquifer recharge areas, and geologically hazardous areas.

6.1.2 Existing Management Plans

Table 37 Summary of existing managment plans

Tribal	Wy-Kan-Ush-Mi Wa-Kish-Wit
Tribal/Federal/State	*U.S. v. Oregon* Columbia River Fish Management Plan
Federal	Columbia Gorge Scenic Area Management Plan
	Columbia River Basin Fish and Wildlife Plan (NPPC) (See NPCC below)
	Endangered Species Act Implementation Plan for the FCRPS
	FCRPS Biological Opinion and the Basinwide Salmon Recovery Strategy
	ESA Resource Management Systems for Dry Cropland and Range and Pastureland in Gilliam, Sherman and Wasco Counties, Oregon
	U.S. Fish and Wildlife Service 1986 Pacific States Bald Eagle Recovery Plan
State (Oregon/Washington)	Oregon Plan for Salmon and Watersheds
	Washington Statewide Strategy to Recover Salmon
	Washington Department of Fish & Wildlife's Priority Habitat and Species Management Recommendations, Volume IV: Birds
	Oregon Wildlife Diversity Plan
	Western Pond Turtle Recovery Plan
	Washington Aquatic Nuisance Species Management Plan
	Oregon Aquatic Nuisance Species Management Plan
	Oregon Invasive Species Action Plan
	Oregon Noxious Weed Strategic Plan
	Middle Columbia River Dalles Pool Area Geographic Response Plan (GRP)
	Middle Columbia River John Day Pool Area Geographic Response Plan (GRP)
	Middle Columbia River McNary Pool Area Geographic Response Plan (GRP)

Local	Gilliam County Comprehensive Plans
	Sherman County Comprehensive Plans
	Lower Deschutes Agricultural Water Quality Management Area Plan
	Klickitat County Shoreline Master Plan (see Klickitat County Zoning above)

Tribal Plans

This is the Columbia River Anadromous Fish Restoration Plan of the Nez Perce, Umatilla, Warm Springs, and Yakama Tribes (CRITFC 1996). This plan includes adult return targets for each subbasin in the Columbia Basin. Wy-Kan-Ush-Mi Wa-Kish-Wit recommends habitat restoration actions that focus on limiting, restricting, or eliminating land uses and enhancing populations with implementation of new broodstock, release and production programs. The plan was published in 1996, and habitat restoration projects emphasizing implementation of forest, range, and agricultural best management practices have been initiated in priority watersheds since 1997 through the Council's program.

Tribal/Federal/State Plans

Columbia River Fish Management Plan - The Columbia River Fish Management Plan (CRFMP) is an agreement resulting from the U.S. District Court case of U.S. V. Oregon (Case No. 68-513). This agreement between federal agencies, Indian tribes and state agencies (except Idaho) set guidelines for the management, harvest, hatchery production, and rebuilding of Columbia River Basin salmonid stocks. Appropriate harvest levels and methods were established for various levels of attainment of interim population goals for spring chinook, summer chinook, sockeye, fall chinook, summer steelhead, and coho salmon. The plan guaranteed the treaty Indian fisheries a minimum of 10,000 spring and summer chinook annually, not dependent on run size.

Federal Plans

Columbia Gorge Scenic Area Management Plan – The western portion of the Lower Mid-Columbia Mainstem subbasin is within the Scenic Area boundary. Say where boundaries are in LMM. The Federal Act establishing the Columbia River Gorge National Scenic Area mandated that each county within the Scenic Area either adopt regulations to implement the Management Plan for their portions of the Scenic Area or relinquish control of land development within the Scenic Area to the Columbia River Gorge Commission. The Columbia River Gorge National Scenic Area Management Plan (Columbia River Gorge Commission and USDA Forest Service, 1992) is implemented by the USFS and the Columbia Gorge Commission to insure that land use is consistent with the Scenic Area Act. In the Columbia Gorge Subbasin, the Scenic Area Management Plan is implemented primarily by Hood River, Wasco, Skamania, and Klickitat counties, with oversight by the Columbia Gorge Commission.

Endangered Species Act Implementation Plan for the FCRPS - The three action agencies have prepared the implementation plan in acknowledgement of responsibilities for fish protection under the Northwest Power Act and water quality protection under the Clean Water Act, and their obligations to Indian tribes under law, treaty, and Executive Order. The plan responds to the December 2000 Biological Opinions issued by the U.S. Fish and Wildlife Service and the NOAA Fisheries on the effects to listed species from operations of the Columbia River hydropower system. The plan is a five-year blueprint that organizes collective fish recovery actions by the three agencies. The plan looks at the full cycle of the fish, also known as "gravel to gravel" management or an "All-H" approach (hydro, habitat, hatcheries, and harvest). However, it describes only commitments connected to the FCRPS, not the obligations of other federal agencies, states, or private parties. The plan describes the three agencies' goals; the performance standards to gauge results over time; strategies and priorities for each H; detailed five-year action tables for each H; research, monitoring, and evaluation plan (RM&E); and expectations for regional coordination.

Biological Opinion and the Basinwide Salmon Recovery Strategy - NOAA Fisheries has recently developed several documents and initiatives for the recovery of Endangered Species Act listed Snake River steelhead, chinook and sockeye. The Federal Columbia River Power System (FCRPS) Biological Opinion (BiOp) and the Basinwide Salmon Recovery Strategy issued at the end of 2000 contain actions and strategies for habitat restoration and protection for the Columbia River Basin. Action agencies are identified that will lead fast-start efforts in specific aspects of restoration on nonfederal lands. Federal land management will be implemented by current programs that protect important aquatic habitats (PACFISH, ICBEMP). Actions within the FCRPS BiOp are intended to be consistent with or complement the Council's amended Fish and Wildlife Program and state and local watershed planning efforts.

NOAA Fisheries has also initiated recovery planning with the establishment of a Technical Recovery Team for the Interior Columbia, which includes Snake River stocks. The Technical Recovery Team will identify delisting criteria and viability criteria for populations within ESUs, identify factors that limit recovery, and identify early actions for recovery among other things. A stakeholder-based forum will develop a formal recovery plan from these products.

For federally listed resident species (bull trout in the Columbia Gorge mainstem subbasin) impacted by the FCRPS, USFWS is working with State and Tribal agencies to develop the Draft Bull Trout Recovery Plan. The goal of the recovery plan is describe actions needed to achieve the recovery of bull trout and ensure their long term persistence. Specific recovery objectives include maintaining or increasing the present distribution within core areas; maintaining stable or increasing trends in abundance; restoring and maintaining habitat conditions that are suitable for bull trout across all life history stages and strategies; and conserving genetic diversity and providing opportunity for genetic exchange.

Under the 2000 FCRPS BiOp, NOAA Fisheries expects the Bonneville Power Administration, the Corps of Engineers, and the Bureau of Reclamation to meet their ESA obligations in part through offsite mitigation. Subbasin plans will become local recovery plans or will become a substantial component of NOAA Fisheries recovery planning. The BiOp relies on subbasin plans to identify and prioritize specific actions needed to recover listed salmon and steelhead in tributary habitats. NOAA Fisheries expects subbasin plans to include implementation of the BiOp's offsite mitigation actions in the Reasonable and Prudent Alternative (RPA). Specifically, subbasin planning should provide for RPA habitat actions 149 through 163 and harvest and hatchery RPA actions 164 through 178 that pertain to and require local planning and management. NOAA Fisheries also expects subbasin plans to incorporate the research, monitoring, and effective strategies and actions, particularly those described in RPA action 179, 180, and 183.

ESA Resource Management Systems for Dry Cropland and Range and Pastureland in Gilliam, Sherman and Wasco Counties, Oregon –Under the Endangered Species Act Section

7 Formal Consultation and the Magnuson-Stevens Fishery and Conservation Management Act Essential Fish Habitat Consultation, the Natural Resources Conservation Service (NRCS), in cooperation with local Soil and Water Conservation Districts (SWCDs) and individual farm and ranch operators, proposes to develop Resource Management Systems (RMS) that will guide the completion of individual farm and ranch conservation plans for Dry Cropland and Range and Pastureland agriculture in Gilliam, Sherman, and Wasco Counties, Oregon. The objective of the consultation is to determine whether the proposed RMS plans within the Tri-County Region, Oregonz—two counties, Sherman and Gilliam are part of the Lower Mid-Columbia Mainstem—are likely to jeopardize the continued existence of 12 listed Columbia Basin salmonids or cause the destruction or adverse modification of their designated critical habitats.

The NRCS proposes to assume program responsibility for each conservation plan by providing engineering designs or other final project specifications and/or pay for all or part of the conservation practices (CPs) necessary to carry out each plan.

As part of the consultation process, NOAA Fisheries, the NRCS, and the farmers and ranch operators agreed to the characteristics that constitute the salmon quality criteria and indicators applicable to the riparian and aquatic habitats within the action area. The salmon quality criteria and indicators and their use in designing, evaluating, installing, and employing of the conservation practices that will make up each farm and ranch conservation plan are the subjects of this consultation.

Over the next five years, the NRCS proposes to develop and complete RMS plans for potentially 853,853 of the 1,141,636 acres of dry land crop and rangeland acres in Gilliam and Sherman counties. The NRCS will help to carry out these plans with technical assistance from the local SWCDs and U.S. Department of Agriculture (USDA) farm program funding. In Oregon, completion of RMS-level planning is a requirement for participation in funding from various USDA farm programs (NRCS 2002).

The salmon quality criteria are based on assessment elements used in the NRCS Stream Visual Assessment Protocol (SVAP) (USDA NRCS 1998), and range from physical habitat conditions to biotic (features of a natural, living system) indicators. While these criteria and indicators represent the health of underlying processes and, taken together, are intended to represent the full suite of minimum habitat functions necessary to conserve the ESA-listed salmon and steelhead analyzed in the Biological Opinion. Use of these criteria will also serve as an important cross-check on the potential adverse effects of management actions, under the control of farm and ranch operators, that can prevent or delay the recovery of desired aquatic habitat conditions so those actions will be modified or excluded as necessary.

The typical Dry Cropland RMS plans involves growing small grains (i.e., soft white wheat, feed barley), usually every other year on a given piece of land. Undesirable vegetation that grows into the fallowed cropland is controlled with mechanical tillage. Supporting long-term CPs such as Diversions (CP362), Terraces (CP600) or Water and Sediment Control Basins (CP638) are constructed as needed in the fields during the fallow period and/or after harvest. The long-term practices are constructed once, and then maintained for their 10 to 20 year life span. Other CPs, including Contour Buffer Strips, Conservation Cover, and Filter Strips or Grassed Waterways (CP393, 327, 393, 412, respectively), Upland Wildlife Habitat Enhancement practices (CP645, 648), including watering facilities, may be installed throughout the year.

A typical RMS plan on rangeland and pastureland in the region consists of prescribed grazing management that incorporates a deferred or rest-rotation type of animal movement to make optimal use of available forage. Prescribed grazing manages animal movements to control the timing, intensity, frequency, and duration of grazing.

Native or established vegetation on rangelands provides livestock food needs, except in winter when snow covers available forage and supplemental feeds may be necessary. Distribution of grazing across the landscape to prevent livestock from overusing stream courses and to decrease plant damage is encouraged through strategic water development and distribution.

Fencing assists in better distribution of livestock for more even use of forages, while excluding livestock (CP472) from sensitive areas such as riparian zones, newly seeded acres, or program restricted areas facilitates vegetation growth and recovery. Animal Trails and Walkways (CP575) can provide easier access to watering areas, livestock movement for rotation. Consideration for existing wildlife in forage allocations is a critical component of the final RMS plan. Seeding mixtures for range planting include species compatible with wildlife habitat needs (CP645).

The salmon quality criteria are based on these essential elements of critical salmonid habitat: (1) Substrate; (2) water quality; (3) water quantity; (4) water temperature; (5) water velocity; (6) cover/shelter; (7) food (juvenile only); (8) riparian vegetation; (9) space; and (10) safe passage conditions (50 CFR 226). Based on migratory and other life history timing, it is, likely that adult and juvenile life stages of these 12 ESA-listed salmon and steelhead would be present downstream of the Tri-County Region in the Columbia River mainstem, estuary, and plume when activities authorized by the proposed actions would be carried out. The MCR steelhead, in particular, migrates, spawns and rears throughout the Tri-County Region including the lower John Day River and lower Deschutes River.

U.S. Fish and Wildlife Service 1986 Pacific States Bald Eagle Recovery Plan - The U.S. Fish and Wildlife Service Pacific Bald Eagle Recovery Plan (1986) includes recommendations for managing habitat and human disturbance and applies to the states of California, Idaho, Montana, Nevada, Oregon, Washington, and Wyoming. Federal permits for projects that may affect bald eagle habitat must be reviewed by the U.S. Fish and Wildlife Service.

State Plans

Oregon Plan for Salmon and Watersheds - Approved by the Oregon legislature in 1997, Oregon Plan for Salmon and Watersheds and the 1998 Steelhead Supplement outlines a statewide approach to ESA concerns based on watershed restoration, ecosystem management, coordination among state agencies, and local solutions to protect and improve salmon and steelhead habitat. The Oregon Watershed Enhancement Board provides grant funds and technical support for watershed groups and others to help implement the Oregon Plan locally.

Washington Statewide Strategy to Recover Salmon – Created by the Washington Governor’s Salmon Recovery Office and Joint Natural Resources Cabinet, this plan describes how Washington’s state agencies and local governments can work together to address habitat, harvest, hatcheries, and hydropower issues as they relate to recovery of listed species.

Washington Department of Fish & Wildlife's Priority Habitat and Species Management Recommendations, Volume IV: Birds - In Washington, landowners who are pursuing land-use changes (e.g., tree-cutting, construction activities) in the vicinity of bald eagle nesting or roosting areas may be required to obtain management plans in order to ensure their new land-use activities comply with bald eagle protection laws. This document contains a description of bald eagle management plans, and the basic elements they address (Watson and Rodrick 2001).

Oregon Wildlife Diversity Plan - The Oregon Fish and Wildlife Commission adopted the Oregon Wildlife Diversity Plan in November 1993 and updated it in January 1999. This plan sets forth the Goal, Objectives, Strategies, Sub-strategies, and Program Priorities for the Oregon Department of Fish and Wildlife's Wildlife Diversity (formerly Nongame) Program. Although the focus of this plan is on nongame species, it addresses all fish and wildlife species, both game and nongame.

In addition to being a policy document to guide the actions of the Oregon Department of Fish and Wildlife, the Oregon Wildlife Diversity Plan is also a reference document containing: history of Oregon’s non-game program and accomplishments; biological information on all fish and wildlife species in the state; habitat information, organized by Oregon's 10 physiographic provinces; summaries of state and federal laws and programs affecting fish and wildlife and their habitats; lists of endangered, threatened, and sensitive species; economic considerations; and the official Oregon list of Neotropical Migratory Birds (ODFW 1993).

Western Pond Turtle Recovery Plan - The recovery plan identifies WDFW recovery goals for three populations of western pond turtle in the Bonneville Pool. Each of the three populations must reach at least 200 animals and meet conservation targets for age structure, reproduction, and habitat security.

Washington Aquatic Nuisance Species Management Plan - The development of a state management plan is called for in Section 1204 of the National Invasive Species Act of 1996 (Appendix A), which provides an opportunity for federal cost–share support for the implementation of state plans approved by the National Aquatic Nuisance Species Task Force. The Washington State Plan was published in 1998 and is revised periodically. The Washington ANS Management Plan is focused on the identification of feasible, cost effective management practices to be implemented in partnership with tribes, private, and public interests for the environmentally sound prevention and control of ANS. The management actions outlined in the 1998 plan concentrated on stopping the spread of ANS already present, and minimizing the risk of further ANS introductions (i.e. both accidental and intentional introductions) into Washington waters through all known pathways, particularly animal species. This revision (WDFW 2001) identifies new and ongoing actions and broadens the focus to address more species.

Oregon Aquatic Nuisance Species Management Plan - The federal Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 amended by the National Invasive Species Act of 1996 calls for the development of state and regional management plans to control aquatic nuisance species. The Oregon management plan addresses specific aquatic nuisance species, provides a management framework, and sets objectives and actions to prevent and reduce the impact of aquatic nuisance species in Oregon. The goal of the Plan is to: Minimize the harmful ecological, economic, and social impact of ANS through prevention and management of introduction, population growth, and dispersal of ANS into, within, and from Oregon. The Plan includes a system to classify all nonindigenous species in Oregon, identifies the proper management for each class, details current authorities and programs, and sets objectives that will lead to the accomplishment of the Plan goal. These objectives include the establishment of a management structure that coordinates ANS activities, a strong prevention program, a monitoring program that allows for the early detection and eradication of pioneering ANS, a control program aimed at established species, education, and research (Hanson and Sytsma 2001).

Oregon Invasive Species Action Plan – This Plan was developed by the Oregon Invasive Species Council in response to a directive from the Oregon Legislature (ORS 561.685). The Plan is designed to improve Oregon's defenses against invasive species (e.g. Micro-Organisms, Aquatic and Land Plants, Aquatic and Land Invertebrates, Fish, Birds, and Mammals). It includes a detailed description of the impact of invasive species in Oregon, lists the most dangerous invaders, potential economic impacts, and provides information on the Oregon Invasive Species Council (OISC 2003).

Oregon Department of Agriculture - Oregon Noxious Weed Strategic Plan - In response to the 1999 House Bill #2118, this document provides a framework and overall strategy for cooperators in noxious weed management. It assesses the magnitude of the problem, highlights the importance of current weed control activities, and offers recommendations. Implementation of this strategic plan will build and expand strong coordinated programs for the future to protect Oregon's agricultural economy and natural resources. Priority activities recommended by this plan are the following: Establish strong statewide, county, and local weed control programs; identify new invaders and potential threats to the state; implement early detection and eradication programs and effective containment projects; develop cooperation and partnerships; provide and implement biological control; prioritize and implement effective projects; and provide leadership, quality inventory and mapping information, funding, assistance to public and private land managers, and education (increasing awareness) to public and private sectors; develop cooperation and partnerships (ODA 2001).

Middle Columbia River Dalles Pool Area Geographic Response Plan (GRP) – This GRP identifies and ranks oil spill protection strategies for sensitive natural resources within the Dalles Pool area of the Columbia River and allows for immediate and proper action. The strategies provide instructions for deployment of a protective boom (a floating barrier to the oil) and collection to contain or collect spilled oil. The GRP prioritizes public natural resources to be protected and allows for immediate and proper action (Northwest Area Committee 2004a).

Middle Columbia River John Day Pool Area Geographic Response Plan (GRP) – This GRP identifies and ranks oil spill protection strategies for sensitive natural resources within the John Day Pool area of the Columbia River and allows for immediate and proper action. The strategies provide instructions for deployment of a protective boom (a floating barrier to the oil) and collection to contain or collect spilled oil. The GRP prioritizes public natural resources to be protected and allows for immediate and proper action (Northwest Area Committee 2004b).

Middle Columbia River McNary Pool Area Geographic Response Plan (GRP) – This GRP identifies and ranks oil spill protection strategies for sensitive natural resources within the McNary Pool area of the Columbia River and allows for immediate and proper action. The strategies provide instructions for deployment of a protective boom (a floating barrier to the oil) and collection to contain or collect spilled oil. The GRP prioritizes public natural resources to be protected and allows for immediate and proper action (Northwest Area Committee 2004c).

Other Plans

Gilliam and Sherman County Comprehensive Land Use Plans – Gilliam 1969-[ongoing], Sherman 1968-1994 – These series of reports document the development and revision of plans for the use of lands within the Sherman and Gilliam counties. They include plans for transportation, energy, housing, population and economics, public facilities and services, urbanization, natural resources, greenways, recreation, agricultural and forest lands, land capability, resource quality, floodplains, landmarks, historic property, rural community center designation, and natural areas. Each plan includes background information about the subject; supporting documentation such as maps, charts, and diagrams; and a narrative description of each aspect of the plan and how it is to be implemented. Reports may also include overall "comprehensive plans" for Sherman and Gilliam counties, which contain both historical and current looks at county land practices and define goals and policies adhered to during the creation and implementation of the plans (OSA 004).

Lower Deschutes Agricultural Water Quality Management Area Plan - This June 2000 plan covers the Spanish Hollow drainage and was developed by the Lower Deschutes Local Advisory Committee with assistance from Oregon Department of Agriculture and Wasco County Soil and Water Conservation District. This area plan applies to agricultural activities on all non-federal and non-tribal agricultural, rural and forest lands in the Lower Deschutes Agricultural Water Quality Management Area. This Management Area consists of 1) all lands drained by the Deschutes River and its tributaries downstream but not inclusive of the Trout Creek drainage and 2) all streams flowing into the Columbia between the Hood River drainage and the John Day Basin

6.1.3 Existing Management Programs

Table 38 Summary of existing management programs

Tribal	Confederated Tribes of the Umatilla Indian Nation
	Confederated Tribes of the Warm Springs Reservation of Oregon
	Nez Perce Tribe
	Yakama Indian Nation
	Columbia River Inter-Tribal Fish Commission
Federal	National Oceanic Atmospheric Administration Fisheries
	National Marine Fisheries Service
	U.S. Fish and Wildlife Service
	U. S. Environmental Protection Agency
	U.S. Army Corps of Engineers
	Northwest Power and Conservation Council
	Bonneville Power Administration
	Bureau of Land Management
	Natural Resource Conservation Service
	Conservation Innovation Grants (CIG)
	Conservation Reserve Program (CRP)
	Continuous Conservation Reserve Program (CCRP)
	Environmental Quality Incentives Program (EQIP)
	Public Law 566 Small Watershed Program (PL 566)
	Wetlands Reserve Program (WRP)
	Wildlife Habitat Incentive Program (WHIP)
State (Oregon/Washington)	Oregon Department of Environmental Quality
	Washington Department of Ecology
	Columbia River Initiative
	Washington Water Resources Inventory Areas
	Oregon Department of Fish and Wildlife
	Oregon Watershed Enhancement Board
	Washington Department of Fish and Wildlife
	Washington Salmon Recovery Funding Board
	Oregon Department of Forestry
	Oregon Department of Transportation

	Washington Department of Transportation
	Oregon Division of State Lands
	Washington Department of Natural Resources
	Oregon Department of Agriculture
	Washington Department of Agriculture
	Washington Conservation Commission
	Enforcement of Hunting and Fishing Regulations
	Land Conservation and Development Commission
	Oregon Invasive Species Council
Local	Gilliam Soil and Water Conservation District, Oregon
	Sherman County Soil and Water Conservation District, Oregon
	North Sherman County Watershed Council, Oregon
	Fulton and Gordon Canyons Watershed Council, Sherman County, Oregon
	Klickitat County, Washington, Citizens Review Committee, Lead Entity for Salmon Recovery

Tribal Programs

The Nez Perce Tribe, the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes of the Warm Springs Reservation of Oregon, and the Confederated Tribes and Bands of the Yakama Indian Nation are the only tribes in the Columbia Basin to have reserved rights to anadromous fish in 1855 treaties with the United States. Each of the four tribes is a co-manager of state fisheries resources along with Oregon Department of Fish and Wildlife and the Washington Department of Fish and Wildlife. The Four Tribes coordinate participation in fisheries management through the Columbia River Inter-Tribal Fish Commission.

Federal Programs

National Oceanic Atmospheric Administration Fisheries - The National Oceanic Atmospheric Administration (NOAA) Fisheries administers the federal Endangered Species Act as it pertains to anadromous fish. Under section seven of the ESA, federal agencies are required to consult with NOAA Fisheries regarding any actions they fund, authorize, or conduct that may affect listed salmon and steelhead. NOAA Fisheries reviews and comments on fill/removal permit applications on streams with anadromous salmonids and on any hydroelectric project proceedings where anadromous fish are involved.

National Marine Fisheries Service - NMFS provides management, research, and other federal services for protection and use of marine resources and administers the ESA as it pertains to anadromous fish. Two listed ESUs migrate through the Columbia River: upper Columbia River spring Chinook salmon and upper Columbia River steelhead.

Under Sections 7 and 10 of the ESA, “take” of listed species is prohibited and permits are required for handling. Recovery actions for listed species also require Fisheries Management and Evaluation Plans.

U.S. Fish and Wildlife Service - The U.S. Fish and Wildlife Service is the principal Federal agency responsible for conserving, protecting and enhancing fish, wildlife and plants and their habitats for the continuing benefit of the American people. The Service manages the National Wildlife Refuge System, National Fish Hatchery System, fishery resource offices, and ecological services field stations. The Service enforces Federal wildlife laws, administers the Endangered species Act, manages migratory bird populations, restores nationally significant fisheries, conserves and restores wildlife habitat such as wetlands, and helps foreign governments with their conservation efforts. It also oversees the Federal Aid program that distributes hundreds of millions of dollars in excise taxes on fishing and hunting equipment to state fish and wildlife agencies.

The U. S. Fish and Wildlife Service also implements the Environmental Contaminants Program, which applies to all watersheds within the Columbia River Basin. The Environmental Contaminants program conducts studies that help reveal the health of terrestrial and aquatic ecosystems. Wildlife and fish populations are assessed for the health of their habitats, populations and individual organisms. The purpose is to identify and prevent the harmful effects of contaminants on fish and wildlife, and to restore resources degraded by contamination.

U. S. Environmental Protection Agency - The mission of the Environmental Protection Agency is to protect human health and the environment. Primary EPA activities include developing and enforcing regulations, performing environmental research, and further environmental education.

U.S. Army Corps of Engineers - The U.S. Army Corps of Engineers operates and maintains Bonneville and The Dalles locks and dams for hydropower production, fish and wildlife protection, recreation and navigation. The USACE is the lead agency for operation of fishways and monitoring fish passage.

Northwest Power and Conservation Council - The Northwest Power and Conservation Council develops and maintains a regional power plan and a Columbia River Basin Fish and Wildlife Program to balance the Northwest's environment and energy needs. The Council is responsible for developing a 20-year electric power plan that guarantees adequate and reliable energy at the lowest economic and environmental cost to the Northwest, developing a program to protect and rebuild fish and wildlife populations affected by hydropower development in the Columbia River Basin, and educating and involving the public in the Council's decision-making process. The Council works to protect, mitigate, and enhance fish and wildlife of the Columbia River and guides Bonneville Power Administration's funding of projects to implement the Fish and Wildlife program.

Bonneville Power Administration - The BPA is a federal agency established to market power produced by the federal dams in the Columbia River Basin. The BPA provides funding for fish and wildlife protection and enhancement to mitigate for the loss of habitat resulting from hydroelectric construction and operations.

Bureau of Land Management - The Bureau of Land Management (BLM) manages lands in the Lower Mid-Columbia Mainstem subbasin. The lands are managed for multiple uses including habitat for native wildlife.

The BLM continues to protect and manage riparian habitat in the Subbasin to enhance riparian habitat and water quality from season-long livestock grazing. Protection allows for proper functioning of healthy riparian systems including silt and sediment entrapment, aquifer recharge, erosion abatement, and fish and wildlife habitat.

The BLM also acquires and manages shrubsteppe habitat for shrubsteppe obligate species including Washington ground squirrel and sage grouse. This project is meant to improve the condition of shrubsteppe habitat and restore degraded and converted cropland. Restoration and management activities include improving grazing management practices through rotational grazing and reduced stocking rates; controlling weeds through spraying and vehicle management (road closures); collecting native grass seeds to create commercially available seed sources; and developing and testing land treatment methods (e.g., mowing, herbicide application, plowing, seeding) to establish native shrubsteppe plant communities on degraded and converted lands.

Natural Resources Conservation Service - One of the purposes of the NRCS is to provide consistent technical assistance to private land users, tribes, communities, government agencies, and conservation districts. The NRCS assists in developing conservation plans, provides technical field-based assistance including project design, and encourages the implementation of conservation practices to improve water quality and fisheries habitat. Programs include the CRP, River Basin Studies, Forestry Incentive Program, Wildlife Habitat Improvement Program, the Environmental Quality Incentives Program, and Wetlands Reserve Program. The USDA Farm Services Administration (FSA) and the NRCS administer and implement the federal CRP and Continuous CRP.

Conservation Innovation Grants (CIG)

CIG is a voluntary program intended to stimulate the development and adoption of innovative conservation approaches and technologies while leveraging federal investment in environmental enhancement and protection, in conjunction with agricultural production. Under CIG, EQIP funds are used to award competitive grants to non-federal governmental or non-governmental organizations, Tribes, or individuals. CIG enables NRCS to work with other public and private entities to accelerate technology transfer and adoption of promising technologies and approaches to address some of the Nation's most pressing natural resource concerns. CIG will benefit agricultural producers by providing more options for environmental enhancement and compliance with federal, state, and local regulations. The USDA oversees CIG and the NRCS administers the program.

Conservation Reserve Program (CRP)

The CRP provides technical and financial assistance to eligible farmers and ranchers to comply with federal, state, and tribal environmental laws and to address soil, water, and related natural resource concerns on their lands in an environmentally beneficial and cost-effective manner. The program is funded through the Commodity Credit Corporation. CRP is administered by the Farm Service Agency, with NRCS providing technical land eligibility determinations, Environmental Benefit Index Scoring, and conservation planning (Bareither, pers. comm., 2004).

The enrollment of agricultural land with a previous cropping history into CRP has removed highly erodible land from commodity production. The land is converted into permanent herbaceous or woody vegetation to reduce soil and water erosion. Farmers receive an annual rental payment for the term of the contract (Bareither, pers. comm., 2004), a maximum of 10 years (the contracts may be extended). Cover Practices that occur under CRP include planting introduced or native grasses, wildlife cover, conifers, filter strips, grassed waterways, riparian forest buffers, and field windbreaks. There are 209,206 acres of CRP in Klickitat (WA.), Gilliam and Sherman (OR.) counties combined.

CRP contract approval is based, in part, on the types of vegetation landowners are willing to plant. Cover Practice planting combinations are assigned points based on the potential value to wildlife. For example, cover types more beneficial to wildlife are awarded higher scores. Seed mixes containing diverse native species generally receive the highest scores (FSA 2003).

CRP and associated cover practices that emphasize wildlife habitat increase the extent of shrubsteppe-like habitat, provide connectivity/corridors between extant native shrubsteppe and other habitat types, reduce habitat fragmentation, increase landscape habitat diversity and edge effect, reduce soil erosion and stream sedimentation, and provide habitat for wildlife species.

Continuous Conservation Reserve Program (CCRP)

The CCRP focuses on the improvement of water quality and riparian areas. Practices include shallow water areas with associated wetland and upland wildlife habitat, riparian forest buffers, filter strips, grassed waterways and field windbreaks. Enrollment for these practices is not limited to highly erodible land, as is required for the CRP, and carries a longer contract period (10 - 15 years), higher installation reimbursement rate, and higher annual annuity rate.

Environmental Quality Incentives Program (EQIP)

The EQIP was established in the 1996 Farm Bill and was reauthorized in the Farm Security and Rural Investment Act of 2002 (Bareither, pers. comm., 2004). The EQIP is administered and implemented by the NRCS and provides technical, educational, and financial assistance to eligible farmers and ranchers to address soil, water, and related natural resource concerns on their lands in an environmentally beneficial and cost-effective manner. The program assists farmers and ranchers with federal, state, and tribal environmental compliance, and encourages environmental stewardship. The program is funded through the Commodity Credit Corporation.

Program goals and objectives are achieved through the implementation of a conservation plan that incorporates structural, vegetative, and land management practices on eligible land. Eligible producers commit to 5 to 10-year contracts. Cost-share payments are paid for implementation of one or more eligible structural or vegetative practices such as animal waste management facilities, terraces, filter strips, tree planting, and permanent wildlife habitat. Furthermore, incentive payments are made for implementation of one or more land management practices such as nutrient management, pest management, and grazing land management.

Public Law 566 Small Watershed Program (PL 566)

PL 566 can be leveraged with other federal, state, or local program funds to provide wildlife and fisheries protection. Soil and water conservation districts using other project funding sources leverage NRCS program resources in combination to concentrate conservation within watersheds of concern.

Wetlands Reserve Program (WRP)

This voluntary program is designed to restore wetlands. Participating landowners can establish permanent or 30-year conservation easements, or they can enter into restoration cost-share agreements where no easement is involved. In exchange for establishing a permanent easement, the landowner receives payment up to the agricultural value of the land and 100 percent of the restoration costs for restoring the wetlands. The 30-year easement payment is 75 percent of what would be provided for a permanent easement on the same site and 75 percent of the restoration cost. The voluntary agreements are a minimum of 10 years in duration and provide for 75 percent of the cost of restoring the involved wetlands. The goal of NRCS is to achieve the greatest wetland functions and values, along with optimum wildlife habitat, on every acre enrolled in the program (Bareither, pers. comm., 2004). This program establishes wetland protection and restoration as the primary land use for the duration of the easement or agreement (Ashley and Stovall 2004) and establishes long-term conservation and wildlife practices and protection (Bareither, pers. comm., 2004). There are no Wetland Reserve Program projects within the Subbasin.

Wildlife Habitat Incentive Program (WHIP)

The WHIP is administered and implemented by NRCS and provides financial incentives to develop wildlife habitat on private lands. Participants agree to implement a wildlife habitat development plan and NRCS agrees to provide cost-share assistance for the initial implementation of wildlife habitat development practices. The NRCS and program participants enter into a cost-share agreement for wildlife habitat development. This agreement generally lasts a minimum of 10 years.

State Programs

Oregon Department of Environmental Quality - The Oregon Department of Environmental Quality (ODEQ) is required by the Federal Clean Water Act to establish water quality standards to protect the beneficial uses of the State’s waters. Based on the water quality standards, ODEQ is then required to: identify stream segments where the standards are not being met; develop a list of these water-quality limited water bodies (called the 303(d) list from Section 303(d) of the Clean Water Act); and develop a Total Maximum Daily Load (TMDL) allocation for each water body included on the 303(d) lists. The TMDL describes the maximum amount of pollutants (from all sources) that may enter a specific water body without violating water quality standards.

The Department of Environmental Quality administers the EPA 319 Non-Point Source (319) Program in the State of Oregon. The 319 Program provides up to 60% cost-share for projects targeting nonpoint source water pollution issues. 319 funds are for implementation activities, including monitoring used to support TMDL development, implementation and measuring progress toward achieving TMDL allocations.

Washington Department of Ecology - Washington's principal environmental management agency. Their mission is to protect, preserve and enhance Washington's environment, and promote the wise management of our air, land and water for the benefit of current and future generations. Department goals are to prevent pollution, clean up pollution, and support sustainable communities and natural resources.

Columbia River Initiative

Conservation and fishing advocates have argued that for over a century Washington state has managed the Columbia River without knowing how much water should be left in the river and how much was actually being taken out. In 1999, a petition was filed with the Department of

Ecology by the Center for Environmental Law and Policy and American Rivers, seeking a moratorium on additional water withdrawals until Ecology determined how much water needs to be kept in the river to protect salmon and steelhead and water quality.

This promted a request by Ecology to the National Research Council to to analyze how much water should be kept in the Columbia to protect the river's salmon and steelhead (most are protected under the ESA), and to provide advice regarding salmon and water management decisions. The National Research Council reviewed and evaluated existing scientific data and analyses related to fish species listed under the ESA in the Columbia River basin, and reviewed and evaluated environmental parameters critical to the survival and recovery of listed fish species. The cumulative effects and the risks to the survival of listed fish species of potential future water withdrawals of between approximately 250,000 acre-feet and 1,300,000 acre-feet per year were also evaluated. In addition, the effects of proposed management criteria, specific diversion quantities, and specific features of potential water management alternatives provided by the State of Washington were to be evaluated.

The NRC's resulting report, *Managing the Columbia River: Instream Flows, Water Withdrawals, and Salmon Survival* (2004), is an essential building block in the Department of Ecology's effort to establish new rules for issuing water rights from the Columbia River, a process known as the Columbia River Initiative. The purpose of the Columbia River Initiative is to develop a state water-management program for the Columbia River that: allows the basin's economy to grow, diversify, and be sustained; reflects scientifically sound information; reduces the risks to fish and maintains healthy watersheds. The Initiative involves two main ideas: 1) Securing and dedicating water to the Columbia River mainstem that will benefit fish and will allow the state to authorize new off-stream uses that are mitigated by this water; 2) State investment to secure the water, offset by annual mitigation payments from new water users.

Ecology is currently working on a comprehensive implementation package that will include: negotiated agreements with the Bureau of Reclamation, the Columbia Basin irrigation districts, the Colville Tribes and others to secure water; an executive request policy bill allowing for full legislative consideration of this approach; a substantial budget initiative to fund water acquisition and to begin to move towards new off-channel storage; and, a proposed draft rule to implement the policy bill and to comply with the terms of our legal settlement with the Columbia Snake irrigators.

The State's proposal offers a pragmatic and responsible approach for securing water in a timely and affordable manner. It addresses water needs during drought years, considers future storage capabilities, and recommends funding for water conservation and water acquisition programs.

Washington Water Resources Inventory Areas – The WRIA program is responsible for Washington's watershed planning and is managed by the Department of Ecology. Also see Watershed Management Act (WMA, ESHB 2514) in State Laws. Watershed planning focuses on assessing all aspects of water quantity and quality in the state's designated 62 watersheds. Planning has commenced in the Rock, Pine and Glade Creek watersheds (WRIA 31), but is not expected to produce reports until 2007.

Oregon Department of Fish and Wildlife - Oregon Department of Fish and Wildlife (ODFW) is responsible for protecting and enhancing Oregon's fish and wildlife and their habitats for use and enjoyment by present and future generations. Management of the fish and wildlife and their habitats in the Columbia Gorge subbasin is guided by ODFW policies and federal and state legislation. ODFW policies and plans that pertain to the subbasin include the Natural Production Policy (OAR 635-07-521 to 524), The Native Fish Conservation Policy (635-007-0502 to 0505), and Oregon Guidelines for Timing In-Water Work to Protect Fish and Wildlife Resources. These plans present systematic approaches to conserving aquatic resources and establishing management priorities within the subbasin.

Oregon Watershed Enhancement Board – OWEB is a state agency led by a policy oversight board. Together, they promote and fund voluntary actions that strive to enhance Oregon's watersheds. The Board fosters the collaboration of citizens, agencies, and local interests. OWEB's programs support Oregon's efforts to restore salmon runs, improve water quality, and strengthen ecosystems that are critical to healthy watersheds and sustainable communities. OWEB administers a grant program that awards more than $20 million annually to support voluntary efforts by Oregonians seeking to create and maintain healthy watersheds. To accomplish this OWEB funds projects that restore, maintain, and enhance the state's watersheds; supports the capacity of local watershed-based citizen groups to carry out a variety of restoration projects; promotes citizen understanding of watershed needs and restoration ideas; provides technical skills to citizens working to restore urban and rural watersheds; and monitors the effectiveness of investments in watershed restoration. http://www.oweb.state.or.us/

Washington Department of Fish and Wildlife - Washington Department of Fish and Wildlife manages land for fish, wildlife, and recreation needs. The Department is mandated to preserve, protect, and perpetuate fish and wildlife and their habitat. A goal of the Department is to encourage and assist local governments in adopting policies and regulations to protect fish and wildlife habitat. The Priority Habitats and Species Program is the principal means by which the Department provides important fish, wildlife, and habitat information to local governments, state and federal agencies, private landowners and consultants, and tribal biologists for land use planning purposes. The Department also provides a partnership-based information system that characterizes freshwater and estuary habitat conditions and distribution of salmonid stocks in Washington.

Washington Salmon Recovery Funding Board - In 1999 the Legislature created the Salmon Recovery Funding Board. Composed of five citizens appointed by the Governor and five state agency directors, the Board brings together the experiences and viewpoints of citizens and the major state natural resource agencies. The Board provides grant funds to protect or restore salmon habitat and assist related activities. It works closely with local watershed groups known as lead entities. SRFB has helped finance over 500 projects. Its mission "supports salmon recovery by funding habitat protection and restoration projects. It also supports related programs and activities that produce sustainable and measurable benefits for fish and their habitat." http://www.iac.wa.gov/srfb/

Oregon Department of Forestry - The Oregon Department of Forestry regulates forest management activities on non-federal lands. The Oregon Forest Practices Act (ORS 527 and administrative rules division 629-600 through 629-680) regulates forest management activities including harvesting, road construction, slash burning, chemical application and reforestation. The rules contain a large body of water protection rules (OAR 629-635 through 629-660) based on current science that reflect the best management practices required by operators when conducting cultural practices in the forest. These guidelines include mandatory stream buffers and riparian management areas, as well as protection to small tributaries important for maintaining cool water temperature downstream.

Oregon Department of Transportation - The Oregon Department of Transportation (ODOT) maintains state highways in the Columbia Gorge subbasin. Bridges and culverts, as they are upgraded or replaced, must meet guidelines designed to protect fish and fish habitat. In particular, guidelines are specified in the 4d Rule for threatened Mid-Columbia steelhead, written by NOAA Fisheries.

Washington Department of Transportation - The Environmental Services Department of the Department of Transportation is responsible for implementation of the department's transportation services with consideration of environmental resources. The goal of the program is to ensure that fish have access to available functional habitat for spawning, rearing, and migration. The Biology Branch addresses issues involved with the Endangered Species Act, Fish Passage, Wetland Mitigation, and Wetland Monitoring. The Compliance Branch addresses regulatory compliance with the National Environmental Policy Act (NEPA) and administers the Advance Environmental Mitigation Revolving Account for watershed management. Compliance also addresses flood management and hydrogeology, stormwater management, and NPDES. The Resource Branch addresses cultural resources, hazardous materials, water quality and erosion control, and air quality.

Oregon Division of State Lands - Oregon Division of State Lands is responsible for regulating the removal and fill of materials in natural waterways. Permitted fill or removal activities are required to be consistent with instream work periods established by ODFW.

Washington Department of Natural Resources - The Department of Natural Resources manages state-owned lands for various resource uses. These include preservation, mineral extraction, commercial and industrial development, dredged material disposal, and recreational development. The Department has a Habitat Conservation Plan (HCP) in place with the U. S. Fish and Wildlife Service that incorporates restoration, protection, and maintenance of existing habitat. The Department manages the Riparian Management Zone (RMZ) under the HCP for all Washington State lands. The Department oversees 2.2 million acres of forested trust lands, which include requirements for the RMZ on certain water types affected by timber harvest activities. The goal of the Department’s Aquatic Land Management Program is to restore and maintain riparian habitat on non-federal forestland, while meeting the requirements of the Clean Water Act, and supporting a harvestable supply of fish.

Oregon Department of Agriculture - The DOA regulates the importation of some exotic animal species and administers the Oregon ESA for plants through its conservation Biology Program. It also administers laws for the destruction, eradication, or control of predatory animals (ODFW 1993).

Washington Department of Agriculture - The goal of the Department of Agriculture’s Water Quality Protection Program is to work together with the agricultural community and regulators to protect water resources. The program addresses a variety of surface and ground water issues that involve fertilizers and pesticides. The Department is also evaluating current pesticide use practices in conjunction with pesticide residue data in surface waters that provide habitat for ESA-listed species.

Washington Conservation Commission - The WSCC supports conservation districts in Washington, promoting conservation stewardship by funding natural resource projects. The WSCC provides basic funding to conservation districts as well as implementation funds, professional engineering grants, and Dairy Program grants and loans to prevent the degradation of surface and ground waters. The Agriculture Fish and Water Program (AFWP) is a collaborative process aimed at voluntary compliance. The AFWP involves negotiating changes to the existing NRCS Field Office Technical Guide and the development of guidelines for irrigation districts to enhance, restore, and protect habitat for endangered fish and wildlife species, and address state water quality needs. This two-pronged approach has developed into two processes, one involving agricultural interests and the second concerning irrigation districts across the state.

Enforcement of Hunting and Fishing Regulations - Oregon State Police (OSP) and Washington Department of Fish and Wildlife enforce fishing and hunting regulations in the subbasin with special attention to ESA-listed salmonids through covert and overt patrols, and routine checks for licenses, tags, bag limits, weapon/gear type, area, season, and other regulations. Two Fish and Wildlife Law Enforcement Officers are based in Hood River, one of which is funded by the Oregon Plan for Salmon and Watersheds. The officers are part of a regional team of 7 covering a 5-county area. The Columbia River Inter-Tribal Fisheries Enforcement (CRITFE) monitors tribal fisheries and enforces fishing regulations in the Columbia River between Bonneville and McNary Dams.

Land Conservation and Development Commission - The Land Conservation and Development Commission regulates land use on the state level in Oregon. County land-use plans must comply with statewide land-use goals. Land-use plans have been helpful in protecting fish habitat, particularly by curtailing excessive development along streams.

Oregon Invasive Species Council - Oregon's Invasive Species Council was created by the Oregon legislature (ORS 561.685). The council began work on January 1, 2002, and is directed to conduct a coordinated and comprehensive effort to keep invasive species out of Oregon and to eliminate, reduce, or mitigate the impacts of invasive species already established in Oregon. This includes the following tasks: create and publicize a system for reporting sightings of invasive species and referring those reports to the appropriate agency, undertake educational activities to increase awareness of invasive species issues, create a statewide plan for dealing with invasive species, and administer a trust account for funding eradication and education projects. The council consists of the following members: Oregon Department of Agriculture, Portland State University, Oregon Department of Fish & Wildlife, and the Sea Grant College of Oregon State University, as well as eight at large members (two-year terms) from federal, state, and local governments, universities, industry and other groups having an interest in invasive species (OISC 2003).

Local Programs

Gilliam Soil and Water Conservation District – The Gilliam Soil and Water Conservation District was formed under the Oregon State Statues. Chapter 586. Section 210-800. The referendum was held on April 22, 1946. The district boundaries are the same as the Gilliam County boundaries.

The district was formed to provide technical assistance to farmers and ranchers in the district area. Original objectives included research needs, special equipment needs, trials on new grass and legume varieties, and technical assistance on conservation. Current objectives also include soil erosion and improving water conservation and quality. Natural resource concerns (problems, issues, needs) for Gilliam County include: Soil Condition (soil tilth and organic matter), wind Erosion, sheet and rill erosion, plant condition (productivity, health, and vigor), concentrated flow, wildlife habitat (cover and/or shelter), aquatic habitat (sediment delivery), streambank erosion, nutrient management (inorganic and organic), water quality, irrigation induced erosion, and weed control.

Gilliam's County SWCD mission is to provide support for economic sustainability for the rural community and to educate and assist the community for conservation while maintaining soil and water erosion for the future. As a small community they are able to work with one another and help each other with assistance from their district directors, OSA, NRCS, OACD, and the Watershed Council.

The seven locally elected directors who serve without pay administer the conservation programs. The directors are landowners, managers, operators and residents of Gilliam County. Directors serve four years to direct the available technical service needed to accomplish the district's long-term annual objective.

Sherman County Soil and Water Conservation District, Oregon – The Sherman County Soil and Water Conservation District (SWCD) was formed in 1950. The District is responsible for protecting and promoting the natural resources within its boundaries. Their goals are to efficiently deliver treatments to the ground, reduce soil erosion, improve water quality, enhance and restore watersheds (in conjunction with Senate Bill 1010 and The Oregon Plan), secure funding for on-the-ground projects, provide education regarding natural resources and conservation, develop and implement agricultural water quality management plans for the lower Deschutes and lower John Day rivers, and act as a buffer between government agencies and landowners whenever needed (Sherman County SWSD 2004a).

North Serman County Watershed Council, Oregton - The North Sherman County Watershed Council was established in December 2001, to address watershed management issues. The council works to improve water quality in the area's streams by reducing soil erosion and flood damage through effective resource planning. A Watershed Action Plan has been developed for North Sherman County watershed, and the council is actively in search of funding for monitoring and implementation of the plan. The council seeks support and cooperation from the Sherman County Court, the Sherman County Soil and Water Conservation District, and other interested agencies or individuals in developing and implementing the Plan (Sherman County SWCD 2004b).

Fulton and Gordon Canyons Watershed Council, Sherman County, Oregon - The Fulton and Gordon Canyons Watershed Council was formed in April 1997, to address watershed management issues. The council works to improve water quality in the area's streams by reducing soil erosion and flood damage through effective resource planning. A Watershed Action Plan has been developed for Fulton and Gordon Canyons watershed, and the council is actively in search of funding for monitoring and implementation of the plan. The council seeks support and cooperation from the Sherman County Court, the Sherman County Soil and Water

Conservation District, and other interested agencies or individuals in developing and implementing the Plan (Sherman County SWCD 2004b).

Klickitat County, Washington, Citizens Review Committee, Lead Entity for Salmon Recovery - Lead entities are voluntary organizations under contract with WDFW to see that the best projects are proposed to the Salmon Recovery Funding Board (SRFB) for funding in its annual grant process. All lead entities have a set of technical experts that assist in development of strategies, and identification and prioritization of projects. The lead entity citizen committee is responsible under state law for developing the final prioritized project list and submitting it to the SRFB for funding consideration. Lead entity technical experts and citizen committees perform important unique and complementary roles. The complementary roles of both lead entity technical experts and citizen committees help propose the best projects and increase the technical and community support for salmon recovery.

6.1.4 Projects

Table 39 Projects within the Lower Mid-Columbia Mainstem assessment unit related to conservation, restoration, and research activities

Project # and/or Name/	Responsible Party	Target Species	Project Description	Project Duration	Project Location or Geographic Scale Affected	GAP Analysis Statement
Boardman Grasslands Preserve – habitat conservation and T&E species recovery (TNC 2003)	TNC, ODFW, and Threemile Canyon Farms;	White-tailed jackrabbit, burrowing owl, ferruginous hawk, Swainson's hawk, loggerhead shrike, long-billed curlew, grasshopper sparrow, sage sparrow, and northern sagebrush lizard	Agreement to establish habitat conservation measures on the preserve to protect various wildlife species that could become federally listed as threatened or endangered unless their population declines are reversed. TNC will develop a long-term management plan. Working with state agencies, elected officials and conservation groups, the farm and the TNC are pursuing options to purchase the entire site from the state, including the conservation area.	2001-2040	Boardman Grassland Preserve, OR	
Boardman Grasslands Preserve – Vegetation Restoration Grant $22,287. (USFWS 2004c)	USFWS and TNC	White-tailed jackrabbit, burrowing owl, ferruginous hawk, Swainson's hawk, loggerhead shrike, long-billed curlew, grasshopper sparrow, sage sparrow, and northern sagebrush lizard	This grant will restore native grasses, forbes, and shrubs to 20 acres of grassland and shrub-steppe habitat on the 22,642-acre Boardman Conservation Area.	2004-Ongoing	Boardman Grasslands Preserve	
Boardman Grasslands	National Fish and Wildlife	Multiple, terrestrial wildlife and plant	A grant from the NFWF is supporting creation of a		Boardman Grasslands Preserve, OR.	

Project # and/or Name/	Responsible Party	Target Species	Project Description	Project Duration	Project Location or Geographic Scale Affected	GAP Analysis Statement
Preserve - Weed Management Area (TNC 2003)	Foundation (NFWF)	species	collaborative 205,000-acre Weed Management Area, which will engage local landowners across the region in coordinated efforts to control the most damaging invasive species.			
USFWSPrivate Stewardship Grant Program (USFWS 2004c)	USFWS	Federally listed T&E species	In the Pacific Northwest, the U.S. Fish and Wildlife Service is awarding $839,810 in grants under the Private Stewardship Grant program. This program provides federal grants to individuals and groups engaged in voluntary conservation efforts on private lands that benefit federally listed T&E, candidate, and other at-risk species.	2004-Ongoing	Pacific Northwest	
Mule Deer - Hunting Season Management - CRP Development	WDFW	Mule deer, upland game birds	Ongoing effort to survey and manage deer populaton via hunting program. Surveys and harvest statistics provide annual data used to set hunting seasons and address population trends. WDFW is working with landowners to implement Conservation Reserve Program that benefits a multitude of species associated with grassland and shrub steppe habitat.	1950s-ongoing	Rock Creek Subbasin agricultural lands, WA.	

Project # and/or Name/	Responsible Party	Target Species	Project Description	Project Duration	Project Location or Geographic Scale Affected	GAP Analysis Statement
Synthesis and Comparison of Baseline Avian and Bat Use, Raptor Nesting and Mortality Information from Proposed and Existing Wind Developments (West Inc. 2002)	Prepared for BPA by West, Inc.	Birds, including raptors, bats, and sensitive species	Baseline and operational monitoring data were collected at proposed and existing U.S. wind plants to estimate the overall project impacts on birds (especially raptors and state and federally listed species), to guide future placement of turbines within a project boundary, and strengthen our ability to accurately predict and mitigate impacts from new projects.	2002	Oregon, Washington and other states. Within Oregon and Washington: Northeast OR.; Vansycle Wind Project, Umatilla Co.; Condon Wind Project; Stateline Project, Vansycle Ridge; Klondike Wind Project, Sherman Co.	
Western gray squirrel research and management	WDFW	Western gray squirrel	Ongoing effort to survey and manage WGS population and associated habitat. Periodic surveys are done to document occurrences in Rock Creek drainage with emphasis in the the upper subbasin. WDFW monitors timber harvest through forest practice regulations and land divisions through county planning dept. BLM is currently funding research project on WGS habitat use. The Nature Conservancy has acquired land in Rock Creek drainage and places emphasis on WGS protection.	1990-ongoing	Rock Creek Subbasin, WA.	

Project # and/or Name/	Responsible Party	Target Species	Project Description	Project Duration	Project Location or Geographic Scale Affected	GAP Analysis Statement
Managing the Columbia River: Instream Flows, Water Withdrawals, and Salmon Survival	Washington Department of Ecology and National Research Council	Salmon and steelhead	The National Research Council (NRC) was commissioned by the Washington Department of Ecology to analyze how much water should be kept in the Columbia to protect the river's salmon and steelhead. NRC completed their report in 2004. It is used by Ecology to establish new rules for issuing water rights from the Columbia River.	1999-2004	Portions of the Columbia River Mainstem that flow through the state of Washington	
Environmental Contaminants In Aquatic Resources From The Columbia River - Study	USFWS, Oregon F&W Office	Multiple Species: Migratory birds and ESA species	Collected sediment, invertebrates, fish, and eggs of piscivorous and non-piscivorous birds in within various river segments to determine contaminant concentrations, compare concentrations within river segments, identify concentrations that exceed guidance or reference levels, evaluate magnitude of exceedances, and derive biomagnification factors (BMFs) for persistent, bioaccumulative compounds. BMFs were used to develop target fish concentrations (TFCs), or the concentrations in fish estimated to be protective of upper trophic level species such as bald	1990-1991	Samples were collected in the lower Columbia River below Bonneville Dam (four river segments including three NWRs), at Umatilla NWR and above McNary Dam, and in the lower Willamette River near Portland.	

Project # and/or Name/	Responsible Party	Target Species	Project Description	Project Duration	Project Location or Geographic Scale Affected	GAP Analysis Statement
			eagles.			
198903500 Umatilla Hatchery operation and maintenance	Oregon Department of Fish and Wildlife	Spring, fall chinook, summer steelhead, coho	Restore Umatilla River Chinook and steelhead fisheries and populations through release of subyearling and yearling smolts produced at Umatilla Hatchery.	Operation began in 1991		
199000500 Umatilla Fish Hatchery monitoring and evaluation	ODFW	Sping, fall chinook, summer steelhead, coho	Evaluate juvenile rearing, adult survival, stock life history, straying, fish health and sport fishing and catch contribution for salmon and steelhead reared in oxygen supplemented and standard raceways at Umatilla Hatchery.	Ongoing since 1991		
199007700 Northern Pikeminnow Management Program	Pacific States Marine Fisheries Commission	Reduce predation on juvenile salmonids	Reduce predation on juvenile salmonids by implementing fisheries to harvest northern pikeminnow in the mainstem Columbia and Snake rivers. Monitor effects of fisheries on predation by northern pikeminnow and other resident fish.	Ongoing since 1990	Columbia River from Cathlamet Washington upstream to Priest Rapids Dam; Snake River from mouth upstream to Hells Canyon Dam	
199406900 Estimate production potential of fall chinook salmon in the Hanford Reach of the Columbia River	Pacific Northwest National Laboratory	Fall chinook salmon	Develop a production potential estimate for fall chinook salmon in the Hanford Reach, and evaluate whether the Hanford Reach functions as a healthy alluvial river.	1994	Columbia River's Hanford Reach	

Project # and/or Name/	Responsible Party	Target Species	Project Description	Project Duration	Project Location or Geographic Scale Affected	GAP Analysis Statement
199900301 Evaluate spawning of fall chinook and chum salmon just below the four lowermost mainstem dams	Pacific States Marine Fisheries Commission, Oregon Department of Fish and Wildlife, U.S. Fish and Wildlife Service, U.S. Geological Survey, Pacific Northwest National Laboratory	Fall chinook, chum salmon	Monitor, protect, and enhance the spawning populations of fall chinook and chum below Bonneville Dam. Search for evidence of fall chinook spawning below The Dalles, John Day, and McNary dams.	1999		
CREP	USDA/FSA/ NRCS		Anadromous streams, voluntary program for landowners, the land enrolled in CREP is removed from production and grazing under 10 or 15 year contracts. In return, landowners plant trees and shrubs to stabilize the stream bank.	1999—2016	Landowners adjacent to over 8,000 miles of streams in Washington are eligible to participate in this program.	
White sturgeon assessment BPA - 198605000	ODFW, WDFW, CRITFC, USGS, OSU	White sturgeon	White sturgeon mitigation and restoration.	1986-current	Columbia and Snake rivers upstream from Bonneville Dam	
Columbia River Fish Management Plan (US v. Oregon)	WDFW, ODFW, northwest Indian tribes, federal agencies	spring chinook, summer chinook, sockeye, fall chinook, summer steelhead, and coho salmon	This agreement between federal agencies, Indian tribes and state agencies (except Idaho) set guidelines for the management, harvest, hatchery production, and rebuilding of Columbia River Basin salmonid	1969 though 1998 (though lapsed, the agreement is being renegotiated and parties are using seasonal fish plans in the	Columbia river basin	

Project # and/or Name/	Responsible Party	Target Species	Project Description	Project Duration	Project Location or Geographic Scale Affected	GAP Analysis Statement
			stocks.	interim.)		
Watershed Planning under RCW 90.82 in WRIA 31	WRIA 31 Local Planning Unit		The Watershed Management Act to provides a framework for local citizens, interest groups, and government organizations to collaboratively identify and solve water quantity related issues in the watershed.	Started in 1991, ongoing until 1998.	Rock Creek, Pine Creek, Glade Creek, WA.	
Rock Creek Temperature Study 96-308	Ecology		High temperatures in Rock Creek were evaluated. Riparian canopy cover was compared to Washington Department of Natural Resources target coverages. Management recommendations were made based on these target coverages.	1995	Upper Rock Creek, WA.	
WSPMP92W	Ecology		Ongoing evaluation of pesticide contamination in surface water for the WSPMP.	January 1992 through January 1993	Glade Creek, WA.	
GLADEGW	Ecology		Ground-water quality characterization and investigation of nitrate contamination of ground water and surface water in the Glade Creek Watershed Horse Heaven Hills south-central Washington.	May 1995 through September 1995	Glade Creek, WA.	

7 Synthesis and Interpretation

Introduction

This synthesis and interpretation of information presented in the assessment section of this plan, focuses on the four fish species white sturgeon, summer steelhead, fall chinook, coho, and eight wildlife species, western gray squirrel, whiteheaded woodpecker, mule deer, grasshopper sparrow, Brewer’s sparrow, yellow warbler, American beaver, Lewis’ woodpecker. It would enhance this section, 7. Synthesis and Interpretation, to integrate additional information from 3. Subbasin Description/3.2.8 Anthroprogenic Disturbances on Terresterial and Aquatic Environments and 5. Fish Assessment/5.7.2-5.7.5 Focal Species and 5.8.1-5.8.5 Fish Habit Assessment Units in a future iteration of this subbasin plan.

7.1.1 Data Availability, Data Quality, and Data Gaps

The lower mid-Columbia mainstem, except for sturgeon, and the Oregon side of the subbasin are not reflected in the assessment of data below. For other species and habitats, some data gaps have been identified in the 4.3.4, 4.4.4, and 4.5.3 Wildlife Key Findings and 5.8.1 and 5.8.5 Key Fish Findings and in 8.2.1-8.2.6 Wildlife Objectives and Strategies and in 8.3.1-8.3.5 Fish Objectives and Strategies.

Lower Mid-Columbia Mainstem Columbia Assessment Unit

Data Availability

There was no new data collected as a part of the assessment of white sturgeon in the Lower Mid-Columbia Mainstem Columbia River. All the data used in this assessment was collected from previously conducted summaries and research. Although much of the data collected on white sturgeon in the Lower Mid-Columbia Mainstem Columbia in recent years was available, much has yet to be published and was not available for this assessment.

Data Quality

The data that was used in this assessment and management plan was obtained through public sources and much of it was peer reviewed. However, the subbasin planners assume that the data used in the assessment was of high quality.

Data Gaps

The data from recent years sturgeon research is still being analyzed in was not available for this assessment.

Key Assumptions

We assume that the data used in this assessment and management plan was of high quality and reliably reflects the current status of research regarding white sturgeon in the Lower Mid-Columbia Mainstem Columbia River.

7.1.2 Interpretation and Hypothesis – Wildlife and Fish

Key Habitat/Population Relationships – Limiting Factors

Primary limiting factors for fish, wildlife, and associated habitats in the mainstem Columbia River are generally a result of (1) hydropower system development and operation, (2) other human activities such as farming, grazing, transportation, and industrial development, or (3) introduction and proliferation of exotic species. These factors are often interrelated and hard to separate. Therefore, the following summaries of major limiting factors are not necessarily organized by these major categories.

Wildlife

Hydropower System Development and Operations

The development and operation of the hydropower system resulted in widespread changes in riparian, riverine, and upland habitats. A tremendous amount of habitat has been lost or significantly altered. Wildlife loss assessments conducted in the late 1980s documented losses associated with each hydropower facility.

Effects of hydropower development and operations on wildlife and wildlife habitat may be direct or indirect (secondary). Direct effects include stream channelization, inundation of habitat, degradation of habitat from water level fluctuations (e.g., draining and filling of wetlands, rip-rapped shorelines, and erosion), and construction and maintenance of power transmission corridors. Secondary effects include the building of numerous roads and railways, the expansion of irrigation, which has resulted in extensive habitat conversion, and increased access to and harassment of wildlife.

Specific effects of hydropower operation include limiting the availability of secure nesting and brood-rearing habitat for Canada geese, breeding ducks, and colonial nesting birds. Islands provide protection of nesting birds from terrestrial predators, and to some extent, disturbance by humans. Many islands used by birds are eroding rapidly, especially in the John Day Reservoir, thus reducing the size of islands and eliminating nests on islands with maximum nest density (McCabe 1976).

Water fluctuations cause some islands to be connected to shore during periods of low water, allowing access by terrestrial predators. Some brooding sites are a great distance from nesting sites, and mortality of young birds can be very high while traveling from nesting islands to distant brooding habitat, especially during windy conditions. Massive waves, characteristic of some parts of the Columbia River, kill young birds directly and reduce the productivity of shallow water areas used for feeding. At some brooding sites, low water elevation is lower than the downslope extent of plants, resulting in a wide band of un-vegetated shoreline. Adults and young birds attempting to traverse this un-vegetated area are very susceptible to predation. Conversely, at some brooding sites, plants eaten by birds are unreachable due to inundation. Fluctuating water levels that occur in shallow areas with highly variable bathymetry contribute to avian botulism outbreaks when terrestrial and aquatic invertebrates die as land areas are repeatedly flooded and desiccated in warm ambient conditions (Locke and Friend 1987; Levine 1965). Water level fluctuations may also reduce the productivity and availability of critical migrant shorebird habitat at deltas.

Table 40 Loss of wildlife habitat associated with federal hydropower facilities in the lower Columbia River

Hydropower Facility	Habitat Inundated (ha)	Habitat Units Lost
Bonneville	8,400	12,317
The Dalles	780	2,230
John Day	11,115	14,398
McNary	6,276	19,397

Rassmussen and Wright 1990

Hydropower operations that produce atypically high discharges can displace spawned-out salmon carcasses from the open shoreline into the permanent and dense shoreline vegetation. The dense vegetation may act to conceal those carcasses from predators such as the bald eagle, and may effectively reduce a primary food item that is especially important for wintering juvenile eagles along the Hanford Reach (Brett Tiller, PNNL, unpublished data).

Birds, and other wildlife, dependent on riparian or upland areas are also affected by hydropower development and operations. Filling of reservoirs inundated riparian and upland (shrub-steppe and steppe) habitats, and short-term water level fluctuations that result from power production at dams reduce the quantity and quality of riparian habitat on shorelines. Most species of upland game birds nest on the ground, and their nests are sometimes subject to inundation and failure. Water fluctuations and waves also decrease beaver and muskrat production by alternating flooding and exposing dens.

Mule deer in the subbasin often use islands as a location to give birth. Does likely select islands because of the security from land predators, primarily coyotes. The use of islands, in this subbasin, by mule deer is limited by the scarcity and small size (due to erosion) of islands, the formation of land bridges during low water, and inundation during high water levels.

Land Management Practices and Land Prices

Dry-land farming and extensive livestock grazing of open range land has eliminated and degraded shrub-steppe habitat and much of the riparian zone within the Lower Mid-Columbia Mainstem subbasin. Irrigated agriculture has also reduced habitat diversity and wildlife abundance through the creation of monocultures. In addition, forest practices have reduced the availability and quality of habitat. The development of the Columbia Basin Irrigation Project converted vast acreage of former shrub-steppe habitat to irrigated farming, and created a connected system of waterways and seepage areas unsuitable for farming. Generally, these areas are degraded and in need of restoration, but may be suitable to replace some functions of lost mainstem riparian zones.

Opportunities to restore wildlife populations and improve habitat diminish over time as habitat loss and degradation continue. Further, land prices continue to rise, making it more economically difficult to preserve remaining undeveloped lands for wildlife and fish.

Nutrient Cycling & Food Webs

Continued decline in populations of salmon and other fish species results in loss of overall biomass being contributed to the subbasin. This reduction has negative effects on wildlife abundance. The dramatic declines in some native wildlife species, particularly blacktail jackrabbits *Lepus californicus* and Washington ground squirrels may have contributed to the decline of associated predators such as ferruginous hawks.

Human Disturbance

Urban expansion, highway traffic, free-ranging dogs, noise pollution, light pollution, etc. can disturb wildlife populations and limit wildlife usage of quality habitat areas. In both the Columbia River and "off-river" parts of the subbasin, human disturbance during brood-rearing period reduces waterfowl and colonial nesting bird production. Mammals such as beaver also suffer high mortality from being hit by trains and cars because of the proximity of highways and railroads to the shoreline of the Columbia River.

Human recreation within the shrub-steppe communities may significantly affect nesting of ferruginous hawks, bald eagles, waterfowl, and many colonial nesting birds. Bald Eagles and American white pelicans are particularly sensitive to boating activities, with juvenile eagles being more sensitive to human activities than adults (Brett Tiller, PNNL, unpublished data).

Effects of Breeding, Transplants, and/or Introductions

The spread of non-native plant and wildlife species is a threat to wildlife habitat quality and to wildlife species themselves. For example, noxious weeds threaten the quality of deer and elk winter range. Milfoil *Myriophylum* spp. is common in the slow-water areas and the benefits and consequences to various vertebrate wildlife is not well understood.

Of particular importance is the invasion of riparian habitats by invasive exotic plant species such as Russian olive. The increase in Russian-olive may indirectly affect wildlife survival by increasing populations of predators such as coyotes and black-billed magpies. Within the adjacent upland areas, the acreage of sagebrush cover is even further reduced by the spread of cheatgrass, which increases fire frequency and magnitude while lengthening the recovery period following larger event.

The bullfrog is another introduced species whose preferred habitat parallels conditions found in the mainstem Columbia River. Numerous studies have shown that bullfrogs out-compete and contribute to the decline of native amphibians due to aggressive behavior, rapid growth rate, and predation (Corkran and Thoms 1996).

At locations away from the Columbia River in this subbasin, duck brooding habitat quantity and quality is limited by wetland succession (e.g., late successional stages characterized by low percent of open water) and high densities of carp. Carp compete with ducklings and other wildlife for invertebrate and submergent aquatic foods.

Fish

Water Quality

While construction and operation of dams and reservoirs within the subbasin have not produced a significant change in average water temperature, upstream storage projects have resulted in a temperature phase shift (Jaske and Goebel 1967). Historical records indicate that fall chinook salmon returning the mid-Columbia River may spawn as much as one month later than populations did at the beginning of the nineteenth century (DeVoto 1953). The effects of a later spawning time on the emergence timing and availability of aquatic food web resources is unknown.

Hydropower System Development and Operations

Hydroelectric development has transformed most fast-moving mainstem riverine habitats into slow-moving reservoir impoundments. Construction of McNary, John Day, and The Dalles dams inundated 200 km of fall chinook salmon spawning habitat in the Mainstem Columbia River (Van Hyning 1973). Today, only the Hanford Reach remains unimpounded and provides the majority of mainstem spawning habitat for fall chinook salmon.

In the Columbia River, flow regimes are highly regulated by the hydroelectric complex and seasonal discharge is influenced by water storage and water use practices (Ebel et al. 1989). Flow regulation hinders fish passage, alters food webs, promotes proliferation of exotic plant species, and alters connections among groundwater, floodplains, and surface water (Stanford et al. 1996), or convergence zones (hyporheic habitats) where biodiversity and bioproduction are frequently high (Stanford and Ward 1993). The relative magnitude and frequency of high flow events also acts to modify channel form, but only within constraints of existing geological features. For example, major floods are less frequent because of upstream flood-control projects constructed since the 1940s. This change is significant because rivers that flood frequently maintain different species and food webs from systems that are more ecologically benign (Stanford et al. 1996).

An important limiting factor associated with hydropower development is downstream and upstream passage of anadromous salmonids and white sturgeon at dams. Passage problems will not be emphasized here; rather, they are dealt with at greater length in other documents.

Operation of the hydropower system and conversion of the majority of the Mainstem Columbia River to reservoirs has resulted in a major decrease in the abundance of mountain whitefish and Pacific lamprey and has limited the spawning success of white sturgeon in the The Dalles, John Day, and McNary reservoirs. The loss of production of benthic insects associated with riverine habitat in the reservoirs is the probable cause for the extremely low abundance of mountain whitefish (WDFW, unpublished data). Reduced spring and summer discharges have decreased the amount of spawning habitat available for white sturgeon, and construction of dams inundated several rapids and falls that probably provided spawning habitat. The Columbia Basin Pacific lamprey work group (CBPLTWG 1999) identified habitat of juvenile and adult life histories as a critical uncertainty. Ongoing projects have focused on evaluating population status in tributaries (Hatch and Parker 1998) and passage requirements at mainstem dams (Mesa et al. 2000; Moursund et al 2000). However, there have been no studies to assess the relative importance of mainstem habitats on the spawning and rearing of Pacific lampreys.

Predation

Of the 50 fish species known to inhabit the mainstem Columbia River between The Dalles and Wanapum dams, 20 are exotic. Of primary concern are species that may compete with or prey on native species, especially salmonids.

Predator-prey relations have been altered by development of the hydropower system in many ways. Primary predators of juvenile salmonids in the Columbia River include northern pikeminnow, smallmouth bass, and walleye. Although northern pikeminnow are a native species and have always preyed on juvenile salmonids, development of the hydropower system has increased the level of predation. Dams have slowed water velocity and decreased turbidity, effects that have increased exposure time of juvenile salmonids to predators and increased predation success. Development of the hydropower system has also resulted in extended periods of warm water, and therefore increased predator activity and consumption. Dams concentrate juvenile salmonids in forebays and tailraces, and fish in tailraces are disoriented from passage through or around turbines, spillways, or bypass systems, further increasing their vulnerability to predation.

Petersen (1994) estimated the annual loss of juvenile salmonids to predation by northern pikeminnow in John Day reservoir to be 1.4 million, approximately 7.3% of all juvenile salmonids entering the reservoir. Rieman et al. (1991) determined that northern pikeminnow accounted for 78% of the loss of juvenile salmonids to fish predators. Ward et al. (1995) estimated predation on juvenile salmonids by northern pikeminnow relative to that in John Day reservoir to be approximately 190% in The Dalles reservoir and 50% in McNary reservoir.

Predation on juvenile salmonids by northern pikeminnow has decreased since implementation of the Northern Pikeminnow Management Program in 1990 (Beamesderfer et al. 1996; Friesen and Ward 1999). From 1992 through 1999, annual exploitation rate of northern pikeminnow longer than 250 mm fork length has averaged approximately 11.4% in The Dalles Reservoir, 5.2% in John Day Reservoir, and 15.3% in McNary Reservoir and the Hanford Reach combined. Friesen and Ward (1999) estimate that predation by northern pikeminnow has decreased approximately 25%, with no compensation by walleye or smallmouth bass.

Smallmouth bass and walleye are both known to prey upon juvenile salmonids and other native fish. Smallmouth bass are responsible for only a small amount of the predation on juvenile salmonids in Columbia River reservoirs (Rieman et al. 1991); however, they may become more important predators when wild subyearling chinook salmon are abundant in late spring and early summer (Tabor et al. 1993). Individual walleye consume as many juvenile salmonids as individual northern pikeminnow (Rieman et al. 1991); however, abundance of walleye is far lower than abundance of northern pikeminnow (Beamesderfer and Rieman 1991).

Food Webs

The transformation of the mainstem Columbia River into a series of reservoirs has altered the food webs that support juvenile salmonids and resident fish. Juvenile fall chinook salmon eat primarily adult and larval midges (Diptera), caddis flies (Trichoptera), and mayflies (Ephemeroptera) (Becker 1973; Dauble et al. 1980; USGS unpublished data), but in the McNary reservoir juveniles consume primarily midges, terrestrially-derived insects, and zooplankton (Rondorf et al. 1990; USGS unpublished data). The limitation imposed by altered reservoir food bases is an increased foraging cost to consume smaller, less energetically profitable zooplankton. Two factors may further limit the use of zooplankton as a food resource. First is the proliferation of *Neomysis mercedis*, an estuarine mysid, in mainstem reservoirs. *Neomysis mercedis* is related to *Mysis relicta*, which has decimated zooplankton communities in coldwater lakes and reservoirs in the western United States (Nessler and Bergersen 1991). It is unknown whether *Neomysis mercedis* eat zooplankton in Columbia River reservoirs. Second is the rapid increase in the American shad population in the last decade. Juvenile American shad are planktivorous and may compete with late-migrating fall chinook salmon for food resources.