8.3 MARBLED MURRELET

8.3.1 STATUS OF THE SPECIES: MARBLED MURRELET

8.3.1.1 Legal Status

The marbled murrelet (*Brachyramphus marmoratus*) (murrelet) was federally listed as a threatened species in Washington, Oregon, and northern California effective September 28, 1992 (U.S. Fish and Wildlife Service 1992). The final rule designating critical habitat for the murrelet (61 FR 26256) became effective on June 24, 1996. The species' decline has largely been caused by extensive removal of late-successional and old-growth coastal forests which serve as nesting habitat for murrelets. Additional listing factors included high nest-site predation rates and human-induced mortality in the marine environment from gillnets and oil spills.

We recently determined the California, Oregon, and Washington distinct population segment of the murrelet does not meet the criteria set forth in the FWS 1996 Distinct Population Segment policy (61 FR 4722) (U.S. Fish and Wildlife Service 2004f). However, the murrelet retains its listing and protected status as a threatened species under the ESA until the original 1992 listing decision is revised through formal rule-making procedures, involving public notice and comment.

The Marbled Murrelet Recovery Plan (U.S. Fish and Wildlife Service 1997a) (Recovery Plan), identified six Conservation Zones throughout the listed range of the species: Puget Sound (Conservation Zone 1), Western Washington Coast Range (Conservation Zone 2), Oregon Coast Range (Conservation Zone 3), Siskiyou Coast Range (Conservation Zone 4), Mendocino (Conservation Zone 5), and Santa Cruz Mountains (Conservation Zone 6).

As specified in the Recovery Plan (U.S. Fish and Wildlife Service and National Marine Fisheries Service 1998) pursuant to the ESA, jeopardy/non-jeopardy conclusions for the murrelet will be made for each affected Conservation Zone rather than exclusively at the species' listed range. However, our overall jeopardy/non-jeopardy determination will include consideration of the long-term viability of the overall population and metapopulations in all Conservation Zones. Accordingly, the following discussion and analysis for this action will focus on Conservation Zones 1 and 2.

Conservation Zone 1

Conservation Zone 1 includes all the waters of the Puget Sound and most waters of the Strait of Juan de Fuca south of the U.S.-Canadian border and extends inland 50 miles from the Puget Sound, including the north Cascade Mountains and the northern and eastern sections of the Olympic Peninsula. Forestlands in the Puget Trough have been predominately replaced by urban development and the remaining suitable habitat in Conservation Zone 1 is typically a considerable distance from the marine environment, lending special importance to nesting habitat close to the Puget Sound (U.S. Fish and Wildlife Service 1997a).

Conservation Zone 2

Conservation Zone 2 includes waters within 1.2 miles of the Pacific Ocean shoreline south of the U.S.-Canadian border off Cape Flattery and extends inland to the midpoint of the Olympic Peninsula. In southwest Washington, the Zone extends inland 50 miles from the Pacific Ocean shoreline. Most of the forestlands in the northwestern portion of Zone 2 occur on public (State, county, city, and Federal) lands, while most forestlands in the southwestern portion are privately owned. Extensive timber harvest has occurred throughout Zone 2 in the last century, but the greatest loss of suitable nest habitat is concentrated in the southwest portion of Zone 2 (U.S. Fish and Wildlife Service 1997a). Thus, murrelet conservation is largely dependent upon Federal lands in the northern portion of Zone 2 and non-Federal lands in the southern portion.

8.3.1.2 Life History

Murrelets are long-lived seabirds that spend most of their life in the marine environment, but use old-growth forests for nesting. Detailed discussions of the biology and status of the murrelet are presented in the final rule listing the murrelet as threatened (U.S. Fish and Wildlife Service 1992), the Recovery Plan, Ecology and Conservation of the Marbled Murrelet (Ralph et al. 1995), the final rule designating murrelet critical habitat (61 FR 26256, U.S. Fish and Wildlife Service 1996a), and the Evaluation Report for the 5-Year Status Review of the Marbled Murrelet in Washington, Oregon, and California (McShane et al. 2004).

Physical Description

The murrelet is taxonomically classified in the family Alcidae (Alicids), a family of Pacific seabirds possessing the ability to dive using wing-propulsion. The plumage of this relatively small (9.5-10 inches) seabird is identical between males and females, but the plumage of adults changes during the winter and breeding periods providing some distinction between adults and juveniles. Breeding adults have light, mottled brown under-parts below sooty-brown upperparts contrasted with dark bars. Adults in winter plumage have white under-parts extending to below the nape and white scapulars with brown and grey mixed upperparts. The plumage of fledged young is similar to the adult winter plumage (U.S. Fish and Wildlife Service 1997a).

Distribution

The range of the murrelet, defined by breeding and wintering areas, extends from the northern terminus of Bristol Bay, Alaska, to the southern terminus of Monterey Bay in central California. The listed portion of the species' range extends from the Canadian border south to central California. Murrelet abundance and distribution has been significantly reduced in portions of the listed range, and the species has been extirpated from some locations. The areas of greatest concern due to small numbers and fragmented distribution include portions of central California, northwestern Oregon, and southwestern Washington (U.S. Fish and Wildlife Service 1997a).

Reproduction

Murrelet breeding is asynchronous and spread over a prolonged season. In Washington, the murrelet breeding season occurs between April 1 and September 15. Egg laying and incubation occur from late April to early August and chick rearing occurs between late May and late August, with all chicks fledging by early September (Hamer et al. 2003).

Murrelets lay a single-egg clutch (Nelson 1997), which may be replaced if egg failure occurs early (Hebert et al. 2003; McFarlane-Tranquilla et al. 2003). However, there is no evidence a second egg is laid after successfully fledging a first chick. Adults typically incubate for a 24-hour period, then exchange duties with their mate at dawn. Hatchlings appear to be brooded by an adult for 1-2 days and are then left alone at the nest for the remainder of the rearing period, except during feedings. Both parents feed the chick, which receives 1-8 meals per day (Nelson 1997). Most meals are delivered early in the morning, while about a third are delivered at dusk and a few meals are sometimes scattered throughout the day (Nelson and Hamer 1995a). Chicks fledge 27-40 days after hatching. The initial flight of a fledgling appears to occur at dusk and parental care is thought to cease after fledging (Nelson 1997).

Murrelets in the Marine Environment

Courtship, foraging, loafing, molting, and preening occur in near-shore marine waters. Beginning in early spring, courtship continues throughout summer with some observations even noted during the winter period (Speckman 1996; Nelson 1997). Observations of courtship occurring in the winter suggest that pair bonds are maintained throughout the year (Speckman 1996; Nelson 1997). Courtship involves bill posturing, swimming together, synchronous diving, vocalizations, and chasing in flights just above the surface of the water. Copulation occurs both inland (in the trees) and at sea (Nelson 1997).

Vocalization

Murrelets are known to vocalize between 480 Hertz and 4.9 kilohertz and have at least 5 distinct call types (Suzanne Sanborn, Personal Communication, 2005). Murrelets tend to be more vocal at sea compared to other alcids (Nelson 1997). Individuals of a pair vocalize after surfacing apart from each other, after a disturbance, and during attempts to reunite after being separated (Strachan et al. 1995).

Loafing

When murrelets are not foraging or attending a nest, they loaf on the water, which includes resting, preening, and other activities during which they appear to drift with the current, or move without direction (Strachan et al. 1995). Strachan et al. (1995) noted that vocalizations occurred during loafing periods, especially during the mid-morning and late afternoon.

Molting

Murrelets go through two molts each year. The timing of molts varies temporally throughout their range likely due to prey availability, stress, and reproductive success (Nelson 1997). Adult (after hatch-year) murrelets have two primary plumage types: alternate (breeding) plumage and basic (winter) plumage. The pre-alternate molt occurs from late February to mid-May. This is an incomplete molt during which the birds lose their body feathers but retain their ability to fly (Carter and Stein 1995; Nelson 1997). A complete pre-basic molt occurs from mid-July through December (Carter and Stein 1995; Nelson 1997). During the pre-basic molt, murrelets lose all flight feathers somewhat synchronously and are flightless for up to 2 months (Nelson 1997). In Washington, there is some indication that the pre-basic molt occurs from mid-July through the end of August (Chris Thompson, WDFW, Personal Communication, 2003).

Flocking

Strachan et al. (1995) defines a flock as three or more birds in close proximity which maintain that formation when moving. Various observers throughout the range of the murrelet report flocks of highly variable sizes. In the southern portion of the murrelet's range (California, Oregon, and Washington), flocks rarely contain more than 10 birds. Larger flocks usually occur during the later part of the breeding season and may contain juvenile and subadult birds (Strachan et al. 1995).

Aggregations of foraging murrelets are probably related to concentrations of prey. In Washington, murrelets are not generally found in interspecific feeding flocks (Strachan et al. 1995). Strong et al. (cited in Strachan et al. 1995) observed that murrelets avoid large feeding flocks of other species and presumed that the small size of murrelets may make them vulnerable to kleptoparasitism or predation in mixed species flocks. Strachan et al. (1995) point out that if murrelets are foraging cooperatively, the confusion of a large flock of birds could reduce foraging efficiency.

Foraging Behavior

Murrelets forage at all times of the day, but most actively in the morning and late afternoon (Strachan et al. 1995). Murrelets typically forage in pairs, but have been observed to forage alone or in groups of three or more (Carter and Sealy 1990; Strachan et al. 1995; Speckman et al. 2003). Strachan et al. (1995) believe pairing influences foraging success and cooperative foraging techniques may be employed. For example, pairs consistently dive together during foraging and often synchronize their dives by swimming towards each other before diving (Carter and Sealy 1990) and resurfacing together on most dives. Strachan et al. (1995) speculate pairs may keep in visual contact underwater. Paired foraging is common throughout the year, even during the incubation period, suggesting that breeding murrelets may temporarily pair up with other foraging individuals (non-mates) (Strachan et al. 1995; Speckman et al. 2003).

Murrelets generally forage within 1.25 miles of shore (Strachan et al. 1995), but are also known to forage in freshwater lakes (Nelson 1997). Traditional feeding areas (nurseries) are used consistently on a daily and yearly basis (Carter and Sealy 1990). Activity patterns and foraging locations are influenced by biological and physical processes that concentrate prey, such as weather, climate, time of day, season, light intensity, up-wellings, tidal rips, narrow passages between islands, shallow banks, and kelp (*Nereocystis* spp.) beds (Ainley et al. 1995; Burger 1995; Strong et al. 1995; Speckman 1996; Nelson 1997).

Juveniles are found closer to shore than adults (rarely greater than 0.625 miles offshore) (Beissinger 1995) and forage without the assistance of adults (Strachan et al. 1995). Kuletz and Piatt (1999) found that in Alaska, juvenile murrelets congregated in kelp beds. Kelp beds are often associated with productive waters and may provide protection from avian predators (Kuletz and Piatt 1999). McAllister (unpublished data–cited in Strachan et al. 1995) found that juveniles were more common within 328 feet of shorelines, particularly, where bull kelp was present.

Murrelets forage most frequently in nearshore water generally less than 98 feet (30 meters) deep (Strachan et al. 1995, Burger 2001). The most common foraging depths are not known. However, murrelets are known to feed on small schools of fish within the upper 16.4 feet (5 meters) of marine waters (Mahon et al. 1992). An alcid the size of a murrelet is expected to have a maximum diving depth of about 154 feet (47 meters) (Mathews and Burger 1998), although the deepest record of a marbled murrelet was from one captured at 89 feet (27 meters) in a gill net off of California (Carter and Erickson 1992). Jodice and Collopy (1999) reported most diving in Oregon occurred in water less than 33 feet (10 meters) deep.

The duration of dives appears to depend upon age (adults vs. juveniles), water depth, and prey depth. Reported dive durations are highly variable for murrelets, ranging from 7 to 42 seconds, with an average of 14 seconds reported from observations in California (Strachan et al. 1995). Carter and Sealy (1990) reported that dive durations in British Columbia averaged 27.8 seconds and Thorensen (1989) reported dive durations in Washington ranged from 15 to 115 seconds.

Adults and subadults often move away from breeding areas prior to molting and must select areas with predictable prey resources during the flightless period (Carter and Stein 1995; Nelson 1997). During the non-breeding season, murrelets disperse and can be found farther from shore (Strachan et al. 1995). Little is known about marine-habitat preference outside of the breeding season, but use during the early spring and fall is thought to be similar to that preferred during the breeding season (Nelson 1997). During the winter there may be a general shift from exposed outer coasts into more protected waters (Nelson 1997), for example many murrelets breeding on the exposed outer coast of Vancouver Island appear to congregate in the more sheltered waters within the Puget Sound and the Strait of Georgia in fall and winter (Burger 1995). However, in many areas, murrelets remain associated with the inland nesting habitat during the winter months (Carter and Erickson 1992) and throughout the listed range, murrelets do not appear to disperse long distances, indicating they are year-round residents (McShane et al. 2004).

Prey Species

Throughout their range, murrelets are opportunistic feeders and utilize prey of diverse sizes and species. They feed primarily on fish and invertebrates in near-shore marine waters although they have also been detected on rivers and inland lakes (Carter and Sealy 1986; U.S. Fish and Wildlife Service 1992). In general, small schooling fish and large pelagic crustaceans are the main prey items. Pacific sand lance *(Ammodytes hexapterus)*, northern anchovy *(Engraulis mordax),* immature Pacific herring *(Clupea harengus)*, capelin *(Mallotus villosus)*, and surf smelt (Osmeridae) are the most common fish species taken and are eaten year round. Squid (*Loligo* spp.), euphausiids, mysid shrimp, and large pelagic amphipods are the main invertebrate prey and are primarily eaten during the non-breeding season, thus they are not a significant part of a nestling's diet.

Murrelets usually carry a single fish to their chicks and appear to select a relatively large (relative to body size), energy-rich fish such as large sand lance, immature herring, anchovy, smelt, and occasionally salmon smolts (Burkett 1995; Nelson 1997). This forces breeding adults to exercise more specific foraging strategies when feeding chicks. Freshwater prey appears to be important to some individuals during several weeks in summer and may facilitate more frequent chick feedings, especially for those that nest far inland (Hobson 1990). As a result, the distribution and abundance of prey suitable for feeding chicks may greatly influence the overall foraging behavior and location(s) during the nesting season. The availability of abundant forage fish during the nestling period may significantly affect the energy demand on adults by influencing both foraging time and number of trips inland required to feed nestlings (U.S. Fish and Wildlife Service 1992).

Predators

At sea predators include bald eagles (*Haliaeetus leucocephalus*), peregrine falcons (*Falco peregrinus*), western gulls (*Larus occidentalis*), and northern fur seals (*Callorhinus ursinus*) (McShane et al. 2004). California sea lions (*Zalophus californianus*), northern sea lions (*Eumetopias jubatus*), and large fish may also be occasional predators (Burger 2002).

Murrelets in the Terrestrial Environment

Murrelets are dependent upon old-growth forests, or forests with an older tree component, for nesting habitat (Hamer and Nelson 1995; Ralph et al. 1995; McShane et al. 2004). Sites occupied by murrelets tend to have a higher proportion of mature forest age-classes than do unoccupied sites (Raphael et al. 1995). Specifically, murrelets prefer high and broad platforms for landing and take-off, and surfaces which will support a nest cup (Hamer and Nelson 1995). The physical condition of a tree appears to be the important factor in determining the tree's suitability for nesting (Ralph et al. 1995); therefore, presence of old-growth in an area does not assure the stand contains sufficient structures (i.e., platforms) for nesting. In Washington, murrelet nests have been found in conifers, specifically, western hemlock, Sitka spruce, Douglas-fir, and western red cedar (Hamer and Meekins 1999; Hamer and Nelson 1995). Nests have been found in trees as small as 2.6 feet in diameter at breast height on limbs at least 65 feet from the ground and 0.36 feet in diameter (Hamer and Meekins 1999).

Murrelet populations may be limited by the availability of suitable nesting habitat. In the Ecology and Conservation of the Marbled Murrelet, Ralph et al. (1995) surmised in the book's summary that the suitable nesting habitat remaining in Washington, Oregon, and California was saturated with murrelets based on: (1) at-sea concentrations of murrelets near suitable nesting habitat during the breeding season; (2) winter visitation to nesting sites; and (3) the limitation of nest sites available in areas with large amounts of habitat removal. Murrelets have been observed visiting nesting habitat during non-breeding periods in Washington, Oregon, and California (Nelson 1997, Naslund 1993) which may indicate adults are defending nesting sites and/or stands (Ralph et al. 1995). Other studies provide further insight to the habitat associations of breeding murrelets, concluding that breeding murrelets displaced by the loss of nesting habitat do not pack in higher densities into remaining habitat (McShane et al. 2004). Thus, murrelets may currently be occupying nesting habitat at or near carrying capacity in highly fragmented areas and/or in areas where a significant portion of the historic nesting habitat has been removed.

Therefore, unoccupied stands containing nesting structures could be important to displaced breeders and first-time breeding adults. Even if nesting habitat is at carrying capacity, there will be years when currently occupied stands become unoccupied as a result of temporary disappearance of inhabitants due to death or to irregular breeding (Ralph et al. 1995). Therefore, unoccupied stands will not necessarily indicate that habitat is not limiting or that these stands are not murrelet habitat (Ralph et al. 1995) and important to the species persistence.

Radar and audio-visual studies have shown murrelet habitat use is positively associated with the presence and abundance of mature and old-growth forests, large core areas of old-growth, low amounts of edge and fragmentation, proximity to the marine environment, total watershed area, and increasing forest age and height (McShane et al. 2004). In California and southern Oregon, areas with abundant numbers of murrelets were farther from roads, occurred more often in parks protected from logging, and were less likely to occupy old-growth habitat if it was isolated > 3 miles (> 5 kilometers) from other nesting murrelets (Meyer et al. 2002). Meyer et al. (2002) also found at least a few years passed before birds abandoned fragmented forests.

Murrelets do not form dense colonies, which is atypical for most seabirds. Limited evidence suggests they may form loose colonies or clusters of nests in some cases (Ralph et al. 1995). The reliance of murrelets on cryptic coloration to avoid detection will suggest they utilize a wide spacing of nests in order to prevent predators from forming a search image (Ralph et al. 1995). However, active nests have been seen within 328 feet (100 meters) of one another in the North Cascades in Washington and within 98 feet (30 meters) in Oregon (Kim Nelson, OSU, Personal Communication, 2005). Estimates of murrelet nest densities vary depending upon the method of data collection. For example, nest densities estimated using radar range from 0.007 to 0.104 mean nests per acre (0.003 to 0.042 mean nests per hectare), while nest densities estimated from tree climbing efforts range from 0.27 to 3.51 mean nests per acre (0.11 to 1.42 mean nests per hectare) (Nelson 2005).

There are few data available regarding murrelet nest site fidelity because of the difficulty in locating nest sites and observing bands on birds attending nests. However, murrelets have been detected in the same nesting stands for many years (at least 20 years in California and 15 in Washington), suggesting murrelets have a high fidelity to nesting areas (Nelson 1997). Use of the same nest platform in successive years and multiple nests in the same tree have been documented, although it is not clear whether the repeated use involved the same birds (Hebert and Golightly 2003; Nelson 1997; Nelson and Peck 1995; Divoky and Horton 1995). The limited observed fidelity to the same nest site in consecutive years appears to be lower than for other alcids, but this may be an adaptive behavior in response to high predation rates (Divoky and Horton 1995). Researchers have suggested annual use of specific or adjacent nesting platforms may be more common in areas where predation is limited or the number of suitable nest sites are few because large, old-growth trees are rare (Nelson and Peck 1995; Singer et al. 1995; Manley 1999).

Ralph et al. (1995) speculated the annual use of nest sites or stands by breeding murrelets may be influenced by the nesting success of previous rearing attempts. Although murrelet nesting behavior in response to failed nest attempts is unknown, nest failures could lead to prospecting for new nest sites or mates. Other alcids have shown an increased likelihood to relocate to a new nest in response to breeding failure (Divoky and Horton 1995). However, murrelets likely remain in the same stand over time as long as the stand is not significantly modified (Ralph et al. 1995).

It is unknown whether juveniles disperse from natal breeding habitat (natal dispersal) or return to their natal breeding habitat after reaching breeding age (natal philopatry). Divoky and Horton (1995) predicted that juvenile dispersal is likely to be high because murrelets are non-colonial and nest in widely dispersed nest sites. Conversely, Swartzman et al. (1997 cited in McShane et al. 2004) suggested juvenile dispersal is likely to be low, as it is for other alcid species. Therefore, the presence of unoccupied suitable nesting habitat on the landscape may be important for first-time nesters if they disperse away from their natal breeding habitat.

Murrelets generally select nests within 37 miles (60 kilometers) of marine waters (Miller and Ralph 1995). However, in Washington, occupied habitat has been documented 52 miles (84 kilometers) from marine waters and murrelets have been detected up to 70 miles (113 kilometers) from marine waters in the southern Cascade Mountains (Evans Mack et al. 2003).

When tending active nests during the breeding season (and much of the non-breeding season in southern parts of the range), breeding pairs forage within commuting distance of the nest site. Daily movements between nest sites and foraging areas for breeding murrelets averaged 10 miles in Prince William Sound, Alaska (McShane et al. 2004), 24 miles in Desolation Sound, British Columbia (Hull et al. 2001), and 48 miles in southeast Alaska. In California, Hebert and Golightly (2003) found the mean extent of north-south distance traveled by breeding adults to be about 46 miles.

Murrelet nests have been located at a variety of elevations from sea level to 5,020 feet (Burger 2002). However, most nests have been found below 3,500 feet. In Conservation Zone 1, murrelets have exhibited occupied behaviors up to 4,400 feet in elevation and have been detected in stands up to 4,900 ft in the north Cascade Mountains (Peter McBride, WDNR, Personal Communication,. 2005). On the Olympic Peninsula, survey efforts for nesting murrelets have encountered occupied stands up to 4,000 feet within Conservation Zone 1 and up to 3,500 feet within Conservation Zone 2. Surveys of murrelet habitat at higher elevations on the Olympic Peninsula have not been conducted. However, recent radio-telemetry work detected a murrelet nest at 3,600 ft elevation on the Olympic Peninsula in Conservation Zone 1 (Martin Raphael, USFS, Personal Communication, 2005).

8.3.1.3 Population Status in the Coterminous United States

Population Abundance

Research on murrelet populations in the early 1990s estimated murrelet abundance in Washington, Oregon, and California at 18,550 to 32,000 (Ralph et al. 1995). However, consistent population survey protocols were not established for murrelets in the coterminous United States until the late 1990s following the development of the marine component of the Effectiveness Monitoring Program for the Northwest Forest Plan (Bentivoglio et al. 2002). As a consequence, sampling procedures have differed and thus the survey data collected prior to the EM Program is unsuitable for estimating population trends for the murrelet (McShane et al. 2004).

The development of the Effectiveness Monitoring Program unified the various at-sea monitoring efforts within the five Conservation Zones encompassed by the Northwest Forest Plan. These efforts along with efforts in Conservation Zone 6 have resulted in annual estimates of murrelet abundance for each Conservation Zone (Bentivoglio 2002; Huff et al. 2003; Lance 2004; Peery et al. 2002) with the annual listed population estimated to be 18,097 in 2000; 22,200 in 2001; 23,700 in 2002; and 22,300 in 2003.

Population Trend

Estimated population trends within each Conservation Zone or for the entire coterminous population are not yet available from the marine survey data. Trend information will eventually be provided through the analysis of marine survey data from the Effectiveness Monitoring Program (Bentivoglio et al. 2002) and from survey data in Zone 6 once a sufficient number of survey years have been completed. Depending on the desired minimum power (80 or 95 percent) to detect annual decreases, at least 8 to 10 years of surveys are required for an overall population estimate and 7 to 16 years are required for population estimates for Conservation Zones 1 and 2 (Huff et al. 2003).

In the interim, demographic modeling has aided attempts to analyze and predict population trends and extinction probabilities of murrelets. Incorporating important population parameters and species distribution data (Beissinger 1995; Beissinger and Nur 1997–cited in U.S. Fish and Wildlife Service 1997a; Cam et al. 2003; McShane et al. 2004), demographic models can provide useful insights into potential population responses from exposure to environmental pressures and perturbations. However, weak assumptions or inaccurate estimates of population parameters such as survivorship rates, breeding success, and juvenile-to-adult ratios, can limit the use of models. Thus, a cautious approach is warranted when forecasting long-term population trends using demographic models.

Most of the published demographic models used to estimate murrelet population trends employ Leslie Matrix modeling (McShane et al. 2004). Two other more complex, unpublished models (Akcakaya 1997 and Swartzman et al. 1997–cited in McShane et al. 2004) evaluate the effect of nest habitat loss on murrelets in Zone 4 (McShane et al. 2004). McShane et al. (2004) developed a stochastic Leslie Matrix model (termed "Zone Model") to project population trends in each murrelet Conservation Zone. The Zone Model was developed to integrate available demographic information for a comparative depiction of current expectations of future population trends and probability of extinction in each Zone (McShane et al. 2004). Table 8-23 lists the four latest murrelet Leslie Matrix models and the values for common demographic parameters used in each.

Table 8-23. The estimated values for demographic parameters used in four population models for the murrelet.

Demographic Parameter	Beissinger 1995	Beissinger and Nur 1997–cited in U.S.* 1997a	Beissinger and Peery 2003	McShane et al. 2004
Juvenile to Adult Ratio	0.10367	0.124 or 0.131	0.089	0.02 - 0.09
Annual Fecundity	0.11848	0.124 or 0.131	0.06-0.12	(See nest success)
Nest Success			0.16-0.43	0.38 - 0.54
Maturation	3	3	3	2 - 5
Estimated Adult Survivorship	85 - 90%	85 - 88%	82 - 90%	83 - 92%

*Fish and Wildlife Service

Regardless of model preference, the overall results of modeling efforts are in agreement, indicating murrelet abundance is declining (McShane 2004:6-27). The rates of decline are highly sensitive to the assumed adult survival rate used for calculation (Beissinger and Peery 2003). The most recent modeling effort using the “Zone Model” (McShane et al. 2004) suggests the murrelet zonal sub-populations are declining at a rate of 3.0 to 6.2 percent per year.

Estimates of breeding success are best determined from nest site data, but difficulties in finding nests has led to the use of other methods, such as juvenile to adult ratios and radio-telemetry estimations, each of which have biases. The nest success data presented in Table 8-23 under McShane et al. (2004) was derived primarily from radio telemetry studies; however the nests sampled in these studies were not representative of large areas and specifically did not include Washington or Oregon. In general, telemetry estimates are preferred over juvenile to adult ratios for estimating breeding success due to fewer biases (McShane et al. 2004), but telemetry data are not currently available for Washington or Oregon. Therefore, it is reasonable to expect that juvenile to adult ratios derived from at-sea survey efforts best represent murrelet reproductive success in Washington, Oregon, and California.

Beissinger and Peery (2003) performed a comparative analysis using data from 24 bird species to predict the juvenile to adult ratio for murrelets of 0.27 (confidence intervals ranged from 0.15 to 0.65). Demographic models suggest murrelet population stability requires a minimum of 0.18 – 0.28 chicks per pair per year (Beissinger and Nur 1997–cited in U.S. Fish and Wildlife Service 1997a). The lower confidence intervals for both the predicted juvenile to adult ratio (0.15) and the stable population juvenile to adult ratio (0.18) are greater than the juvenile to adult ratios observed for any of the Conservation Zones (0.02 – 0.09 chicks per pair, Beissinger and Nur 1997–cited in U.S. Fish and Wildlife Service 1997a; Beissinger and Peery 2003). Therefore, the juvenile to adult ratios observed in the Conservation Zones are lower than predicted ratios and are too low to obtain a stable population in any Conservation Zone, which indicates murrelet populations are declining in all Conservation Zones and will continue to decline until reproductive success improves.

Based upon: (1) the outcome of demographic modeling; (2) the observed juvenile to adult ratios; and (3) adult survivorship rates, the number of murrelets in Washington, Oregon, and California are too low to sustain a murrelet population and the rate of decline for murrelets throughout the listed range is estimated to be between 2.0 to 15.8 percent (Beissinger and Nur 1997–cited in U.S. Fish and Wildlife Service 1997a; McShane et al. 2004).

Murrelets in Washington (Conservation Zones 1 and 2)

Historically, murrelets in Conservation Zones 1 and 2 were "common" (Rathbun 1915 and Miller et al. 1935–cited in U.S. Fish and Wildlife Service 1997a), "abundant" (Edson 1908 and Rhoades 1893–cited in U.S. Fish and Wildlife Service 1997a), or "numerous" (Miller et al. 1935–cited in McShane et al. 2004).

Conservation Zone 1, encompassing the Puget Sound in northwest Washington, contains one of the larger murrelet populations in the species' listed range, and supports an estimated 41 percent of the murrelets in the coterminous United States (Huff et al. 2003). The 2003 population estimate (with 95 percent confidence intervals) for Conservation Zone 1 is 8,500 (6,000 – 11,300) and Conservation Zone 2 is 3,400 (2,000 – 4,900) (Huff et al. 2003). In Conservation Zone 2, a higher density of murrelets occurs in the northern portion of the Zone (Huff et al. 2003) where the majority of available nesting habitat occurs. In Conservation Zone 1, higher densities of murrelets occur in the Straits of Juan de Fuca, the San Juan Islands, and the Hood Canal (Huff et al. 2003), which are in proximity to nesting habitat on the Olympic Peninsula and the North Cascade Mountains.

Although population numbers in Conservation Zones 1 and 2 are likely declining, the precise rate of decline is unknown. The juvenile to adult ratio derived from at-sea survey efforts in Conservation Zone 1 is 0.09. Juvenile to adult ratio is not collected in Conservation Zone 2; however, the juvenile to adult ratio for Conservation Zone 3 is 0.08. Therefore, it is reasonable to infer that a juvenile to adult ratio for Conservation Zone 2 is likely between 0.08 and 0.09. These low juvenile to adult ratios infer there is insufficient juvenile recruitment to sustain a murrelet population in Conservation Zones 1 and 2. Beissinger and Peery (2003) estimated the rate of decline for Conservation Zone 1 to be between 2.0 to 12.6 percent and between 2.8 to13.4 percent in Conservation Zone 3. It is likely that the rate of decline in Conservation Zone 2 is similar to that of Conservation Zones 1 and 3.

Juvenile to adult ratios in Washington may be skewed by murrelets coming and going to British Columbia. At-sea surveys are timed to occur when the least number of murrelets from British Columbia are expected to be present. However, recent radio-telemetry information indicates: (1) murrelets nesting in British Columbia forage in Washington waters during the breeding season (Martin Raphael, USFS, Personal Communication, 2005) and could be counted during at-sea surveys; and (2) adult murrelets foraging in Washington during the early breeding season moved to British Columbia in mid-June and mid-July (Bloxton and Raphael 2004) and would not have been counted during the at-sea surveys. The movements of juvenile murrelets in Washington and southern British Columbia are unclear. Therefore, until further information is obtained to define the impact of exchange of murrelets between British Columbia and Washington, we will continue to rely on the at-sea derived juvenile to adult ratios to evaluate the population status in Conservation Zones 1 and 2.

8.3.1.4 Habitat Abundance

Estimates on the amount of available suitable nesting habitat vary as much as the methods used for estimating murrelet habitat. McShane et al. (2004) estimates murrelet habitat in Washington State at 1,022,695 acres, representing approximately 48 percent of the estimated 2,223,048 acres of remaining suitable habitat in the listed range. McShane et al. (2004) caution about making direct comparisons between current and past estimates due to the evolving definition of suitable habitat and methods used to quantify habitat. As part of the ongoing pursuit to improve habitat estimates, information was collected and analyzed by the FWS in 2005 resulting in an estimated 751,831 acres of suitable nesting habitat in Conservation Zone 1 and 585,821 acres in Conservation Zone 2 (Table 8-24).

Table 8-24. Estimated acres of suitable nesting habitat for the murrelet on Federal and non-Federal lands in Conservation Zones 1 and 2.

Conservation Zone	Estimated acres of suitable murrelet habitat by land management category *				
	Federal	**State**	**Private***	**Tribal**	**Total**
Puget Sound (Zone 1)	650,937	98,036	2,338	520	751,831
Western Washington Coast Range (Zone 2)	485,574	82,349	9,184	8,714	585,821
Totals	**1,136,511**	**180,385**	**11,522**	**9,234**	**1,337,652**

* Estimated acres of private land represent "occupied" habitat based on surveys submitted to WDFW. Additional suitable nesting habitat not surveyed or considered to be "unoccupied" is not included in this estimate.

Estimated acreages of suitable habitat on Federal lands in Table 8-24 are based on modeling and aerial photo interpretation and likely overestimate the actual acres of suitable murrelet habitat because: (1) most acreages are based on models predicting spotted owl nesting habitat which include forested lands that do not have structures suitable for murrelet nesting; and (2) neither modeling or aerial photo interpretation can distinguish microhabitat features, such as nesting platforms or the presence of moss, that are necessary for murrelet nesting. The amount of high quality murrelet nesting habitat available in Washington, defined by the FWS as large, old, contiguously forested areas not subject to human influences (e.g., timber harvest or urbanization) is expected to be a small subset of the estimated acreages in Table 8-24. Murrelets nesting in high-quality nesting habitat are assumed to have a higher nesting success rate than murrelets nesting in fragmented habitat near humans.

Other Recent Assessments of Murrelet Habitat in Washington

Two recent assessments of marbled murrelet potential nesting habitat were developed for monitoring the Northwest Forest Plan (Raphael et al. 2005). This study provides a provincial-scale analysis of marbled murrelet habitat derived from vegetation base maps, and includes estimates of habitat on State and private lands in Washington for the period of 1994 – 1996. Using vegetation data derived from satellite imagery, Raphael and others (2005) developed two different approaches to model habitat suitability. The first model is referred to as the Expert Judgment Model, and is based on the judgment of an expert panel that used existing forest structure classification criteria (e.g., percent conifer cover, canopy structure, quadratic mean diameter, forest patch size, etc.) to classify forests into four classes of habitat suitability, with Class 1 indicating the least suitable habitat and Class 4 indicating the most highly suitable habitat. Raphael and others (2005) found that across the murrelet range, most habitat-capable (i.e., forested lands capable of producing suitable marbled murrelet habitat) land (52 percent) is classified as Class 1 (lowest suitability) habitat and 18 percent is classified as Class 4 (highest suitability) habitat. In Washington, they found that there were approximately 954,200 acres of Class 4 habitat in 1994-1996 (Table 8-25). However, only 60 percent of known nest sites in their study area were located in Class 4 habitat.

The second habitat model developed by Raphael et al. (2005) used the Biomapper Ecological Niche-Factor Analysis model developed by Hirzel and others (2002). The resulting murrelet habitat suitability maps are based on both the physical and vegetative attributes adjacent to known murrelet occupied polygons or nest locations for each Northwest Forest Plan province. The resulting raster maps are a grid of 269 square foot-cells (25 square meter-cells) (0.15 acres per pixel). Each cell in the raster is assigned a value of 0-100. Values closer to 100 represent areas that match the murrelet nesting locations, values closer to 0 are likely unsuitable for nesting (Raphael et al. 2005). These maps do not provide absolute habitat estimates, but rather a range of habitat suitability values, which can be interpreted in various ways. Raphael et al. (2005) noted that the results from the Ecological Niche Factor Analysis (ENFA) are not easily compared to results from the Expert Judgment Model because it was not clear what threshold from the habitat suitability ranking to use. Raphael and others (2005) elected to display habitat suitability scores greater than 60 (HS >60) as a "generous" portrayal of potential nesting habitat and a threshold greater than 80 (HS >80) as a more conservative estimate. In Washington, there were over 2.1 million acres of HS >60 habitat, but only 440,700 acres of HS >80 habitat (Table 8-25). It is important to note that HS >60 habitat map captures 82 percent of the occupied nests sites in Washington, whereas the HS >80 habitat map only captures 36 percent of the occupied nests in Washington.

Table 8-25. Comparison of different habitat modeling results for the Washington nearshore zone (0-40 miles inland = Northwest Forest Plan murrelet zone 1).

Murrelet Habitat Model	Habitat Acres on Federal Reserves (LSRs, Natl.Parks)	Habitat Acres on Federal, Non-Reserves (USFS Matrix)	Total Habitat Acres on Federal Lands	Total Habitat Acres on Non-Federal Lands (City, State, Private, Tribal)	Total Habitat Acres - All Ownerships	% of Total Habitat Acres on Non-Federal Lands	% of Known Murrelet Nest Sites in Study Area that Occurred in this Habitat Classification
ENFA HS >80	284,300	18,600	302,900	137,800	440,700	31%	36%
EJM Class 4	659,200	40,700	699,900	254,300	954,200	11%	60%
EJM Class 3 and Class 4	770,600	54,700	825,300	535,200	1,360,500	16%	65%
ENFA HS >60	927,000	85,300	1,012,300	1,147,100	2,159,400	53%	82%

ENFA = Ecological Niche Facto Analysis. EJM = Expert Judgment Model. Results were summarized directly from Tables 4 and 5 and Tables 9 and 10 in Raphael et al (2005). All habitat estimates represent 1994-1996 values.

Because the HS >60 model performed best for capturing known murrelet nest sites, Raphael et al. (2005) suggest that the ENFA HS >60 model yields a reasonable estimate of potential murrelet nesting habitat. However, we found that large areas in southwest Washington identified in the HS >60 model likely overestimates the actual suitable habitat in this landscape due to a known lack of old-forest in this landscape. Despite the uncertainties associated with interpreting the various map data developed by Raphael and others (2005), it is apparent that there is a significant portion of suitable habitat acres located on non-Federal lands in Washington, suggesting that non-Federal lands may play a greater role in the conservation needs of the species than has previously been considered. Using the most conservative criteria developed by Raphael et al. (2005) the amount of high-quality murrelet nesting habitat on non-Federal lands in Washington varies from 11 percent to as high as 31 percent (Table 8-25).

Raphael et al. (2005) note that the spatial accuracy of the map data are limited and that the habitat maps are best used for provincial-scale analysis. Due to potential errors in vegetation mapping and other potential errors, these maps are not appropriate for fine-scale project mapping. These data have not been published in their final form yet, although they have been available on the internet for public review and use since May 2005.

Conservation Zone 1

The majority of suitable murrelet habitat in Conservation Zone 1 occurs in northwest Washington and is found on Forest Service and National Park Service lands, and to a lesser extent on State lands. The majority of the historic habitat along the eastern and southern shores of the Puget Sound has been replaced by urban development resulting in the remaining suitable habitat being farther inland from the marine environment than what occurred historically (U.S. Fish and Wildlife Service 1997a).

Conservation Zone 2

Murrelet nesting habitat north of Grays Harbor in Conservation Zone 2 occurs largely on State, Forest Service, National Park Service, and tribal lands, and to a lesser extent, on private lands. Alternatively, the majority of habitat in the southern portion of Conservation Zone 2 occurs primarily on State lands, with a small amount on private lands.

8.3.1.5 Threats

Murrelets remain subject to a variety of anthropogenic threats within the upland and marine environment. They also face threats from low population numbers, low immigration rates, high predation rates, and disease.

Threats in the Marine Environment

Threats to murrelets in the marine environment include declines in prey availability; mortality associated with exposure to oil spills, gill net, and other fisheries; contaminants suspended in marine waters; and visual or sound disturbance from recreational or commercial watercrafts (U.S. Fish and Wildlife Service 1992, 1997a; Ralph et al. 1995; McShane et al. 2004).

Prey Availability

Many fish populations have been depleted due to overfishing, reduction in the amount or quality of spawning habitat, and pollution. Primary murrelet prey species have little commercial fishery value and, in general, there is little geographic overlap between murrelet distribution and areas of commercial harvest (McShane et al. 2004). However, there are several fisheries for herring and surf smelt in Puget Sound and for anchovy in Grays Harbor, Willapa Bay, and along the outer coast (Bargmann 1998). The extent of the effects of these fisheries on murrelets is unknown, but is presumed to be minor.

In addition to fishing pressure, oceanographic variation can influence prey availability. While the effects to murrelets from events such as El Niño have not been well documented, El Niño events are thought to reduce overall prey availability and several studies have found that El Niño events can influence the behavior of murrelets (McShane et al. 2004). Even though changes in prey availability may be due to natural and cyclic oceanographic variation, these changes may exacerbate other threats to murrelets in the marine environment.

Shoreline development has affected and will continue to effect coastal processes. Shipping, bulkheads, and other shoreline developments have contributed to the reduction in eelgrass beds and other spawning and rearing areas for forage fish such as herring. Pacific herring and other small marine fish, such as sand lance and surf smelt, are important prey species. They make up a large part of the diet of murrelets.

There are 19[1] known stocks of Pacific herring in Puget Sound. Of these populations, 15 are considered healthy or moderately healthy, three are considered depressed or critical, and the status of the remaining stock is unknown. According to WDNR (2000: pg. 99), herring spawning stocks decreased from over 20,000 tons in the 1970s to less than 10,000 tons in recent years. Cherry Point, within the Strait of Georgia, supports the largest herring stock in Washington and has experienced a precipitous decline. The decline of this stock may be affecting the forage base for murrelets in this region of Puget Sound. There is a moderate likelihood that organic contaminants are incrementally affecting this stock. Past research has shown that exposure to contamination reduces reproductive capability, growth rates, and resistance to disease, and may lead to lower survival for salmon (WDNR 2000).

Following the Exxon-Valdez oil spill, a study was initiated in Prince William Sound that included a comparison of oiled areas with unoiled areas and also compared pre-spill populations with post-spill populations (Klosiewski and Laing 1994). That study indicated that murrelets decreased in both oiled and unoiled areas. Total population estimates declined from 304,400 in 1972-73 to 98,400 in 1989-1991. In the conclusion of that study, which also addressed many other bird species, it was noted that a number of bird species feeding on small fish have decreased in the past several decades, while bird species feeding on benthic organisms did not decrease similarly.

Oil Spills

Murrelet mortality from oil pollution is a conservation issue in Washington (U.S. Fish and Wildlife Service 1997a). Most oil spills and chronic oil pollution that can affect murrelets occur in areas of high shipping traffic, such as the Strait of Juan de Fuca and Puget Sound. There have been at least 47 oil spills of 10,000 gallons or more in Washington since 1964 (WDOE 2004b). However, the number of oil spills has generally declined since passage of the U.S. Oil Pollution Act in 1990. The estimated annual mortality of murrelets from oil spills in Washington has decreased from 3 - 41 birds per year (1977 to 1992) to 1 - 2 birds per year (1993 to 2003) (McShane et al. 2004).

Since the murrelet was listed, the amount of oil tanker and shipping traffic has continued to increase (U.S. Fish and Wildlife Service 1997a; Burger 2002). Large commercial ships, including oil tankers, cargo ships, fish processing ships, and cruise ships, enter Washington waters more than 7,000 times each year, bound for ports in Puget Sound, British Columbia, Grays Harbor, and the Columbia River (WDOE 2004b). Additionally, 4,500 tank-barge transits, 160,000 ferry transits, and military vessel traffic occur in these same waters each year (WDOE 2004b). Individually these vessels may carry up to 33 million gallons of crude oil or refined petroleum products, but collectively, they carry about 15.1 billion gallons across Puget Sound waters each year (WDOE 2004b). These numbers are expected to increase as the human population and commerce continues to grow. Currently, there are State and Federal requirements for tug escorts of laden oil tankers transiting the waters of Puget Sound east of Dungeness Spit. However, the Federal requirements do not apply to double-hulled tankers and will no longer be in effect once the single-hull tanker phase-out is complete (WDOE 2005b). Washington State is considering revising their

[1] A spawning ground at Wollochet Bay was not included in surveys prior to 2002. In previous publications, the number of stocks of Pacific herring has been reported at 18 (PSAT 2005).

tug escort requirements (WDOE 2005b); however, the current tug escort requirements remain in place until the Washington State Legislature makes a change.

The U.S. Coast Guard rated the Dungeness area in the Strait of Juan de Fuca as being in the top five high-risk areas of the United States for being impacted by oil spills (U.S. Fish and Wildlife Service 2005). Therefore, even though the threat from oil spills appears to have been reduced since the murrelet was listed, the risk of a catastrophic oil spill remains, and could severely impact adult and/or juvenile murrelets in Conservation Zones 1 and 2.

Gillnets

Murrelet mortality from gillnet fishing has been considered a conservation issue in Washington (U.S. Fish and Wildlife Service 1997a; Melvin et al. 1999). Murrelets can also be killed by hooking with fishing lures and entanglement with fishing lines (Carter et al. 1995). There is little information available on murrelet mortality from net fishing prior to the 1990s, although it was known to occur (Carter et al. 1995). In the mid 1990s, a series of fisheries restrictions and changes were implemented to address mortality of all species of seabirds, resulting in a lower mortality rate of murrelets (McShane et al. 2004). Fishing effort has also decreased since the 1980s because of lower catches, fewer fishing vessels, and greater restrictions (McShane et al. 2004), although a regrowth in gill net fishing is likely to occur if salmon stocks increase. In most areas, the threat from gill net fishing has been reduced or eliminated since 1992, but threats to adult and juvenile murrelets are still present in Washington nearshore zones due to gill net mortality (McShane et al. 2004).

Marine Contaminants

The primary consequence from the exposure of murrelets to contaminants is reproductive impairment. Reproduction can be impacted by food web bioaccumulation of organochlorine pollutants and heavy metals discharged into marine areas where murrelets feed and prey species concentrate (Fry 1995). However, murrelet exposure is likely a rare event because murrelets have widely dispersed foraging areas and they feed extensively on transient juvenile and subadult midwater fish species that are expected to have low pollutant loads (McShane et al. 2004). The greatest exposure risk to murrelets may occur at regular feeding areas near major pollutant sources, such as those found in Puget Sound (McShane et al. 2004).

Disturbance

In coastal and offshore marine environments, vehicular disturbance (e.g., boats, airplanes, personal watercraft) is known to elicit behavioral responses in murrelets of all age classes (Kuletz 1996; Speckman 1996; Nelson 1997). Aircraft flying at low altitudes and boating activity, in particular motorized watercraft, are known to cause murrelets to dive and are thought to especially affect adults holding fish (Nelson 1997). It is unclear to what extent this kind of disturbance affects the distribution and movements of murrelets. However, it is unlikely this type of disturbance has decreased since 1992 because the shipping traffic and recreational boat use in the Puget Sound and Strait of Juan de Fuca has continued to increase.

Marine projects that include seismic exploration, pile driving, detonation of explosives and other activities that generate percussive sounds can expose murrelets to elevated underwater sound pressure levels (SPLs). High underwater SPLs can have adverse physiological and neurological effects on a wide variety of vertebrate species (Cudahy and Ellison 2002; USDD Department of Navy 2002; Fothergill et al. 2001; Popper 2003; Stevens et al. 1999; Yelverton and Richmond 1981; Yelverton et al. 1973). High underwater SPLs are known to injure and/or kill fish by causing barotraumas (pathologies associated with high sound levels including hemorrhage and rupture of internal organs), as well as causing temporary stunning and alterations in behavior (Hastings and Popper 2005; Popper 2003; Turnpenny and Nedwell 1994; Turnpenny et al. 1994). During monitoring of seabird response to pile driving in Hood Canal, Washington, a pigeon guillemot (*Cepphus columba*) was observed having difficulty getting airborne after being exposed to underwater sound from impact pile driving (Entranco and Hamer Environmental 2005). In controlled experiments using underwater explosives, rapid change in SPLs caused internal hemorrhaging and mortality in submerged mallard ducks (*Anas platyrhnchos*) (Yelverton et al. 1973). Risk of injury appears related to the effect of rapid pressure changes, especially on gas filled spaces in the bodies of exposed organisms (Turnpenny et al. 1994). In studies on ducks (*Anas spp.*) and a variety of mammals, all species exposed to underwater blasts had injuries to gas filled organs including eardrums (Yelverton and Richmond 1981). These studies indicate that similar effects can be expected across taxanomical species groups.

Physical injury may not result in immediate mortality. If an animal is injured, death may occur several hours or days later, or injuries may be sublethal. Sublethal injuries can interfere with the ability of an organism to carry out essential life functions such as feeding and predator avoidance. Diving birds are able to detect and alter their behavior based on sound in the underwater environment (Ross et al. 2001) and elevated underwater SPLs may cause murrelets to alter normal behaviors, such as foraging. Disturbance related to elevated underwater SPLs may reduce foraging efficiency resulting in increased energetic costs to all murrelet age classes in the marine environment and may result in fewer deliveries or lower quality food being delivered to nestlings.

Threats in the Terrestrial Environment

Habitat

Extensive harvest of late-successional and old-growth forest was the primary reason for listing the murrelet as threatened. Due primarily to extensive timber cutting over the past 150 years, at least 82 percent of the old-growth forests existing in western Washington and Oregon prior to the 1840s have been harvested (Booth 1991; Teensma et al. 1991; Ripple 1994; Perry 1995). About 10 percent of pre-settlement old-growth forests remain in western Washington (Norse 1990; Booth 1991). Although the Northwest Forest Plan has reduced the rate of habitat loss on Federal lands, the threat of continued loss of suitable nesting habitat remains on Federal and non-Federal lands through timber harvest and natural events such as wildfire, insect outbreaks, and windthrow.

Natural disturbance has the potential to affect the amount and quality of murrelet nesting habitat. Wildfire and windthrow result in immediate loss of habitat and can also influence the quality of adjacent habitat. Global warming, combined with long-term fire suppression on Federal lands, may result in higher incidences of stand-replacing fires in the future (McShane et al. 2004). As forest fragmentation increases, the threat of habitat loss due to windthrow is likely to increase. In addition, insects and disease can kill complete stands of habitat and can contribute to hazardous forest fire conditions.

Between 1992 and 2003, the loss of suitable murrelet habitat totaled 22,398 acres in Washington, Oregon, and California combined, of which 5,364 acres resulted from timber harvest and 17,034 acres resulted from natural events (McShane et al. 2004). The data presented by McShane represented losses primarily on Federal lands, and did not include data for most private lands within the marbled murrelets' range.

Habitat loss and fragmentation is expected to continue in the near future, but at an uncertain rate (McShane et al. 2004). Raphael et al. (2005) recently completed a change analysis for marbled murrelet habitat on both Federal and non-Federal lands for the period from 1992 to 2003, based on stand disturbance map data developed by Healey et al. (2003). Raphael et al. (2005) estimated that habitat loss ranging from 60,000 acres up to 278,000 acres has occurred across the listed range of the species, with approximately 10 percent of habitat loss occurring on Federal lands, and 90 percent occurring on non-Federal lands. The variation in the acreage estimates provided by Raphael et al. (2005) are dependant upon the habitat model used (see Table 8-25) to evaluate habitat change over time.

Gains in suitable nesting habitat are expected to occur on Federal lands over the next 40 to 50 years, but due to the extensive historic habitat loss and the slow replacement rate of murrelets and their habitat, the species is potentially facing a severe reduction in numbers in the coming 20 to 100 years (U.S. Forest Service and U.S. Fish and Wildlife Service 1994b; Beissinger 2002).

In addition to direct habitat removal, forest management practices can fragment murrelet habitat; this reduces the amount and heterogeneous nature of the habitat, reduces the forest patch sizes, reduces the amount of interior or core habitat, increases the amount of forest edge, isolates remaining habitat patches, and creates "sink" habitats (McShane et al. 2004). There are no estimates available for the amount of suitable habitat that has been fragmented or degraded since 1992. However, the ecological consequences of these habitat changes to murrelets can include effects on population viability and size, local or regional extinctions, displacement, fewer nesting attempts, failure to breed, reduced fecundity, reduced nest abundance, lower nest success, increased predation and parasitism rates, crowding in remaining patches, and reductions in adult survival (Raphael et al. 2002b).

Predation

Predation is expected to be the principal factor limiting murrelet reproductive success and nest site selection (Ralph et al. 1995; Nelson and Hamer 1995b). Murrelets are believed to be highly vulnerable to nest predation compared to other alcids and forest nesting birds (Nelson and Hamer 1995b; U.S. Fish and Wildlife Service 1997a). Murrelets have no protection at nest sites other than the ability to remain hidden. Nelson and Hamer (1995b) hypothesized that small increases in murrelet predation will have deleterious effects on murrelet population viability due to their low reproductive rate (one egg clutches).

Known predators of adult murrelets in the forest environment include the peregrine falcon (*Falco peregrinus*), sharp-shinned hawk (*Accipiter striatus*), common raven (*Corvus corax*), northern goshawk (*Accipiter gentilis*), and bald eagle (*Haliaeetus leucocephalus*). Common ravens and Stellar's jays (*Cyanocitta stelleri*) are known to take both eggs and chicks at the nest, while sharp-shinned hawks have been found to take chicks. Common ravens account for the majority of egg depredation, as they appear to be the only predator capable of flushing incubating or brooding adults from a nest (Nelson and Hamer 1995b). Suspected nest predators include great horned owls (*Bubo virginianus*), barred owls (*Strix varia*), Cooper's hawks (*Accipiter cooperi*), northwestern crows (*Corvus caurinus*), American crows (*Corvus brachyrhynchos*), and gray jays (*Perisoreus canadensis*) (Nelson and Hamer 1995b; Nelson 1997; Manley 1999). Predation by squirrels and mice has been documented at artificial nests and these animals cannot be discounted as potential predators on eggs and chicks (Luginbuhl et al. 2001; Raphael et al. 2002b; Bradley and Marzluff 2003).

Losses of eggs and chicks to avian predators have been determined to be the most important cause of nest failure (Nelson and Hamer 1995b; McShane et al. 2004). The risk of predation by avian predators appears to be highest in complex structured landscapes in proximity to edges and human activity, where many of the corvid (e.g., crows, ravens) species are in high abundance. Predation rates are influenced mainly by habitat stand size, habitat quality, nest placement (on the edge of a stand versus the interior of a stand), and proximity of the stand to human activity centers. The quality of murrelet nest habitat decreases in smaller stands because forest edge increases in relation to the amount of interior forest, while forest stands near human activity centers (less than 0.62 miles (1 kilometer)), regardless of size, are often exposed to a higher density of corvids due to their attraction to human food sources (Marzluff et al. 2000). The loss of nest contents to avian predators increases with habitat fragmentation and an increase in the ratio of forest edge to interior habitat (Nelson and Hamer 1995b; McShane et al. 2004). For example, Nelson and Hamer (1995b) found successful nests were farther from edges (greater than 55 meters) and were better concealed than unsuccessful nests.

The abundance of several corvid species has increased dramatically in western North America as a result of forest fragmentation, increased agriculture, and urbanization (McShane et al. 2004). It is reasonable to infer that as predator abundance has increased, predation on murrelet chicks and eggs has also increased, and murrelet reproductive success has decreased. It is also reasonable to assume that this trend will not be interrupted or reversed in the near future, as forest fragmentation, agriculture, and urbanization continue to occur.

Other Threats

Murrelets are subject to additional threats from diseases and genetic-related influences as a result of low population numbers and low immigration rates. To date, inbreeding (mating between close genetic relatives) and/or hybridizing (breeding with a different species or subspecies) have not been identified as threats to murrelet populations. However, as abundance declines, a corresponding decrease in the resilience of the population to disease, inbreeding or hybridization, and other perturbations may occur. Additionally, murrelets are considered to have low recolonization potential because their low immigration rate makes the species slow to recover from local disturbances (McShane et al. 2004).

The emergence of fungal, parasitic, bacterial, and viral diseases has affected populations of seabirds in recent years. West Nile virus disease has been reported in California which is known to be lethal to seabirds. While the amount of negative impact this disease may bring is unknown, researchers agree that it is only a matter time before West Nile virus reaches the Washington seabird population (McShane et al. 2004). Effects on murrelets from West Nile virus and other diseases are expected to increase in the near future due to an accumulation of stressors such as oceanic temperature changes, overfishing, and habitat loss (McShane et al. 2004).

Murrelets may be sensitive to human-caused disturbance due to their secretive nature and their vulnerability to predation. There are little data concerning the murrelet's vulnerability to disturbance effects, except anecdotal researcher observations that indicate murrelets typically exhibit a limited, temporary behavioral response (if any) to noise disturbance at nest sites and are able to adapt to auditory stimuli (Singer et al. 1995 cited in McShane et al. 2005; Long and Ralph 1998; Golightly et al. 2002). In general, responses to auditory stimuli at nests sites have been modifications of posture and on-nest behaviors (Long and Ralph 1998). While the unique breeding biology of the murrelet is not conducive to comparison of the reproductive success of other species, studies on other alcid and seabird species have revealed detrimental effects of disturbance to breeding success and the maintenance of viable populations (Cairns 1980; Pierce and Simons 1986; Piatt et al. 1990; Beale and Monaghan 2004).

Research on a variety of other species, including other seabirds, indicate an animal's response to disturbance follows the same pattern as its response to encountering predators, and anti-predator behavior has a cost to other fitness enhancing activities, such as feeding and parental care (Frid and Dill 2002). Some authors indicate disturbance stimuli can directly affect the behavior of individuals and indirectly affect fitness and population dynamics through increased energetic costs (Frid and Dill 2002; Carney and Sydeman 1999). Responses by murrelet adults and chicks to calls from corvids and other potential predators include no response, alert posturing, aggressive attack, and temporarily leaving a nest (adults only) (McShane et al. 2004). However, the most typical behavior of chicks and adults in response to the presence of a potential predator is to flatten against a tree branch and remain motionless (Nelson and Hamer 1995b; McShane et al. 2004). Therefore, researcher's anecdotal observations of little or no physical response by murrelets are consistent with the behavior they will exhibit in response to a predator. In addition, there may have been physiological responses researchers cannot account for with visual observations. Corticosterone studies have not been conducted on murrelets, but studies on other avian species indicate chronic high levels of this stress hormone may have negative consequences on reproduction or physical condition (Wasser et al. 1997; Marra and Holberton 1998 cited in McShane et al. 2004).

Although detecting effects of sub-lethal noise disturbance at the population level is hindered by the breeding biology of the murrelet, the effect of noise disturbance on murrelet fitness and reproductive success should not be completely discounted (McShane et al. 2004). In recently completed analyses, the FWS concluded the potential for injury associated with disturbance (visual and sound) to murrelets in the terrestrial environment includes flushing from the nest, aborted feeding, and postponed feedings (U.S. Fish and Wildlife Service 2003). These responses by individual murrelets to disturbance stimuli can reduce productivity of the nesting pair, as well as the entire population (U.S. Fish and Wildlife Service 1997a).

8.3.1.6 Conservation Needs

The Recovery Plan outlines the conservation strategy for the species. In the short-term, specific actions necessary to stabilize the population include maintaining occupied habitat, maintaining large blocks of suitable habitat, maintaining and enhancing buffer habitat, decreasing risks of nesting habitat loss due to fire and windthrow, reducing predation, and minimizing disturbance.

Long-term conservation needs include increasing productivity (abundance, the ratio of juveniles to adults, and nest success) and population size; increasing the amount (stand size and number of stands), quality, and distribution of suitable nesting habitat; protecting and improving the quality of the marine environment; and reducing or eliminating threats to survivorship by reducing predation in the terrestrial environment and anthropogenic sources of mortality at sea. We (U.S. Fish and Wildlife Service 1997a) estimate recovery of the murrelet will require at least 50 years.

The Recovery Plan states that four of the six Conservation Zones must be functional to effectively recover the murrelet in the short- and long-term; that is, to maintain viable populations that are well-distributed. Based on the new population estimates, it appears three of the six Conservation Zones contain relatively large numbers of murrelets (Zones 1, 3, and 4). Conservation Zones 1 and 4 contain the largest number of murrelets compared to the other four Zones. This alone will seem to indicate a better condition there, but areas of concern remain. For example, the population in Conservation Zone 4 was impacted when oil spills killed an estimated 10 percent of the population (Bentivoglio et al. 2002; Ford et al. 2002), small oil spills continue to occur in Conservation Zone 1, and the juvenile-to-adult ratios in both of these Conservation Zones continue to be too low to establish stable or increasing populations (Beissinger and Peery 2003).

Murrelets in Conservation Zones 3, 5, and 6 have suffered variously from past oil spills which killed a large number of murrelets (Zone 3) (Ford et al. 2001), extremely small population sizes (Zones 5 and 6), and alarmingly low reproductive rates (Zone 6) (Peery et al. 2002). These factors have brought the status of the species to a point where recovery in Conservation Zones 5 and 6 may be precluded (Beissinger 2002). The poor status of murrelet populations in the southern Conservation Zones emphasizes the importance of supporting murrelet populations in Conservation Zones 1 and 2 in order to preserve the opportunity to achieve murrelet recovery objectives.

8.3.1.7 Conservation Strategy

Marine Environment

Protection of marine habitat is also a component of the recovery strategy. The main threat to murrelets in the marine environment is the loss of individuals through death or injury, generally associated with oil spills and gill-net entanglements. The recovery strategy recommends managing all waters within 1.2 miles of shore within the Puget Sound and Strait of Juan de Fuca, and along the Pacific Coast from Cape Flattery to Willapa Bay in such a way as to reduce or eliminate murrelet mortality (U.S. Fish and Wildlife Service 1997a). Management strategies could include exclusion of vessels, stricter hull requirements, exclusion of net fisheries, or modification of fishing gear.

In Washington State, the Washington Fish and Game Commission requires the use of alternative gear (i.e., visual alerts within the upper 7 feet of a multifilament net), prohibits nocturnal and dawn fishing for all non-treaty gill-net fisheries, and closes areas to gill-net fishing in order to reduce by-catch of murrelets.

The Olympic Coast National Marine Sanctuary was established in 1994 along the outer Washington coast from Cape Flattery south to approximately the Copalis River and extending between 25 and 40 miles offshore. Oil exploration and development are prohibited within this Sanctuary (USDC 1993).

Terrestrial Habitat Management

The loss of nesting habitat (old-growth/mature forest) has generally been identified as the primary cause of the murrelet population decline and disappearance across portions of its range (Ralph et al. 1995). Logging, urbanization, and agricultural development have all contributed to the loss of habitat, especially at lower elevations.

The recovery strategy for the murrelet (U.S. Fish and Wildlife Service 1997a) relies heavily on the Northwest Forest Plan to achieve recovery on Federal lands in Washington, Oregon, and California. However, the Recovery Plan also addresses the role of non-Federal lands in recovery, including Habitat Conservation Plans, state forest practices, and Tribal lands. The importance of non-Federal lands in the survival and recovery of murrelets is particularly high in Conservation Zones where Federal lands, and privately held conservation lands (e.g., The Nature Conservancy Teal Slough, Ellsworth), within 50 miles of marine waters are sparse, such as the southern half of Conservation Zone 2.

Lands considered essential for the recovery of the murrelet within Conservation Zones 1 and 2 are: (1) any suitable habitat in a Late-Successional Reserves within the Northwest Forest Plan; (2) all suitable habitat located in the Olympic Adaptive Management Area within the Northwest Forest Plan; (3) large areas of suitable nesting habitat outside of Late Successional Reserves on Federal lands, such as habitat located in the Olympic National Park; (4) suitable habitat on State lands within 40 miles of marine waters; and (4) habitat within occupied murrelet sites on private lands (U.S. Fish and Wildlife Service 1997a).

Northwest Forest Plan

When the U.S. Forest Service (USFS) and Bureau of Land Management incorporated the Northwest Forest Plan as the management framework for public lands, a long-term habitat management strategy for murrelets (U.S. Forest Service and U.S. Fish and Wildlife Service 1994a, b) was established. The Northwest Forest Plan instituted pre-project surveys of murrelet habitat in areas planned for timber harvest and the protection of existing habitat at sites determined through surveys to be occupied by murrelets.

In the short-term, all known-occupied sites of murrelets occurring on U.S. Forest Service or Bureau of Land Management lands under the Northwest Forest Plan are to be managed as Late Successional Reserves. In the long-term, unsuitable or marginally suitable habitat occurring in Late Successional Reserves will be managed, overall, to develop late-successional forest conditions, thereby providing a larger long-term habitat base into which murrelets may eventually expand. Thus, the Northwest Forest Plan approach offers both short-term and long-term benefits to the murrelet.

Over 80 percent of murrelet habitat on Federal lands in Washington occurs within land management allocations that protect the habitat from removal or significant degradation. Scientists predicted implementation of the Northwest Forest Plan will result in an 80 percent likelihood of achieving a well-distributed murrelet population on Federal lands over the next 100 years (U.S. Forest Service and U.S. Fish and Wildlife Service 1994a). Although the Northwest Forest Plan offers protection of known-occupied murrelet sites, concerns over the lingering effects of the historic widespread removal of suitable habitat will remain until the habitat recovers to late-successional characteristics. This habitat recovery may require over 100 years.

Habitat Conservation Plans

Four Habitat Conservation Plans (HCP) addressing murrelets in Washington have been completed for private/corporate forestland managers within the range of the murrelet: (1) West Fork Timber Corporation (Murray Pacific Corporation 1993, 1995, U.S. Fish and Wildlife Service 1995) (Mineral Tree Farm HCP); (2) Plum Creek Timber Company (Plum Creek Timber Company 1996, 1999, U.S. Fish and Wildlife Service 1996b, 1999b) (Cascades HCP; I-90 HCP); (3) Port Blakely Tree Farms, L.P. (Port Blakely Tree Farms 1996, U.S. Fish and Wildlife Service 1996c) (R.B. Eddy Tree Farm HCP); and (4) Simpson Timber Company (Simpson Timber Company 2000b; U.S. Fish and Wildlife Service 2000a) (Olympic Tree Farm HCP). Habitat Conservation Plans have also been completed for the Washington Department of Natural Resources (WDNR 1997c; U.S. Fish and Wildlife Service1997b) (WDNR HCP) and two municipal watersheds, City of Tacoma (Tacoma Public Utilities 2001, U.S. Fish and Wildlife Service 2001b) (Green River HCP); and City of Seattle (City of Seattle 2001; U.S. Fish and Wildlife Service 2000b) (Cedar River HCP). The HCPs which address murrelets cover approximately 500,000 acres of non-Federal (private/corporate) lands, over 100,000 acres of municipal watershed, and over 1.6 million acres of State-managed lands. However, only a portion of these lands contain suitable murrelet habitat.

The WDNR HCP addresses murrelets in Conservation Zones 1 and 2. All of the others address murrelets in Conservation Zone 1. Most of the murrelet HCPs in Washington employ a consistent approach for murrelets by requiring the majority of habitat to be surveyed prior to timber management. Only poor-quality marginal habitat (with a low likelihood of occupancy) is released for harvest without survey. All known occupied habitat is protected to varying degrees, but a “safe-harbor-like” approach is used to address stands which may be retained as, or develop into, suitable habitat and become occupied in the future. This approach will allow harvest of habitat in the future, which is not currently nesting habitat.

Washington State Forest Practices Regulations

Under the Washington Forest Practices Rules, which apply to all non-Federal lands not covered by an HCP (Washington Forest Practices Board 1996), surveys for murrelets are required prior to the harvest of stands that meets certain platform numbers and stand size criteria. These criteria vary depending on the location of the stand. For stands found to be occupied or known to be previously occupied, the WDNR makes a decision to approve individual Forest Practices Applications based upon a significance determination. If a determination of significance is made, preparation of a State Environmental Policy Act - Environmental Impact Statement is required prior to proceeding. If a determination of non-significance or mitigated determination of non-significance is reached, the action can proceed without further environmental assessment. (A more detailed discussion of the Washington Forest Practices regulations is provided in the marbled murrelet environmental baseline).

Tribal Management

The management strategy of the Bureau of Indian Affairs for the murrelet focuses on working with tribal governments on a government-to-government basis to develop management strategies for reservation lands and trust resources. The Bureau of Indian Affairs’ management strategy typically focus on avoiding harm to murrelets when feasible, to facilitate the trust responsibilities of the United States. However, other factors must be considered. Strategies must foster tribal self-determination, and must balance the needs of the species and the environmental, economic, and other objectives of Indian Tribes within the range of the murrelet (Renwald 1993). For example, one of the Bureau of Indian Affairs’ main goals for murrelet protection includes assisting Native American Tribes in managing habitat consistent with tribal priorities, reserved treaty rights, and legislative mandates.

8.3.1.8 Status of Designated Critical Habitat for the Murrelet

The final rule designating critical habitat for the marbled murrelet (61 FR 26256; USDI Fish and Wildlife Service 1996a) became effective on June 24, 1996. Thirty-two units totaling 3,887,800 acres were designated on Federal, State, county, city, and private lands in Washington, Oregon, and California. Of the 3,887,800 acres designated as critical habitat rangewide, approximately 1,631,100 acres were designated in Washington State (Table 8-26) (USDI Fish and Wildlife Service 1996a). The majority of these acres (78 percent) occur on Federal lands, 21 percent occur on State lands, 1.2 percent occur on private lands, 0.2 percent occur on county lands, and 0.003 percent occur on city lands. Critical Habitat Units do not include non-Federal lands covered by a legally operative incidental take permit for marbled murrelets (USDI Fish and Wildlife Service 1996a, 61 FR 26278). Therefore, critical habitat designations were excluded on State lands upon completion of the WDNR Habitat Conservation Plan. We did not include any of the marine environment as critical habitat, but instead relied on other existing regulations for protection of this area. Therefore, about 99.8 percent of the critical habitat in Washington State is on Federal lands.

Table 8-26. Land ownerships in Washington designated as murrelet critical habitat (USDI Fish and Wildlife Service 1996a). Acreage totaled 1,204,500 (1,631,300 - 426,800 = 1,204,500) after suspension of WDNR-managed lands.

Ownership	Designation	Designated Critical Habitat (Acres)
Federal	Congressionally Withdrawn	1,800
	Late-Successional Reserve	1,200,200
	Federal total	**1,202,000**
Non-Federal	State*	426,800
	Private, City, and County	2,500
	Non-Federal total	**429,300**
	Overall total	***1,631,300***

* Some lands managed by WDNR were originally designated as critical habitat, but designation was suspended following approval of the WDNR HCP.

In the 1996 Final Rule designating critical habitat for the murrelet (61 FR 26256, USDI Fish and Wildlife Service 1996a), we identified two primary constituent elements essential to provide and support suitable nesting habitat for successful reproduction. These are: (1) individual trees with potential nesting platforms; and (2) forested areas within 0.5 miles of individual trees with potential nesting platforms and a canopy height of at least one-half the site-potential tree height. These primary constituent elements were deemed essential for providing suitable nesting habitat for successful reproduction of the murrelet, and require special management considerations.

Although most of the areas designated as marbled murrelet critical habitat occur on Federal lands (Northwest Forest Plan Late Successional Reserves), we designated selected non-Federal lands that met the selection criteria where Federal lands were insufficient to provide suitable nesting habitat for the recovery of the species. The designated critical habitat units are distributed more or less evenly across the range of the species in Washington and Oregon, and less so in California.

In Washington State, there is a clear reliance on Federal lands to fulfill the functions for which critical habitat was designated. These functions are also met by non-designated Federal lands in National Parks, Wilderness Areas, and portions of Adaptive Management Areas and Matrix lands within the Northwest Forest Plan found to be occupied.

Eleven critical habitat units totaling 1,631,300 acres were originally designated in Washington State. Of these, nine units included Federal lands, seven units included WDNR-managed lands, and portions of two units occurred on private lands.*

The quality of forests occurring within the boundaries of the Critical Habitat Units ranges from non-habitat (e.g., young plantations) to high-quality habitat (i.e., large blocks of old-growth forest). While significant amounts of high-quality murrelet habitat are present in some of the Critical Habitat Units, much of the habitat in Critical Habitat Units, particularly on non-Federal lands, is of lesser quality due to its occurrence in smaller, more fragmented blocks. Some of the highest quality murrelet habitat occurs in National Parks and designated Wilderness Areas where harvest historically has not occurred. Given the high quality of this habitat and reduced threat of habitat loss or modification due to management, designation of critical habitat was deemed unnecessary in National Parks and Wilderness Areas.

8.3.1.9 Summary

The existing long-term population data for Washington, Oregon, and California can not be used to empirically identify a three-state trend, although several leading murrelet experts believe the data suggest a decline across the southern range (McShane et al. 2004). The low fecundity levels across Washington, Oregon, and California, as determined through nest success values (i.e., the number of fledglings per breeding pair of murrelets per year), indicate a population that is not stable through reproduction (Beissinger and Peery 2003).

Some of the threats to the murrelet population may have been reduced as a result of the species' listing under the ESA, such as the passage of the Oil Pollution Act and implementation of the Northwest Forest Plan. However, no threats have been reversed since listing and in some areas threats, such as predation and West Nile Virus, may be increasing or emerging.

8.3.2 ENVIRONMENTAL BASELINE – Marbled Murrelet and Marbled Murrelet Critical Habitat

Regulations implementing the ESA (50 CFR § 402.02) define the environmental baseline as the past and present effects of all Federal, State, or private actions and other human activities in the FPHCP Action Area. Also included in the environmental baseline are the expected effects of all proposed Federal projects in the FPHCP Action Area that have undergone section 7 consultation, and the effects of State and private actions that are contemporaneous with the consultation in progress. Such actions include, but are not limited to, previous timber harvests and other land-management activities.

8.3.2.1 Assessment of Marbled Murrelet Habitat in Washington

Until recently there has been limited information for estimating marbled murrelet habitat on non-Federal lands in Washington. As described in the status of the species section, two recent assessments of potential nesting habitat for murrelets in Washington were completed by Raphael et al. (2005) (Table 8-25).

We used the map data developed by Raphael et al. (2005) to evaluate murrelet habitat conditions on the FPHCP covered lands. We chose the Expert Judgment Model outputs of Class 3 (moderately suitable) and Class 4 (highly suitable) (EJM Class 3-4) to depict murrelet habitat because this model output represents the median of the range of possible values derived from the habitat models developed by Raphael et al. (2005). The EJM Class 3-4 model is consistent with our current view of the distribution of murrelet habitat in Washington. The Class 3 category was included in the model output because this category depicts some acres of "moderate suitability" murrelet habitat in southwest Washington, which is consistent with the distribution of known murrelet observations on that landscape. Based on the information provided by Raphael et al. (2005), we believe the EJM Class 3-4 model provides a reasonable estimate of potential murrelet nesting habitat in Washington; however, we recognize that this model may overestimate potential nesting habitat in some landscapes (e.g., the western Washington lowlands).

Raphael et al. (2005) produced habitat maps that were based on 1992-1996 satellite images, therefore, all habitat values listed in their study reflect 1992-1996 base values. Although dated, these data represent the best provincial-scale maps of murrelet habitat currently available, and we used these maps in our assessment of murrelet habitat on FPHCP covered lands. Raphael et al. (2005) did conduct a change analysis for murrelet habitat based on the work of Healey et al. (2003). However, they did not report their change analysis results by region or State. Therefore, we used Healey et al.'s (2003) data to evaluate the effects of the stand-replacing fires and timber harvests on murrelet habitat that occurred between 1992 and 2002. This data only includes stand-replacing disturbance, and does not capture the effects of partial harvests such as commercial thinning. By overlaying Healey et al.'s (2003) disturbance maps with Raphael et al.'s (2005) 1992-1996 habitat maps, we were able to estimate the acres of murrelet habitat that were harvested between 1992 and 2002 in Washington. It is important to note that all potential nesting habitat estimates that we generated from the Raphael et al. (2005) data are general estimates based on our interpretation of the data. (For more information on our GIS analysis completed to derive these estimates, refer to the marbled murrelet GIS memo in the administrative record).

Using the Raphael et al. (2005) map data, we calculated the total habitat-capable acres in Washington at 9.75 million acres. Habitat-capable acres were defined as forested lands capable of producing suitable marbled murrelet habitat. High-elevation areas and naturally non-forested areas were removed from the Raphael et al. (2005) study area. Using the EJM Class 3-4 model output, the Raphael et al. (2005) data indicate there were approximately 1.57 million acres of potential marbled murrelet nesting habitat in Washington (all ownerships) in 2003, which represent about 16 percent of the total habitat-capable acres (Table 8-27).

Table 8-27. FPHCP covered lands and potential nesting habitat acres within the range of the marbled murrelet in Washington.

Murrelet Recovery Zone	Area	Total Habitat-Capable Area (acres)	Total Murrelet Nesting Habitat (acres - all ownerships)	Total Murrelet Nesting Habitat on Federal Lands (acres)	FPHCP Covered Lands (acres)	Murrelet Nesting Habitat on FPHCP Covered Lands (acres)	% of Murrelet Nesting Habitat in Zone on FPHCP Covered Lands (percent %)
Zone 1 - Puget Sound/ Strait of Juan de Fuca - Olympic Peninsula and North Cascades	Coastal (0-40 mi.)	nc	826,300	492,100	2,838,500	165,400	20%
	Inland (40-55 mi.)	nc	251,600	235,600	63,700	7,300	3%
Subtotals for Zone 1		**nc**	**1,077,900**	**727,700**	**2,902,200**	**172,700**	**16%**
Zone 2 - Pacific Coast - Olympic Peninsula and Southwest Washington	Coastal (0-40 mi.)	nc	471,600	332,400	2,176,400	59,200	13%
	Inland (40-55 mi.)	nc	25,500	10,800	380,400	10,200	40%
Subtotals for Zone 2		**nc**	**497,100**	**343,200**	**2,556,800**	**69,400**	**14%**
Washington Totals	Coastal (0-40 mi.)	8,629,500	1,297,900	824,500	5,014,900	224,600	17%
	Inland (40-55 mi.)	1,125,700	277,100	246,400	444,100	17,500	6%
Totals for Washington		**9,755,200**	**1,575,000**	**1,070,900**	**5,459,000**	**242,100**	**15%**

Note: nc = not calculated. All figures are approximate values derived from GIS data. Totals were computed prior to rounding. Marbled murrelet habitat estimates represent approximate conditions in 2003, as depicted by Raphael et al. (2005) map data, Expert Judgment Model Class 3 and Class 4, and account for stand-replacing timber harvest and fire losses that occurred from 1992 to 2002 (Healey et al. 2003). Habitat-capable acres were summarized directly from Tables 4, 5 9, and 10 in Raphael et al. (2005).

8.3.2.2 Marbled Murrelet Habitat on Forest Practices Habitat Conservation Plan Lands

Of the 9.3 million acres of FPHCP covered lands in Washington, over 5.4 million acres (58 percent) of the covered lands are within the range of the marbled murrelet. Potential murrelet nesting habitat exists on approximately 1.57 million acres in Washington. About 15 percent of potential murrelet nesting habitat is located on FPHCP covered lands (Table 8-27). However, much of the suitable habitat on FPHCP covered lands exists as small isolated patches which may be too fragmented to support murrelets. The 15 percent figure likely over-estimates the actual suitable murrelet habitat on FPHCP covered lands.

8.3.2.3 Conservation Role of the FPHCP Covered Lands for Marbled Murrelets

Lands considered essential to the recovery of the marbled murrelet within Conservation Zones 1 and 2 include all nesting habitat located within the range of the murrelet on Federal lands; nesting habitat on State lands within 40 miles of marine waters; and nesting habitat within occupied murrelet sites on private lands (U.S. Fish and Wildlife Service 1997a). Over 50 percent of the habitat-capable acres within the range of the marbled murrelet in Washington occur on the FPHCP covered lands. Currently only about 15 percent of the extant habitat acres are located on these lands. In areas with few Federal acres (e.g., southwest Washington), the conservation of marbled murrelets is almost entirely dependent upon conservation efforts on State or private lands. In southwest Washington, FPHCP covered lands comprise the majority of that landscape, and many stands have been identified as occupied by murrelets. We consider all occupied murrelet nesting habitat to be important for the conservation of the species (U.S. Fish and Wildlife Service 1997a; 2004f).

We recognize that not all suitable murrelet habitat is currently occupied by marbled murrelets. Unoccupied habitats can also be important for murrelet conservation to provide potential nesting opportunities for displaced breeders and/or first-time breeding adults seeking nesting habitat to colonize (U.S. Fish and Wildlife Service 1997a). Although much of the murrelet habitat that occurs on non-Federal lands is located in small patches or is of marginal quality, suitable habitat on non-Federal lands in landscapes with few Federal acres (e.g., southwest Washington) is important for murrelet recovery because these landscapes currently support small breeding populations of murrelets and represent a substantial portion of the historic range in Washington (U.S. Fish and Wildlife Service 1997a).

Other landscapes (e.g., the Kitsap Peninsula) have small patches (< 5 acres) of potentially suitable habitat scattered over large areas, with few or no documented murrelet detections. When counted together, these small patches of habitat may add up to a substantial figure (e.g., 22,000 acres on the Kitsap Peninsula); however, these areas likely have limited value for murrelet recovery because they lack sufficient stand size to support murrelets; there are limited State or Federal reserves in the area to provide old-growth habitat over time; and non-Federal lands in the area consist primarily of second-growth forests managed for timber production on a 40 – 80 year rotation.

8.3.2.4 Marbled Murrelets on FPHCP Covered Lands

The number of inland marbled murrelet observations documented in Washington has increased over the past few years as surveys on State and private lands have been completed. Much of the existing survey information comes from State lands where WDNR has engaged in a multiple-year survey effort for marbled murrelets on lands managed under the WDNR HCP (WDNR 1997c). Survey requirements associated with the Forest Practices regulations have also resulted in the documentation of many status 1-4 murrelet sites on the FPHCP covered lands. For the purposes of this analysis, we consider the status 1-4 murrelet sites documented in the WDFW database to be the best estimate of the current marbled murrelet sites on FPHCP covered lands.

As of July 2005, there were 4,922 occupied murrelet sites (status 1, 2, or 3) documented in the WDFW database. Status 1-3 sites represent documented nest platforms (*n* = 37), documented sites with juveniles, eggs, or eggshell fragments (*n* = 17), or documented sites where murrelets were observed flying within the forest canopy (*n* = 4,868) (WDFW 2005c). There are an additional 25,246 sites documented where murrelets were heard or observed flying above the forest canopy (site status 4). The database contains observations documented from 1993 through 2005. Due to the apparent decline in murrelet populations in Washington (Huff et al. 2003), these figures may over estimate the actual number of active murrelet sites in Washington.

Status 1-4 murrelet sites are used to identify management areas for murrelets under the Washington Forest Practices Rules (WAC 222-16-080 (j). Most (65 percent) of the potential murrelet nesting habitat in Washington is located on Federal lands (Raphael et al. 2005), but only 27 percent (*n* = 1,339) of the status 1-3 sites are located on Federal lands. This is primarily due to the limited survey effort that has occurred on Federal lands. Most of the status 1-3 murrelet sites documented in Washington (54 percent) occur on WDNR lands (*n* = 2,684). Of the 4,922 status 1-3 murrelet sites that occur in Washington, 848 sites (17 percent) occur on FPHCP covered lands (Table 8-28).

Marbled murrelets in Washington generally use large patches of old-forest or uneven-aged forest with old-growth characteristics for nesting habitat (Hamer and Nelson 1995). Hamer and Nelson (1995) described both landscape and forest stand characteristics of 36 marbled murrelet nest stands in the Pacific Northwest (a stand being defined as a contiguous group of trees with no gaps larger than 330 feet). Nest stands in the Pacific Northwest averaged 510 acres. The smallest nest stand was 7 acres, and the largest was 2,725 acres. Because it is difficult to locate marbled murrelet nests, a 1.5-mile radius circle mapped from the point where murrelets were observed flying within the forest canopy or circling above the forest canopy (occupied behavior) is used to delineate occupied murrelet habitat in Washington (WAC 222-16-080 (j)). All suitable murrelet habitat located within a contiguous stand from the point of observation within the 1.5-mile radius circle is considered to be occupied habitat (Table 8-28).

To evaluate the amount and distribution of occupied murrelet habitat in Washington, we selected the status 1-3 sites and used GIS to map 1.5-mile radius circles around each of these sites. We did not include the status 4 sites because not all status 4 sites listed in WDFW's murrelet database meet the "occupied marbled murrelet site" definition of circling within one tree-height of the forest canopy (WAC 222-16-010). However, we believe the 4,922 status 1-3 sites provide a rough estimate of occupied murrelet habitat on non-Federal lands. Because we were not able to evaluate the contiguity of suitable habitat within the 1.5-mile radius, we simply tallied the total habitat acres in the circles and used these acres as a way to estimate known occupied habitat on the FPHCP covered lands, recognizing that the acres calculated using this method likely overestimates the actual "occupied" acres within contiguous stands.

Occupied marbled murrelet sites are not evenly distributed across the murrelet range in Washington. Occupied sites in Zone 2 comprise 73 percent (*n* = 3,588) of the total status 1-3 sites in the State. This is due to the high level of survey effort in Zone 2, as compared to Zone 1, which comprises a larger area with a substantially larger murrelet population (Miller et al. 2005).

Table 8-28. Known occupied marbled murrelet (MAMU) habitat associated with Status 1-3 murrelet sites.

Murrelet Recovery Zone	Area	Total Status 1-3 MAMU Sites in Zone	Status 1-3 MAMU Sites on FPHCP Covered Lands	Total MAMU Nesting Habitat (acres - all owner-ships)	MAMU Habitat in Status 1-3 Sites – 1.5-mi. radius circles	% of MAMU Habitat in 1.5-mi. radius circles	MAMU Habitat on FPCHP Lands	MAMU Habitat on FPHCP Covered Lands in Status 1-3 Sites – 1.5-mi. radius circles	% of MAMU habitat on FPHCP Covered Lands in Status 1-3 Sites
Zone 1 - Puget Sound/ Strait of Juan de Fuca Olympic Peninsula and Cascades	Coastal (0-40 mi.)	1,327	95	826,300	207,500	25%	165,400	14,300	9%
	Inland (40-55 mi.)	7	0	251,600	9,900	4%	7,300	0	0
Subtotals for Zone 1		**1,334**	**95**	**1,077,900**	**217,400**	**20%**	**172,700**	**14,300**	**8%**
Zone 2 - Pacific Coast - Olympic Peninsula and Southwest Washington	Coastal (0-40 mi.)	3,588	753	471,600	172,000	36%	59,200	11,400	19%
	Inland (40-55 mi.)	0	0	25,500	0	0	10,200	0	0
Subtotals for Zone 2		**3,588**	**753**	**497,100**	**172,000**	**35%**	**69,400**	**11,400**	**16%**
Washington Totals	Coastal (0-40 mi.)	4,915	848	1,297,900	379,500	29%	224,600	25,700	11%
	Inland (40-55 mi.)	7	0	277,100	9,900	3%	17,500	0	0
Totals for Washington		**4,922**	**848**	**1,575,000**	**389,400**	**25%**	**242,100**	**25,700**	**11%**

All figures are approximate values derived from GIS data. Totals were computed prior to rounding. Marbled murrelet habitat estimates represent approximate conditions in 2003, as depicted by Raphael et al. (2005) map data, Expert Judgment Model Class 3 and Class 4, and account for stand-replacing timber harvest and fire losses that occurred from 1992 to 2002 (Healey et al. 2003). Habitat-capable acres were summarized directly from Tables 4, 5, 9, and 10 in Raphael et al. (2005).

Over 99 percent of the status 1-3 murrelet sites occur in the coastal areas from 0-40 miles inland. Few occupied sites ($n = 7$) occur in the inland area from 40 to 55 miles inland. Overall, about 25 percent of the potential murrelet nesting habitat in Washington is associated with the status 1-3 sites, and about 11 percent of the murrelet habitat on the FPHCP covered lands is associated with status 1-3 sites (Table 8-28).

8.3.2.5 Marbled Murrelet Habitat in the FPHCP Riparian Management Zones

Due to the high density of rivers and streams in Washington, riparian areas occupy a substantial portion of the landscape. Within the range of the marbled murrelet in Washington, the RMZs comprise about 13 percent of the total FPHCP acres. About 15 percent of all suitable marbled murrelet habitat on the

FPHCP covered lands is located in RMZs. However, less than 5 percent of the RMZ acres contain mature or old-forest habitat that is potentially suitable for marbled murrelets (Table 8-29).

Table 8-29. Marbled murrelet (MAMU) potential nesting habitat in riparian management zones (RMZs) on the FPHCP covered lands (acres).

Murrelet Recovery Zone	Area	Acres in Type S RMZs	Acres in Type F RMZs	Acres in Type Np RMZs	Total Acres in RMZs	Occupied MAMU Habitat in RMZs (status 1-3 sites)	FPHCP Covered Lands (acres) and %
Zone 1 - Puget Sound/Strait of Juan de Fuca - Olympic Peninsula and Cascades	Total Acres	94,600	164,600	63,900	323,100	nc	2,902,200
	Potential MAMU Habitat	9,000	11,000	4,400	24,400	2,500	172,700
	Percent of MAMU habitat in RMZs	5%	6%	3%	14%	1%	14%
Zone 2 - Pacific Coast - Olympic Peninsula and Southwest Washington	Total Acres	103,600	241,600	62,600	407,700	nc	2,556,800
	Potential MAMU Habitat	4,000	6,000	1,800	11,800	2,500	69,400
	Percent of MAMU habitat in RMZs	6%	9%	3%	17%	4%	17%
Washington Totals	Total Acres	198,100	406,200	126,500	730,800	nc	5,459,000
	Potential MAMU Habitat	13,000	17,000	6,200	36,200	5,000	242,100
	Percent of MAMU habitat in RMZs	5%	7%	3%	15%	2%	15%

Notes: nc= not calculated. All figures are approximate values derived from GIS data. Totals were computed prior to rounding. Marbled murrelet habitat estimates represent approximate conditions in 2003, as depicted by Raphael et al. (2005) map data, Expert Judgment Model Class 3 and Class 4, and account for stand-replacing timber harvest and fire losses that occurred from 1992 to 2002 (Healey et al. 2003). Riparian areas include average RMZ widths along Type S, F, and Np stream types based on the average 100-year site-potential tree height for site index 2 and 3.

Marbled murrelets are known to locate their nests throughout forest stands and fragments, including various types of natural and man-made edges (McShane et al. 2004). Riparian forests can provide potential nest sites for marbled murrelets if the appropriate structures are present (e.g., large trees with suitable nest platforms located within a patch of suitable nesting habitat). McShane et al. (2004) reviewed several studies describing murrelet nest locations and summarized their review: "Most of the nests occurred along edges (76 %), but in most cases these were natural edges (59%). [In this review, edge areas were defined as within 50 meters of an edge]….Nests on natural edges occur along streams, wetlands, forest gaps, large natural openings, or avalanche chutes". In summary, marbled murrelets may select riparian areas for nesting if the appropriate habitat features are available. Murrelets appear to require canopy gaps to access nest sites, and many nest sites documented by research studies have been located along natural edges such as stream corridors or wetland areas. However, there are no studies that demonstrate that murrelets specifically select edge habitats over other available habitats (e.g., interior forest) (McShane et al. 2004).

There are currently 848 status 1-3 marbled murrelet sites documented on the FPHCP covered lands, and 243 sites are located in mapped RMZs (27 percent). The status 1-3 sites are locations where a murrelet observation was documented, and are not necessarily an indication of an actual nest location within the RMZ. Of the 25,700 acres of occupied murrelet habitat on the FPHCP covered lands, about 5,000 acres (19%) are located in RMZs (Table 8-29). This information suggests that riparian forests on the FPHCP covered lands can provide important habitat for marbled murrelets if suitable nesting habitat is present in sufficient quantities (i.e., large, contiguous patches of uneven-aged or old-forest habitat) to support nesting murrelets.

8.3.2.6 Marbled Murrelet Habitat Management under the Washington Forest Practices Rules

Marbled murrelets in Washington are protected under both State and Federal regulations. The Washington Fish and Wildlife Commission listed the marbled murrelet as a State threatened species, and the murrelet was listed as a Federal threatened species in 1992. The Washington Forest Practice regulations require that both State and federally listed species be considered for designation of "critical habitat state" – a designation that serves as a trigger for State Environmental Policy Act (SEPA) review (WAC 222-16-050(1)(b)). In addition, Section 9 of the ESA prohibits "take" of listed species. Together, the State and Federal regulations provide a framework for marbled murrelet management guidelines in Washington.

Timber harvest on the FPHCP covered lands is subject to the provisions of the Washington Forest Practices Rules for marbled murrelets that were adopted by the Forest Practices Board in 1996 (WAC 222-10-042). The Washington Forest Practices Rules for murrelets were adopted by the Forest Practices Board because the Board recognized that the protection of occupied murrelet habitat on State and private lands would contribute to the overall conservation of marbled murrelets in Washington (Washington Forest Practices Board 1996). Generally, the Washington Forest Practices Rules are designed to identify and protect occupied murrelet habitat on non-Federal lands through survey requirements and the SEPA review process.

Important Definitions Pertaining to Marbled Murrelets

The Washington Forest Practice Rules contain several specific definitions that pertain to the identification and management of marbled murrelet habitat (WAC 222-16-010). We refer to these definitions whenever the following terms are used in our analysis of the environmental baseline and the effects to murrelets:

"Critical nesting season" means for marbled murrelets April 1 to August 31.

"Daily peak activity" means for marbled murrelets – one hour before official sunrise to two hours after official sunrise and one hour before official sunset to one hour after official sunset.

"Marbled murrelet detection area" means an area of land associated with a visual or audible detection of a marbled murrelet, made by a qualified surveyor which is documented and recorded in the WDFW database. The marbled murrelet detection area shall be comprised of the section of land in which the marbled murrelet detection was made and the eight sections of land immediately adjacent to that section.

“Marbled murrelet nesting platform” means any horizontal tree structure such as a limb, an area where limb branches, a surface created by multiple leaders, a deformity, or a debris/moss platform or stick nest equal to or greater than 7 inches in diameter including associated moss if present, that is 50 feet or more above the ground in trees 32 inches dbh and greater (generally over 90 years of age) and is cabable of supporting nesting by marbled murrelets.

“Occupied marbled murrelet site” means:

1. A contiguous area of suitable marbled murrelet habitat where at least one of the following marbled murrelet behaviors or conditions occur:
    a. A nest is located; or
    b. Downy chicks or eggs or egg shells are found; or
    c. Marbled murrelets are detected flying below, through, into or out of the forest canopy; or
    d. Birds calling from a stationary position within the area; or
    e. Birds circling above a timber stand within one tree height of the top of the canopy; or,
2. A contiguous forested area which does not meet the definition of suitable marbled murrelet habitat, in which any of the behaviors or conditions listed above has been documented by the WDFW and which is distinguishable from the adjacent forest based on vegetative characteristics important to nesting marbled murrelets.
3. For sites defined in (1) above, the outer perimeter of the occupied site shall be presumed to be the closer, measured from the point where the observed behaviors or conditions listed in (1) above occurred, of the following:
    a. 1.5 miles from the point where the observed behaviors or conditions listed in (1) above occurred; or
    b. The beginning of any gap greater than 300 feet wide lacking one or more of the vegetative characteristics listed under “suitable marbled murrelet habitat”; or
    c. The beginning of any narrow area of “suitable marbled murrelet habitat” less than 300 feet in width and more that 300 feet in length.
4. For sites defined under (2) above, the outer perimeter of the occupied site shall be presumed to be the closer, measured from the point where the observed behaviors or conditions listed in (1) above occurred, of the following:
    a. 1.5 miles from the point where the observed behaviors or conditions listed in (1) above occurred; or
    b. The beginning of any gap greater than 300 feet wide lacking one or more of the distinguishing vegetative characteristics important to murrelets; or
    c. The beginning of any narrow area of “suitable marbled murrelet habitat” less than 300 feet in width and more that 300 feet in length.

5. In determining the existence, location, and status of occupied marbled murrelet sites, the WDNR shall consult with the WDFW and use only those sites documented in substantial compliance with guidelines or protocols and quality-control methods established by and available from the WDFW.

"Suitable marbled murrelet habitat" means a contiguous forested area containing trees capable of providing nesting opportunities:

1. With all of the following indicators unless the WDNR, in consultation with the department of fish and wildlife, has determined that the habitat is not likely to be occupied by marbled murrelets:
   a. Within 50 miles of marine waters;
   b. At least 40 percent of the dominant and co-dominant trees are Douglas-fir, western hemlock, western red cedar, or Sitka spruce;
   c. Two or more nesting platforms per acre;
   d. At least 7 acres in size, including the contiguous forested area within 300 feet of nesting platforms, with similar forest stand characteristics to the forested are in which the nesting platforms occur.

8.3.2.7 Class IV-Special Forest Practices Activities Affecting Marbled Murrelets

Timber harvesting and road construction within an occupied marbled murrelet site, or timber harvesting or road construction in suitable habitat within a marbled murrelet detection area are considered "likely to have a probable significant adverse impact on the environment." Such activities are considered "Class-IV-Special" and therefore require the development of an Environmental Impact Statement under SEPA regulations (WAC 222-10-042). Under the "Class-IV-Special" regulations, WDNR makes a decision to approve individual Forest Practices Applications based upon a significance determination. If a determination of significance is made, preparation of a State Environmental Policy Act - Environmental Impact Statement is required prior to proceeding. If a determination of non-significance or mitigated determination of non-significance is reached, the action can proceed without further environmental assessment. Other "Class-IV Special" activities include harvesting suitable habitat outside of marbled murrelet detection areas with at least a 60 percent probability of occupancy (i.e., 7 platforms per acre); or, harvesting of suitable habitat outside murrelet detection areas with at least a 50 percent probability of occupancy (i.e., 5 platforms per acre) within the southwest Washington marbled murrelet special landscape (WAC 222-16-087).

Generally, once an occupied marbled murrelet site is documented, the suitable habitat in the occupied site is protected from timber harvest. Occupied murrelet sites are further protected with a 300-foot managed buffer zone adjacent to the occupied site. This rule protects occupied sites by prohibiting clearcut timber harvest within 300 feet of the occupied stand (WAC 222-16-080 (j)(v)). Under the managed buffer rule, trees within the managed buffer may be thinned to a density of 75 trees per acre. The primary consideration for the design of the managed buffer is to mediate edge effects to occupied sites.

Occupied marbled murrelet habitat is further protected from disturbance-associated forest practice activities. Restricted activities include road construction, operation of heavy equipment, blasting, timber felling, yarding, helicopter operations, slash disposal, or prescribed burning. These activities are prohibited within 0.25 miles of an occupied marbled murrelet site during the daily peak activity periods within the critical nesting season (April 1 through August 31) (WAC-222-30-050, -060, -065, -070, -100).

Exemptions to the "Class IV Special" Rules for Marbled Murrelets

The critical habitat (State) rules listed above do not apply where a landowner owns less than 500 acres of forestland and the land does not contain an occupied murrelet site. Therefore, if a small landowner has suitable murrelet habitat that is not part of an occupied site, this habitat could be harvested without a SEPA review. Additionally, any suitable murrelet habitat on private lands outside of occupied murrelet sites may be harvested where a protocol survey (WAC 222-12-090(14)) has been conducted and no murrelets were detected. Currently, the Washington Forest Practices Rules refer to the most recent version of the Pacific seabird survey protocol in effect January 6, 2003 (Evans Mack et al. 2003). Other exemptions to the Class IV-Special marbled murrelet rules include areas that are managed under a completed HCP for marbled murrelets approved by the FWS, or a special wildlife management plan that has gone through SEPA review (WAC 22-16-080 (6)).

In summary, the Washington Forest Practices Rules for marbled murrelets are designed to identify and protect occupied murrelet habitat on non-Federal lands within 50 miles of marine waters. There are few documented murrelet observations located beyond 50 miles from marine waters (n = 6 out of 30,168 sites), but survey efforts for murrelets in this region have been limited. The Washington Forest Practices Rules emphasize protecting habitat in occupied sites and in detection areas, and in areas with a high probability of occupancy. Potential nesting habitat that is not protected by the Washington Forest Practices Rules are areas that occur on small land ownerships that do not contain an occupied murrelet site; locations outside of murrelet detection areas with few nesting platforms (low probability of occupancy); or, areas that have been surveyed to protocol and murrelets were not detected.

8.3.2.8 Potential Marbled Murrelet Nesting Habitat in Marbled Murrelet Detection Areas

We analyzed the amount of potential murrelet nesting habitat on FPHCP covered lands that occurs in the marbled murrelet detection areas. Marbled murrelet detection areas include the section of land where a status 1-4 murrelet observation was documented, and the 8 surrounding sections. This analysis indicated that overall about 20 percent (47,900 acres) of the murrelet habitat on FPHCP covered lands is located in murrelet detection areas. In Zone 1, about 18 percent of the potential habitat in the coastal zone of the FPHCP covered lands is in detection areas; in Zone 2, about 31 percent of the potential habitat in the coastal zone FPHCP covered lands is in detection areas (Table 8-30). We also found that there was high level of overlap (>90 percent) of habitat acres located in the occupied sites (Table 8-28) and the murrelet detection areas.

The murrelet detection areas are important because all suitable murrelet habitat (i.e., ≥ 2 platforms per acre) in these areas requires a protocol survey prior to timber harvest, and occupied sites detected in these areas are managed for murrelet conservation. Outside the detection areas murrelet habitat is at a greater risk of harvest because only sites with a high probability of occupancy have a pre-harvest survey requirement. Determining which areas meet the criteria for high probability of occupancy (e.g., 5-7 platforms per acre) requires field surveys for verification. Landowners can request that WDFW perform these surveys; or they could hire a qualified contractor to conduct pre-harvest surveys.

Table 8-30. Marbled murrelet potential nesting habitat in marbled murrelet detection areas. Detection areas include the section in which a status 1-4 murrelet site is documented, and the 8 surrounding sections.

Murrelet Recovery Zone	Area	Total Murrelet Nesting Habitat (acres - all ownerships)	Murrelet Nesting Habitat in Detection Area (acres - all ownerships)	% of Murrelet Nesting Habitat in Detection Areas (acres - all ownerships)	Murrelet Nesting Habitat on FPHCP Covered Lands (acres)	Murrelet Nesting Habitat in Detection Areas on FPHCP Covered Lands (acres)	% of Murrelet Nesting Habitat in Zone on FPHCP Covered Lands
Zone 1 - Puget Sound/ Strait of Juan de Fuca -	Coastal (0-40 mi.)	826,300	362,900	44%	165,400	29,100	18%
Olympic Peninsula and Cascades	Inland (40-55 mi.)	251,600	27,600	11%	7,300	200	2%
Subtotals for Zone 1		**1,077,900**	**390,500**	**36%**	**172,700**	**29,200**	**17%**
Zone 2 - Pacific Coast - Olympic	Coastal (0-40 mi.)	471,600	249,000	53%	59,200	18,400	31%
Peninsula and Southwest Washington	Inland (40-55 mi.)	25,500	18,400	72%	10,200	200	2%
Subtotals for Zone 2		**497,100**	**267,400**	**54%**	**69,400**	**18,600**	**27%**
Washington Totals	Coastal (0-40 mi.)	1,297,900	611,900	47%	224,600	47,500	21%
	Inland (40-55 mi.)	277,100	46,000	17%	17,500	400	2%
Totals for Washington		**1,575,000**	**657,900**	**42%**	**242,100**	**47,900**	**20%**

Note: All figures are approximate values derived from GIS data. Marbled murrelet habitat estimates represent approximate conditions in 2003, as depicted by Raphael et al. (2005) map data, Expert Judgment Model Class 3 and Class 4, and account for stand-replacing timber harvest and fire losses that occurred from 1992 to 2002 (Healey et al. 2003).

We currently have no reliable way of identifying the high probability suitable habitat acres with the murrelet habitat suitability maps developed by Raphael et al. (2005). These maps provide categories of suitability, with Class 4 representing the highest-quality habitat based on coarse-scale measures such as percent conifer cover, quadratic mean diameter, patch size, etc. (Raphael et al. 2005). On the FPHCP covered lands in the coastal areas (0-40 miles inland) about 63 percent of the potential murrelet habitat is Class 3 “moderate suitability” habitat, and 37 percent is Class 4 “highest suitability” habitat. In contrast, only about 15 percent of the potential murrelet habitat on Federal lands in the coastal areas is Class 3 habitat, and 85 percent is Class 4 habitat. However, these coarse-scale indicators do not provide an indication of nesting platforms per acre.

8.3.2.9 Timber Harvest on FPHCP Covered Lands within the Range of the Marbled Murrelet

We estimated the annual rates of timber harvest on the FPHCP covered lands for the period of 1992 – 2002 using the data compiled by Healey et al. (2003). This map data depicts stand replacing disturbance associated with timber harvest and wildfire, but does not portray changes associated with partial harvests such as commercial thinning. Within the range of the marbled murrelet in Washington, we found that stand-replacing timber harvest is occurring at a rate of about 1.2 percent per year on the FPHCP covered lands (Table 8-31). For the 10 year period of 1992-2002, there were over 66,000 acres of timber harvested annually (all forest types). Over 99.3 percent of the acres were identified as timber harvest, only about 430 acres were identified as stand-replacing wildfire.

Table 8-31. Timber harvest from 1992 – 2002 within the range of the marbled murrelet in Washington.

Murrelet Recovery Zone	Area	Total Acres of Timber Harvest 1992-2002 (all ownerships)	Total Acres of Timber Harvest on FPHCP Covered Lands (1992-2002)	% of Total Acres of Timber Harvested that occurred on FPHCP Covered Lands (1992-2002)	Total FPHCP Acres in Zone	% of Acres of Timber Harvested on FPHCP Covered Lands (1992-2002)
Zone 1 - Puget Sound/Strait of Juan de Fuca - Olympic	Coastal (0-40 mi.)	342,600	265,100	77%	2,838,500	9%
Peninsula and Cascades	Inland (40-55 mi.)	16,700	6,900	41%	63,700	11%
Subtotals for Zone 1		**359,300**	**272,000**	**76%**	**2,902,200**	**9%**
Zone 2 - Pacific Coast - Olympic	Coastal (0-40 mi.)	417,100	328,800	79%	2,176,400	15%
Peninsula and Southwest Washington	Inland (40-55 mi.)	68,700	62,200	91%	380,400	16%
Subtotals for Zone 2		**485,800**	**391,000**	**80%**	**2,556,800**	**15%**
Washington Totals	Coastal (0-40 mi.)	759,700	593,900	78%	5,014,900	12%
	Inland (40-55 mi.)	85,400	69,100	81%	444,100	16%
Totals for Washington		**845,100**	**663,000**	**78%**	**5,459,000**	**12%**

All figures are approximate values derived from GIS data. Totals were computed prior to rounding. Marbled murrelet habitat estimates represent approximate conditions in 2003, as depicted by Raphael et al. (2005) map data, Expert Judgment Model Class 3 and Class 4, and account for stand-replacing timber harvest and fire losses that occurred from 1992 to 2002 (Healey et al. 2003).

We estimated the acres of potential marbled murrelet habitat removed by overlaying the Healey et al. (2003) disturbance data with the Raphael et al. (2005) EJM Class 3-4 habitat suitability maps. The information derived from this analysis provides a general estimate of the rate of habitat loss in Washington, but does not represent absolute values. We found that over 65,000 acres of marbled murrelet habitat was harvested from 1992 - 2002 on all lands in Washington, representing a decadal loss of about 4 percent (Table 8-32). Timber harvest on the FPHCP covered lands accounted for about 80 percent of the total habitat acres removed (51,900 acres). Harvest on Federal, tribal, or other HCP-covered lands accounted for the remaining 20 percent of habitat loss.

Table 8-32. Estimated acres of potential marbled murrelet (MAMU) habitat harvested on FPHCP covered lands 1992-2002.

Murrelet Recovery Zone	Area	Potential MAMU nesting habitat circa 1994 on all ownerships (acres)	MAMU potential nesting habitat harvested 1992-2002 (all owner-ships)(acres)	Potential MAMU nesting habitat on FPHCP covered lands circa 1994 (acres)	Potential MAMU nesting habitat harvested on FPHCP covered lands 1992-2002 (acres)	% of Potential MAMU nesting habitat harvested on FPHCP covered lands 1992-2002
Zone 1 - Puget Sound/Strait of Juan de Fuca - Olympic	Coastal (0-40 mi.)	864,400	38,100	193,600	28,200	15%
Peninsula and Cascades	Inland (40-55 mi.)	253,500	2,000	9,200	1,900	20%
Subtotals for Zone 1		**1,117,900**	**40,100**	**202,800**	**30,100**	**15%**
Zone 2 - Pacific Coast - Olympic Peninsula and	Coastal (0-40 mi.)	492,800	21,200	77,600	18,400	24%
Southwest Washington	Inland (40-55 mi.)	29,300	3,800	13,500	3,400	25%
Subtotals for Zone 2		**522,100**	**25,000**	**91,100**	**21,800**	**24%**
Washington Totals	Coastal (0-40 mi.)	1,357,200	59,300	271,200	46,600	17%
	Inland (40-55 mi.)	282,800	5,800	22,700	5,300	23%
Totals for Washington		**1,640,000**	**65,100**	**293,900**	**51,900**	**18%**

All figures are approximate values derived from GIS data. Totals were computed prior to rounding. Marbled murrelet habitat estimates represent approximate conditions in 2003, as depicted by Raphael et al. (2005) map data, Expert Judgment Model Class 3 and Class 4, and account for stand-replacing timber harvest and fire losses that occurred from 1992 to 2002 (Healey et al. 2003).

Timber harvest on the FPHCP covered lands removed about 18 percent of the potential murrelet habitat that was present in 1992-1996. Most of the habitat loss (54 percent) occurred in coastal Zone 1 (0-40 miles inland), and about 37 percent occurred in coastal Zone 2. Only about 10 percent of habitat loss occurred in the inland zones (40 -55 miles inland) (Table 8-32). The average rate of murrelet habitat loss on the FPHCP covered lands was about 1.5 percent per year in Zone 1, and about 2.4 percent per year in

Zone 2. It is important to note that much of the habitat loss that has occurred over the past decade has occurred in small, isolated patches that presumably had a low probability of occupancy, or, occurred in areas that were surveyed to protocol and murrelets were not detected.

8.3.2.10 Federally Designated Marbled Murrelet Critical Habitat

Federally designated marbled murrelet critical habitat in Washington covers approximately 1.2 million acres distributed across 10 critical habitat units (Critical Habitat Units). Each Critical Habitat Unit is comprised of several subunits. There are a total of 33 critical habitat subunits in Washington ranging from 200 acres to over 108,000 acres in size. Lands designated were those areas identified as essential to the conservation of the marbled murrelet, with the major foundation of the designation being Federal lands managed under the Northwest Forest Plan (U.S. Fish and Wildlife Service 1996a). For this analysis, we refer to these subunits as Critical Habitat Units. Using the Raphael et al. (2005) EJM Class 3-4 habitat model, we estimated that the Critical Habitat Units in Washington encompass a total of approximately 401,200 acres of potential murrelet habitat. This represents approximately 33 percent of the designated acres. There is a high percentage of second-growth forest and some naturally non-suitable habitat areas within the Critical Habitat Units. Over 99 percent of the Critical Habitat Units in Washington are located on Federal lands that are managed as Late-Successional Reserves under the Northwest Forest Plan.

There are approximately 2,500 acres designated critical habitat that occur on private lands, including about 2,300 acres on the FPHCP covered lands. Under the Washington Forest Practices Rules, federally designated critical habitat on non-Federal lands is managed under the provisions of the State's marbled murrelet rule (WAC 222-16-080(2)). The designated private lands occur primarily in coastal Zone 2, in southwest Washington. All of the private lands that are within designated critical habitat occur within 1.5-mile radius circles surrounding status 1-3 occupied murrelet sites. Therefore, all occupied murrelet habitat within these non-Federal Critical Habitat Units is protected under the existing Washington Forest Practice Rules.

8.3.3 EFFECTS OF THE ACTION – Marbled Murrelet and Marbled Murrelet Critical Habitat

8.3.3.1 Context of the Effects Analysis

The analysis for the marbled murrelet and its designated critical habitat includes only those effects that would be expected to occur as effects of permit issuance, such as the effects of timber-harvest activities in the Riparian Zone (of influence) and road-related activities. The framework for analysis section of this Opinion described the primary activities that are considered effects of permit issuance for the FPHCP. Future timber harvest activities in upland areas would be essentially unchanged by permit issuance for the FPHCP, and therefore these activities are not analyzed in this section, but will be addressed in the analysis of cumulative effects.

Our analysis in this Opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead we have relied upon the statute and the August 6, 2004, Ninth Circuit Court of Appeals decision in Gifford Pinchot Task Force v. U.S. Fish and Wildlife Service (No. 03-35279) to complete the following analysis with respect to critical habitat.

8.3.3.2 Effect Determinations For Marbled Murrelet and Marbled Murrelet Critical Habitat

We have determined that the forest practices activities covered under the FPHCP "may affect, and is likely to adversely affect" the marbled murrelet and federally designated marbled murrelet critical habitat. The effect determination for marbled murrelets is based on our assessment that the effects of activities under the Permit are likely to result in the degradation and loss of marbled murrelet habitat on the FPHCP covered lands. The effect determination for critical habitat is based on our assessment that the forest practices activities are likely to result in the degradation and loss (i.e., due to windthrow) of suitable marbled murrelet critical habitat. Therefore, in accordance with section 7(a)(2) of the ESA, we have prepared the following effects analysis of the proposed Federal action (i.e., issuance of the FPHCP incidental take permit for aquatic species) for the marbled murrelet and its designated critical habitat.

8.3.3.3 Assumptions Regarding Incidental Take of Marbled Murrelets

The marbled murrelet is not a covered species under the FPHCP; therefore, we do not anticipate or authorize any incidental take of marbled murrelets associated with the implementation of the FPHCP. Any "take" would violate the prohibitions in Section 9 of the ESA, and would therefore invalidate the FPHCP Permit with respect to all listed covered species for that forest practices application that resulted in unauthorized "take." ESA section 3(19) defines the term "take" to include "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct". The terms "harm" and "harass" have been further defined by regulations at 50 CFR §17.3 as follows:

Harass means an intentional or negligent act or omission that creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns that include, but are not limited to, breeding, feeding, or sheltering.

Harm means an act that actually kills or injures wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering.

Marbled murrelets are likely to be taken as a result of activities that: (1) kill or injure birds; (2) impair essential behaviors by adversely affecting occupied or unsurveyed suitable breeding habitat; or (3) cause significant disturbance of breeding birds, leading to reduced reproductive success (U.S. Fish and Wildlife Service 1997a).

In the absence of a federally-approved HCP or a State-approved special wildlife management plan, suitable murrelet habitat on non-Federal lands is only protected by the Washington Forest Practices Rules where protocol surveys document an occupied murrelet site. Due to specific exemptions within the Washington Forest Practices Rules, a landowner in Washington could be in full compliance with the Forest Practices regulations and have some risk of causing "take" if their forest practices activity resulted in the loss of occupied marbled murrelet habitat (i.e., take). These situations include:

3. Timber harvesting or road construction in suitable marbled murrelet habitat that occurs outside marbled murrelet detection areas. Outside murrelet detection areas, only habitat that has a high probability of murrelet occupancy (i.e., ≥ 5-7 nest platforms/acre, depending on the location) is required to be surveyed prior to harvest (WAC 222-16-080(j)(iii) and (iv)). Murrelet habitat with fewer than 5-7 platforms per acre has a lower probability of occupancy. However, lower platform density does not ensure that the habitat is unoccupied by marbled murrelets. Timber harvest that removes suitable murrelet habitat without pre-harvest protocol

surveys can potentially result in the loss of occupied habitat and take of marbled murrelets (U.S. Fish and Wildlife Service 1997a).

4. Timber harvesting or road construction in suitable marbled murrelet habitat that occurs where a landowner owns less than 500 acres and the land does not contain a known occupied murrelet site (WAC 222-16-080(j)(vi). Landowners with less than 500 acres are not required by the Washington Forest Practices Rules to conduct pre-harvest marbled murrelet surveys. Therefore, if a small landowner has suitable murrelet habitat on their property that is not part of a known occupied site, this habitat could be harvested without a SEPA review or pre-harvest surveys, potentially resulting in the loss of occupied habitat and take of marbled murrelets.

5. Timber harvesting along Federal boundary areas with suitable murrelet habitat. Unless there is an occupied murrelet site documented on the adjacent Federal lands to trigger the protections of the Washington Forest Practices Rules for marbled murrelets, a landowner could harvest timber (non-habitat) up to the Federal boundary, potentially resulting in a significant disruption of murrelet breeding if the harvest occurs during the nesting season (harassment). Clearcut harvest could also result in long-term adverse effects to the suitable habitat on adjacent Federal lands associated with exposed clearcut boundaries. There are few occupied murrelet sites documented on Federal lands, so the Washington Forest Practices Rules that require seasonal restrictions to avoid disturbance, and managed buffers to avoid edge effects to occupied murrelet sites may not be applied to Federal boundary areas. Some boundary areas may be identified and protected under the SEPA review process, but it is not clear to the FWS that WDNR will identify suitable murrelet habitat on Federal boundary areas as likely to be occupied habitat.

The above situations represent the greatest risk for landowners to have a potential violation of section 9 of the ESA (i.e., unauthorized incidental take).

Other situations that have the potential to result in take of marbled murrelets include: (1) harvesting suitable murrelet habitat that is located farther than 50 miles from marine waters; (2) disturbance harassment associated with forest practices; (3) harvesting suitable murrelet habitat that occurs in stands less than 7 acres in size; and (4) harvesting occupied murrelet habitat that has been surveyed to protocol, but the surveys failed to detect murrelets (i.e., survey error). Even though each of these situations has the potential to result in the loss of occupied murrelet habitat, the risk of incidental take in these situations is relatively low.

Although a few murrelets sightings have been documented beyond 50 miles from marine waters, there are no known nest sites or observations of behavior indicating occupancy in this region. We have not identified these far inland areas as important for recovery (U.S. Fish and Wildlife Service 1997a). The majority of suitable murrelet habitat that occurs beyond 50 miles from marine waters is located on Federal lands and is protected by the standards and guidelines for land management under the Northwest Forest Plan.

We expect that some sound and activity- related disturbances (i.e., harassment) to nesting murrelets may occur on the FPHCP covered lands and adjacent ownerships, but the risk for potential injury to murrelets is relatively low due to the 0.25-mile disturbance buffers and daily activity restrictions required by the Washington Forest Practices Rules. The Washington Forest Practices Rules minimize the potential for adverse effects from disturbance associated with forest practices to nesting murrelets, but they do not ensure that all murrelets will be protected from disturbance under all circumstances. Blasting within a mile of an occupied murrelet site, unrestricted activities during the mid-day hours, and unrestricted forest practices during the late nesting season (September) are all situations which may result in murrelets flushing from a nest, aborted feedings, or postponed feedings. Additionally, timber harvesting or other forest practice activities adjacent to unsurveyed, suitable habitat on Federal lands could result in harassment of murrelets nesting on Federal lands.

There is no known minimum patch size for marbled murrelet nesting habitat. Murrelets occupancy has been documented in stands as small as 5 acres (D. Lynch, Personal Communication, 2006). The Washington Forest Practices Rules define suitable murrelet habitat as having a minimum stand size of 7 acres (WAC 222-16-010). Because murrelets require only a single tree with suitable nest platforms surrounded by other trees to provide some cover for nesting, suitable habitat that occurs in patches smaller than 7 acres in size could be occupied by murrelets. We have not assessed the risk associated with the potential loss of murrelet habitat that occurs in small patches (i.e., patches less than 7 acres in size). However, the risk of predation and reproductive failure for murrelets is expected to be high in small habitat patches (U.S. Fish and Wildlife Service 1997a). Small patches of habitat have a greater proportion of edge area than do large patches. Nelson and Hamer (1995b) found that successful murrelet nests were significantly further from edge than unsuccessful nests, and cover directly around the nest was significantly greater at successful nests. These findings suggest that murrelet habitat that occurs in small patches may be less important for species recovery due to higher risks of predation and nest failure, but small patch size itself does not ensure that the habitat is unoccupied by murrelets. Because murrelets have rarely been documented nesting in patches smaller than 7 acres, we expect there is a relatively low risk of take in these areas. However, there is a potential for take of marbled murrelets to occur where small patches of unsurveyed suitable habitat are removed.

Both the FWS and the State management agencies (i.e., WDNR and WDFW) are currently relying on the Pacific Seabird Groups' marbled murrelet survey protocol to determine if potential habitat is occupied by nesting murrelets (Evans Mack et al. 2003). This protocol is not error-free, but given the paucity of information on this species and its cryptic behavior, the protocol represents the best available method for determining the murrelet occupancy in potential habitat. Therefore, we assume that take of murrelet is not likely in suitable habitat that has been surveyed to protocol with no occupancy.

8.3.3.4 Summary of the Terrestrial Effects of Timber Harvest in FPHCP Riparian Management Zones

The following is a summary description of the terrestrial effects of the FPHCP riparian management rules. This general overview provides the context for the more detailed analysis of the direct, indirect, and cumulative effects to marbled murrelet and marbled murrelet critical habitat which follows.

Option 1 – Thinning from Below

Under Option 1 (thinning from below), RMZs along Type S or F streams can be managed with partial-harvest strategies in the inner and outer zones. The overall effect is that the Core Zone immediately adjacent to streams will remain intact (i.e., no harvest except at road-crossings and yarding corridors). The Inner Zones may have some "thinning from below" but large trees and a fairly contiguous canopy cover are likely to be retained. At a minimum, at least 57 trees per acre must be retained within the Inner Zone, and the percent of conifer composition within the inner zone cannot be reduced. The Outer Zone can be thinned much more heavily, down to 20 trees per acre, which results in a clearcut with a few scattered trees retained in dispersed or clumped groups to meet the average 20 trees per acre retention requirement. Overall, we estimate 40-60 percent of the existing pre-harvest trees within a site-potential tree height (90 – 200 feet) in the Type S or F RMZs will be retained. In western Washington, upland areas beyond the Outer Zone will most likely be clearcut, although commercial thinning is another harvest method that is used in upland timber harvest.

The short-term physical effects of thinning within the Inner Zone include reduced stem density (trees per acre), reduced overstory canopy cover, reductions in the density of standing snags, and potential reduction in decayed down logs on the forest floor. Species composition may be altered as well, if Inner Zone harvest focuses on the removal of hardwoods or targets specific conifer species. The physical effects of felling trees and removing logs via yarding or other means can result in short-term destruction of understory plants and soil-dwelling organisms. Heavy thinning that occurs in the Outer Zone represents a stand-replacing disturbance that removes greater than 80 percent of the existing overstory trees. Equipment used to harvest timber generates loud sounds that may carry into adjacent forests resulting in short-term disturbance or displacement of wildlife, and post-harvest slash-burning may generate smoke that carries into adjacent stands. If upland areas adjacent to the Inner and Outer Zones are clearcut, the RMZ area which may have had some interior forest characteristics will become an exposed edge habitat, with increased solar radiation, increased fluctuations in temperatures, and increased exposure to windthrow. We anticipate that windthrow and edge effects could occur for distances up to 400 feet into adjacent stands from exposed edges. The edge habitat condition along exposed clear-cut edges will gradually dissipate over time as adjacent upland stands regenerate over a period of 30 to 40 years.

Although there are short-term negative effects associated with thinning, treated stands that are relatively young (i.e., 40-60 years old) tend to recover quickly with increased tree growth (U.S. Forest Service 2002). Positive long-term effects of thinning can include increased growth of trees, increased crown differentiation, increased development of understory vegetation, and increased flowering and fruiting of understory plants (Carey 2004).

Option 2 – Leaving Trees Closest to the Water

Under Option 2 (leaving trees closest to the water), landowners may forego the thinning from below guidelines and harvest trees within the Inner and Outer Zones if the Desired Future Condition (DFC) objectives for the RMZ can be met. In Option 2, trees within 80 to 100 feet of Type F streams (depending on stream size) will be remain intact (no harvest except at road crossings and yarding corridors), while trees from 80 to 100 feet out to 140 to 200 feet (Inner and Outer Zones) may be harvested down to a minimum of 20 trees per acre. Under Option 2, the overall width of potential mature forest development in the RMZs is reduced by 50 to 70 feet, or about 30 to 40 percent over Option 1. Overall, about 45 to 60 percent of the existing pre-harvest riparian trees (within the 100-year site index tree height, 140 to 200 feet) are retained in the short-term to provide for the DFC of a mature riparian stand over time.

Another management option available to landowners is to not harvest timber within the Inner Zone. Under this option, no timber harvest occurs within the Core Zone or the Inner Zone of the RMZ. The Outer Zone may be heavily thinned down to a minimum retention of 20 trees per acre. This option is similar to Option 2; however, no Inner Zone harvest retains about 75 to 80 percent of the existing pre-harvest trees. To date, Option 2, and the no Inner Zone harvest options have been the most-commonly used methods applied for riparian management on the FPHCP covered lands.

The physical effects under Option 2 are similar to the effects described for Outer Zone harvest above under Option 1. The Inner and Outer Zones (beyond 80-100 feet from the stream) can be thinned heavily, down to 20 trees per acre, which results in a clearcut or shelterwood harvest condition with a few scattered trees retained in dispersed or clumped groups to meet the average 20 trees per acre retention requirement. Under Option 2, the potential beneficial effects associated with thinning (increased tree growth, etc.) in the RMZs are not realized; however, the RMZs managed under Option 2 will provide mature riparian stands over time, albeit in narrower strips of habitat than in Option 1. Upland areas beyond the Outer Zone are likely to be clearcut. When upland areas adjacent to the Inner and Outer Zones are clearcut, the RMZ area which may have had some interior forest characteristics will become exposed edge habitat, with increased solar radiation (which stimulates understory growth), increased fluctuations in temperatures, and increased risk of windthrow. We anticipate that windthrow and edge effects are reasonably certain to occur for distances up to 400 feet into adjacent stands from exposed edges. The edge habitat condition along exposed clearcut edges will gradually transition to a closed-forest condition as adjacent upland stands regenerate over a period of 30 to 40 years.

The physical effects of felling trees and removing logs via yarding or other means can result in short-term destruction of understory plants and soil-dwelling organisms. Equipment used to harvest timber generates loud sounds that may carry into adjacent forests. The stand-replacing or stand-altering physical disturbance and noise associated with timber harvest may result in short-term disturbance or displacement of wildlife in the harvest area and adjacent habitat. Post-harvest slash-burning may generate smoke that carries into adjacent stands, also potentially displacing or disturbing wildlife.

Sensitive Sites and RMZs along Type Np and Type Ns Waters

In western Washington, a minimum 50-foot no-harvest buffer must be retained along the lower 500 feet of Type Np waters upstream from the confluence with Type S or F waters. Beyond 500 feet from such confluences, a 50-foot no-harvest buffer is required along approximately 50 percent of the remaining Np stream lengths. Sensitive sites associated with headwall seeps, sidewall seeps, and perennial flow initiation points are also protected with 50-foot to 56-foot radius no-harvest buffers. Type Ns streams are not protected with no-harvest buffers, except in the vicinity of sensitive sites, unstable slopes, and/or buffers associated with Type S or F confluences. Type Ns waters, and unbuffered sections of Type Np waters, do receive some protection with a 30-foot equipment limitation zone that limits the amount of ground disturbance associated with heavy equipment, timber yarding, or skid trails.

The 50-foot no-harvest buffers along portions of Np waters and around other sensitive sites retain about 15 – 20 percent of the existing trees within the 100-year site index tree height of the stream. Outside the 50-foot no-harvest zones, all trees within the 100-year site index tree height (from 50 out to 200 feet, depending on the site) are likely to be clearcut concurrent with adjacent upland harvest. RMZ areas along Type Np waters which may have had some interior forest characteristics prior to timber harvest will become a narrow strip of trees, with increased solar radiation (which stimulates understory growth), increased fluctuations in temperatures, and an increased risk of windthrow. The edge habitat condition along exposed clearcut edges will gradually transition to a closed-forest condition as adjacent upland stands regenerate over a period of 30 to 40 years.

8.3.3.5 Assumptions Regarding Potential Marbled Murrelet Nesting Habitat in RMZs

For this analysis, we use the terms "suitable" habitat or "potential" marbled murrelet nesting habitat to refer to areas with forest cover that have the general attributes of marbled murrelet nesting habitat (i.e., patches of conifer forest with large trees present) as depicted by the habitat maps developed by Raphael et al (2005). We use the term "potential" habitat to emphasize the idea that the habitat values that we selected from the Expert Judgement Model results represent forest cover that has the general attributes of marbled murrelet nesting habitat whether or not marbled murrelets are actually using the habitat. It is important to note that all habitat estimates that we generated from Raphael et al.s' (2005) data are general estimates based on our interpretation of data. The values reported here are coarse estimates used for the purpose of this analysis, and are not intended to represent absolute values. The habitat acres depicted by Raphael et al.'s (2005) data are not expected to accurately depict all areas that would meet the regulatory definitions of "suitable" marbled murrelet habitat defined at WAC 222-16-010.

The environmental baseline analysis indicated that about 15 percent of the potential marbled murrelet nesting habitat on the FPHCP covered lands is located in RMZs (≈ 36,200 acres). Because most RMZs on the FPHCP covered lands are forested with second-growth forests, less than 5 percent of the total RMZ acres (≈ 730,800 acres) contain mature or old-forest habitat that is potentially suitable for marbled murrelets (Table 8-29). Potential murrelet nesting habitat located in RMZs that is not associated with occupied marbled murrelet sites may be directly affected by forest practice activities in the RMZs.

There are currently 848 status 1-3 marbled murrelet sites documented on the FPHCP covered lands, and 243 sites are located in mapped RMZs (27 percent). The status 1-3 sites are locations where a murrelet observation was documented, and are not necessarily an indication of actual occupancy within the RMZ. Due to the site-specific information needed to define an occupied marbled murrelet site, we currently have no reliable way of calculating how much potential nesting habitat is associated with "occupied marbled murrelet sites" as defined by the Washington Forest Practices Rules. For this analysis, we assume that all suitable habitat depicted by the EJM Class 3-4 habitat model that occurs within the 1.5 mile-radius buffers of status 1-3 murrelet sites is "occupied habitat" that is protected from timber harvest. The environmental baseline analysis indicates that approximately 11 percent of the potential murrelet nesting habitat on the FPHCP covered lands (Table 8-28) occurred within the 1.5-mile radius buffers surrounding status 1-3 murrelets sites (≈ 25,700 acres). This is a rough estimate that likely overestimates the actual occupied stands because of the inclusion of disjunct habitat patches within the 1.5-mile radius occupied-site buffers. Of the roughly 25,700 acres of potential nesting habitat that occurs in status 1-3 site buffers, about 5,000 acres are located in RMZs (19 percent).

In summary, there are approximately 36,200 acres of potential murrelet nesting habitat in RMZs, but only about 5,000 acres are associated with known occupied sites. The remaining 31,200 acres of potential murrelet habitat in the RMZs have the potential to be directly affected by forest practices activities unless pre-project surveys document an occupied murrelet site.

Because potential murrelet nesting habitat consists of stands with large trees, we are assuming that Option 2 (leaving trees closest to the water) will be the option selected for managing Type S or Type F RMZs with potential murrelet nesting habitat. We are making this assumption because murrelet nesting habitat generally occurs in old-growth or mature forests with large trees, low tree densities, and a high basal area of dominant and co-dominant trees (Hamer and Nelson 1995). Given the requirement to maintain a minimum of 57 trees per acre within the Inner Zones under Option 1, relatively few trees are likely to be available for a thinning-from-below harvest strategy in stands that are potential murrelet nesting habitat. However, the Option 2 harvest strategy is likely to meet RMZ objectives, because the large trees retained in the no-harvest Core and Inner Zone areas are likely to meet the minimum stand requirements necessary for meeting DFC objectives.

Under Option 2, the width of the no-harvest zone varies from 80 to 100 feet along Type S or Type F waters, and 50 feet along 50 percent of the length of Type Np waters. Type S and Type F RMZs comprise about 83 percent of all RMZ acres on westside FPHCP covered lands, and Type Np RMZs comprise about 17 percent. For the effects analysis for marbled murrelets, we are assuming an average retention of 55 percent of riparian trees in Type S or Type F RMZs, and an average 16 percent retention of riparian trees in Type Np RMZs. We note that there could be slight differences in the effects analysis between Option 1 and Option 2. However, we have determined that Option 2 represents a reasonable worst-case scenario for analysis and that our conclusion would not be different if we analyzed Option 1.

8.3.3.6 Summary of Scientific Research Regarding the Effects of Nesting Habitat Loss and Habitat Fragmentation to Marbled Murrelets

The loss of old-growth nesting habitat is a well-known factor influencing marbled murrelet populations throughout the murrelet range, and is the primary reason the species was listed as a federally threatened species in 1992 (57 FR 45328). The following summary of the effects of habitat loss is adapted from McShane et al. (2004):

Effects of Habitat Loss to the Distribution and Abundance of Marbled Murrelets

The amount of old-growth forests in Washington, Oregon, and California has been reduced from historic levels by more than 80 percent (U.S. Fish and Wildlife Service 1997a), leaving murrelets with small, isolated stands of older trees for nesting. Murrelets are thought to be sensitive to forest fragmentation (Hansen and Urban 1992), and changes in their distribution and abundance have occurred in association with habitat loss and forest fragmentation (U.S. Fish and Wildlife Service 1997a). For example, murrelets no longer occur in areas without suitable forested habitat (e.g., Marin County in California) (U.S. Fish and Wildlife Service 1997a), and they appear to abandon highly fragmented areas over time (areas highly fragmented before the late 1980s generally did not support murrelets by the early 1990s) (Meyer et al. 2002).

Detections of murrelets at inland sites and densities offshore were found to be higher in or adjacent to areas with large patches of old-growth, and in areas of low fragmentation and isolation of old-growth forest patches (Raphael et al. 1995, 2002a, b; Burger 2002; Meyer and Miller 2002; Meyer et al. 2002; Miller et al. 2002). Similarly, murrelet densities (determined with radar) increased with increasing amounts of suitable habitat, interior old-growth, and proximity of patches within specific watersheds (Burger 2002; Raphael et al. 2002a). In addition, several studies have concluded that murrelets do not "pack" into remaining habitat patches at higher densities when nesting habitat is removed (Burger 2001; Manley et al. 2001; Cullen 2002). Burger (2001) suggests that murrelets appear to abandon heavily logged watersheds rather than nesting at higher densities in remaining habitat patches. In contrast, Zharikov et al. (2006) found that murrelets nesting in a highly fragmented landscape tended to select smaller than average patches of old forest habitat for nesting, and that many successful nests were located in stands that were less than 25 acres in size.

The proximity of occupied habitat patches to other patches of suitable habitat appears to be an important factor in determining the likelihood that an unoccupied habitat patch will be colonized by murrelets. Miller et al. (2002) demonstrated that suitable forest patches > 3 miles (>5 kilometers) from known nesting areas were less likely to be occupied by murrelets, and no occupied patches were more than 6.84 miles (11 kilometers) from other occupied sites.

Effects of Nesting Habitat Loss and Habitat Fragmentation to Marbled Murrelet Reproduction and Nesting Success

Raphael et al. (2002b) reviewed the potential effects of forest fragmentation on marbled murrelets. They suggested that a reduced amount of nesting habitat would have long-term effects on the number of nests and short-term effects on nest success, both of which would affect population size. As with other alcids, adult marbled murrelets are believed to have high site fidelity and return to the same nest site in successive years (Nelson and Peck 1995; Nelson 1997). If their nest site is lost to logging or development, it is suspected that some murrelets will lose breeding opportunities in successive years or not breed again, and others may be displaced (if possible) to nearby or disjunct suitable or marginal habitat (Divoky and Horton 1995; U.S. Fish and Wildlife Service 1997a). However, Zharikov et al. (2006) found that marbled murrelets did not appear to respond to habitat fragmentation by either selecting for larger patches or avoiding recent clearcuts. Additionally, Zharikov et al. (2006) found similar breeding success rates for murrelets nesting in a landscape dominated by large patches of old-growth forest and murrelets nesting in fragmented patches of old-forest habitat.

If murrelets are forced to move into marginal habitat, nesting success could decline over time, leading to low nesting density and small populations (Raphael et al. 2002b). Because marbled murrelets nest solitarily, successful nesting is dependent upon the murrelets' ability to remain hidden at the nest site to avoid predation. A cryptic plumage (both adults and juveniles) and secretive behaviors, such as limiting activity primarily to the low light levels of dawn and dusk, visiting the nest infrequently during chick rearing, and minimizing loud vocalizations from the nest, decrease their chances of being discovered by predators (Nelson and Hamer 1995b, Nelson and Peck 1995, Nelson 1997). As suitable nesting habitat becomes scarce and more isolated, and predator populations increase, remaining hidden at the nest may become increasingly more difficult.

Habitat Fragmentation and Edge Effects to Marbled Murrelet Nesting Success

Murrelets are thought to be highly vulnerable to increased levels of nest predation associated with forest edges (U.S. Fish and Wildlife Service 1997a). While the extent of the effects of fragmentation and edge on murrelet nest success is not known, predation has consistently been the most common cause of nest failure at marbled murrelet nests. Corvids have been implicated as the primary predator of murrelet nests (Nelson and Hamer 1995b; Raphael et al. 2002b) and corvid numbers have increased significantly throughout the west in the last century in response to habitat change and human development (Marzluff et al. 1994).

Early research on the success of marbled murrelet nests with respect to edge showed that successful nests were significantly farther from forest edges than failed nests (Nelson and Hamer 1995b). More recent research demonstrates somewhat mixed results. At active murrelet nests in British Columbia, Washington, Oregon, and California, successful nests were found to be farther from forest edges (x=463 feet [141 meters]) than failed nests (x=184 feet [56 meters]) (Manley and Nelson 1999). Nest success was 38 percent (n=29 nests) within 164 feet (50 meters) of the forest edge and 55 percent (n=29 nests) at distances greater than 164 feet (50 meters) from the edge, but the differences were not statistically different (χ^2=4.55, P > 0.05). Most of these nests failed because of predation (60 percent), and predation was higher within 164 feet (50 meters) of an edge than within the forest interior. No murrelet nests >492 feet (150 meters) from the edge failed because of predation.

The replacement of native forest with small, isolated patches and abundant edge can create changes in microclimate, vegetation species, predator-prey dynamics, and other edge effects. Unfragmented, older-aged forests have lower daily temperature fluctuations and higher humidity compared to clearcuts and other open areas (Chen et al. 1993; 1995). Edge habitat is also exposed to increased daily fluctuations in temperature and moisture, high evaporative heat loss, and increased exposure to wind. Fundamental changes in the microclimate of a stand have been recorded at least as far as 787 feet (240 meters) from the forest edge (Chen et al. 1995). The changes in microclimate regimes with forest fragmentation could stress a cold-water adapted seabird (Meyer and Miller 2002) and affect the distribution of epiphytes that murrelets use for nesting.

While there are little data on the effects of radiation and thermal stress on murrelets, both chicks and adults have been observed panting when exposed to direct sunlight (Binford et al. 1975). Exposure to increased temperatures could cause heat stress for adults and chicks and eventually cause adults to abandon the site. Likewise, increased winds at the forest edge could trigger cold stress. The effects, however, would vary with aspect, slope, elevation, and topography. Marbled murrelets do not build nests. Instead, they utilize pre-existing structural tree branch formations and lay their single egg on epiphytes or other substrate covering a large tree limb. Branch epiphytes or substrate have been identified as a key component of murrelet nests (Nelson et al. 2003). The substrate is important for insulating the egg and protecting it from falling. While there are no data on the specific effects of microclimate changes on the availability of murrelet nesting habitat at the branch and tree scales, the penetration of solar radiation, wind, and warm temperatures into the forest could change the distribution of epiphytes or blow moss off nesting platforms. In some portions of their range, murrelets may not nest in areas that lack epiphytes, such as along forest edges or in areas of extreme temperature (Hunter et al. 1998).

8.3.3.7 Risk of Injury or Mortality to Marbled Murrelets from Timber Harvest

Timber-harvest activities can result in direct mortality of adults, eggs, or young. The potential risk for marbled murrelets to be struck and killed or injured by falling trees during timber harvest is highest in the area close to the nest tree. During timber harvest, adult murrelets delivering food to the nest could reasonably be expected to fly away from the area and avoid injury. However, murrelet eggs, chicks, or incubating adults would be killed if their nest tree is felled. These kinds of lethal effects are only likely during the breeding season and then only if breeding activities are underway. Under the Washington Forest Practice Rules, protocol surveys are required to determine murrelet occupancy in murrelet detection areas and in suitable habitat patches with a high probability of occupancy. Documented, occupied sites are then protected from timber harvest, so the likelihood of direct mortality is substantially reduced in surveyed areas.

There are a variety of factors that affect the ability of observers to detect murrelets at inland sites, including weather, daily variation in detection rates, season, conditions at the survey site (tree canopy closure, amount of visible sky), and distance from marine foraging locations (O'Donnell 1995; Baldwin 2002). The error in classifying sites as unoccupied when they were indeed occupied (false negative) is estimated to approach 15.5 percent for surveys conducted prior to 1998. This rate of misclassification of occupied sites in the earlier period of surveys may have led to the loss of an unknown number of breeding sites. The survey protocol has been updated several times, with the most recent version published in 2003 (Evans Mack et al. 2003). The Washington Forest Practices Board has adopted the 2003 survey protocol (WAC-222-12-090(14)) which requires additional site visits compared to earlier versions of the protocol. The current error rate for the 2003 protocol is estimated to be 4.2 percent, indicating substantial improvement over earlier survey methods (McShane et al. 2004).

8.3.3.8 *Effects to Marbled Murrelet Habitat Associated with the FPHCP Riparian Management Zones*

The RMZs will be managed to retain the largest trees that are immediately adjacent to streams, rivers, and shorelines. Currently, only about 5-10 percent of riparian zones in western Washington contain mature conifer habitat, but less than 5 percent contain old-forest structure suitable for marbled murrelets. Over time, as early and mid-seral riparian areas mature, large trees capable of developing murrelet nest platforms in the FPHCP RMZs will increase, ultimately increasing the amount of potential marbled murrelet nesting habitat located in the RMZs.

In most areas, the time required for early- or mid-seral forests to mature into suitable murrelet habitat will likely be 100 to 200 years. However, riparian stands that are currently 60 to 80 years of age could develop some murrelet habitat over the next 50 years, particularly in the coastal zones where western hemlock is prevalent (Hamer and Meekins 1999). The development of large trees in the RMZs may provide some minor benefits to marbled murrelets over the long-term by increasing the amount of potential nesting habitat available on FPHCP covered lands. However, these narrow, linear-strips of riparian trees would have limited value as marbled murrelet habitat, because marbled murrelets generally select large patches of mature and old-forest habitat for nesting. Timber on the FPHCP covered lands is generally managed on a 40-80 year harvest rotation, so the development of large patches of mature or old-forest habitat is not likely to occur in most locations on the FPHCP covered lands. Exceptions include special areas that are protected for occupied marbled murrelet sites, spotted owl habitat, or high-hazard slope areas.

About 5 percent of RMZs on FPHCP covered lands contain potential murrelet nesting habitat, but relatively few of these acres are associated with known occupied sites. Therefore it is likely that murrelet habitat that is not associated with known occupied sites could be removed by timber harvest in RMZs. The stand-replacing timber harvest that is likely to occur in the Outer Zones of Type S or Type F RMZs represents a long-term loss of potential murrelet nesting habitat that would have otherwise have been available for potential use by nesting murrelets colonizing those RMZs. Stand replacing timber harvest in Inner Zones under Option 2, or in the harvested portions of RMZs along Type Np waters also represent a long-term loss of potential nesting habitat. The loss of unoccupied potential nesting habitat within RMZs on the FPHCP covered lands would adversely affect the marbled murrelet by reducing the total amount of potential nesting habitat that is available for marbled murrelet nesting, and by increasing the fragmentation of remaining habitat patches.

The potential murrelet nesting habitat that remains in the protected Core and Inner Zone areas will be reduced to narrow strips that vary in width from 80 to 100 feet-wide along either side of Type S or Type F waters, and strips of 50 feet-wide along either side of 50 percent of the length of Type Np waters. Although the habitat that remains in these retention areas may contain trees with suitable marbled murrelet nesting platforms, these narrow strips of riparian trees will be exposed to edge effects – particularly increased risk of windthrow and increased exposure to avian predators.

Grizzel and Wolff (1998) studied riparian buffer strips on small streams in northwestern Washington and reported that about 33 percent of buffer trees were affected by windthrow. In a study by Rollerson and McGourlick (2001), riparian windthrow averaged about 21 percent of the standing timber along stream edges. They noted there were a large number of plots with only a minor amount of windthrow and conversely only a limited number of areas with substantial amounts of windthrow. The average distance of penetration into standing timber was about 40 feet (12 meters). They also noted that buffers exposed on both sides were more vulnerable and that "feathered edges" had lower amounts of windthrow. The potential effects of windthrow in RMZs are highly variable and dependant on many site-specific factors. There are no reliable methods to estimate or quantify the effects that windthrow may have to potential murrelet habitat at the scale of the FPHCP. However, it is likely that murrelet habitat retained in the protected portions of RMZs will be degraded by the loss of trees with potential nesting platforms, and the loss of trees that provide cover to trees with platforms. In catastrophic wind events, all trees left in an RMZ could be lost to windthrow, but this will likely be uncommon.

The trees retained in RMZs will continue to provide potential nesting habitat for marbled murrelets, but suitable habitat in these areas will be marginal for murrelets due to small patch sizes and loss of interior forest conditions. Research by Nelson and Hamer (1995b), and Manley and Nelson (1999) indicates that murrelets nesting along edges have a higher risk of predation and lower nest success than murrelets nesting in interior forest patches (greater than 164 feet from an edge). Suitable habitat retained in the RMZs will be available for potential colonization by nesting murrelets, but due to higher risks of predation and nest failure, these areas will have limited value as nesting habitat for up to 40 years until the regeneration of adjacent stands is advanced enough to minimize the edge effects associated with stand-replacing harvest in the Outer Zones.

Occupied murrelet sites are protected from edge effects by the Washington Forest Practices Rules that prohibit clearcut timber harvesting within 300-foot “managed buffer zones” surrounding occupied suitable murrelet sites (WAC 222-16-080(j)(v)). The potential for disturbance to nesting marbled murrelets is minimized by the Washington Forest Practices Rules that prohibit forest practices within 0.25 miles of occupied murrelet sites during the daily peak activity periods in the critical nesting season (WAC 222-30-050, -060,-065, -070, -100).

8.3.3.9 Effects of RMZ Management in Marbled Murrelet Conservation Zone 1

In Conservation Zone 1 (Puget Sound), there are over 2.9 million acres of FPHCP covered lands (Table 8-27). The environmental baseline analysis indicates that there was approximately 272,000 acres of stand-replacing timber harvest on the FPHCP covered lands in Zone 1 from 1992 to 2002 (Table 8-31). This equates to a harvest rate of 9 percent per decade on the FPHCP covered lands. For this analysis, we are assuming that this rate of harvest will continue into the future. The RMZs in Zone 1 make up about 11 percent of the FPHCP covered lands (323,100 acres) (Table 8-29). Assuming that about 272,000 acres will be harvested per decade, we estimate that about 11 percent (≈ 30,000 acres) of these acres will include managed RMZs.

About 8 percent of the estimated acres in RMZs in Zone 1 contain potential marbled murrelet nesting habitat (24,400 acres) (Table 8-29). Based on the overall percentage of potential habitat in RMZs, we expect that about 2,400 acres of unoccupied potential murrelet nesting habitat could be affected by forest practices in RMZs per decade (i.e., 8 percent of 30,000 acres = 2,400 acres). Of the 2,400 acres of potential habitat affected, 52 percent (1,240 acres) would be directly affected (i.e., removed) by stand-replacing timber harvest (Table 8-33). Approximately 48 percent (1,160 acres) of the potential habitat acres would be retained in protected Core Zones and the unharvested portions of Inner Zones. These acres would continue to provide potential murrelet habitat, but the quality of the habitat would be degraded by the indirect effects associated with reduced patch size, edge effects, and the increased risk of windthrow.

Table 8-33. Estimated acres of marbled murrelet (MAMU) habitat affected per decade by forest practice activities in RMZs in marbled murrelet Conservation Zone 1 (Puget Sound).

RMZ Type	Total RMZ acres managed per year (acres)	MAMU habitat acres retained in protected portions of RMZs (acres)	MAMU habitat acres removed by timber harvest in RMZs (acres)	Total MAMU habitat acres affected in RMZs (8 percent)
Type S or F (83 percent of RMZ acres)	24,900 acres	1,090 acres (55 %)	900 acres (45 %)	1,990 acres
Type Np (17 percent of RMZ acres)	5,100 acres	70 acres (16 %)	340 acres (84 %)	410 acres
Totals	30,000 acres	1,160 acres (48 %)	1,240 acres (52%)	2,400 acres.

Notes: All figures are approximate values derived from GIS data. Area estimates for RMZs along different water types are from Table 8-29. Marbled murrelet habitat estimates represent approximate conditions in 2003, as depicted by Raphael et al. (2005) map data, Expert Judgment Model Class 3 and Class 4, and account for stand-replacing timber harvest and fire losses that occurred from 1992 to 2002 (Healey et al. 2003). Riparian area estimates for RMZ widths along Type S, F, and Np stream types are based on the average 100-year site-potential tree height for site index 2 and 3.

Over the 50-year life of the FPHCP, a total of approximately 6,200 acres of unoccupied potential murrelet habitat would be directly affected (i.e., removed) by stand-replacing timber harvest in RMZs. Approximately 5,800 acres of potential murrelet habitat would be protected in Core Zones, but these acres would be degraded by the indirect effects associated with habitat fragmentation and edge effects. Edge effects are likely to persist in affected areas for at least 30 to 40 years following RMZ harvest before adjacent regeneration growth will ameliorate these effects. Overall, murrelet habitat in the RMZs will be reduced from the current levels of about 24,400 acres to 18,200 acres, a loss of about 25 percent.

There are currently about 2,500 acres of potential marbled murrelet nesting habitat in RMZs that are associated with occupied murrelet sites. This represents about 10 percent of the total murrelet habitat in RMZs. We expect that these acres will be protected from timber harvest throughout the 50-year life of the FPHCP.

We have no reliable way of estimating how much murrelet habitat could be recruited in the RMZs over the next 50 years due to forest growth and maturation. Our analysis of the western Washington RMZs indicated that about 5 percent of the RMZs are in mature conifer habitat that is not yet suitable as murrelet habitat. If we assume that about 1 percent of the RMZ acres would develop old-forest characteristics (i.e., mistletoe infections, etc.), we could expect a recruitment of perhaps 3,000 acres of murrelet habitat within 50 years in the RMZs in Conservation Zone 1.

8.3.3.10 Effects of RMZ Management in Marbled Murrelet Conservation Zone 2

In Conservation Zone 2 (Pacific Coast), there are over 2.5 million acres of FPHCP covered lands (Table 8-27). The environmental baseline analysis indicates that there was approximately 391,000 acres of stand-replacing timber harvest on the FPHCP covered lands in Zone 2 from 1992 to 2002 (Table 8-31). This equates to a harvest rate of 15 percent per decade on the FPHCP covered lands. For this analysis, we are assuming that this rate of harvest will continue into the future. The RMZs in Zone 2 comprise about 16 percent (407,700 acres) of the FPHCP covered lands (Table 8-29). Assuming that about 391,100 acres will be harvested per decade, we estimate that about 16 percent (≈ 62,000 acres) of these acres will include managed RMZs.

About 3 percent of the estimated acres in RMZs in Zone 2 contain potential marbled murrelet nesting habitat (11,800 acres) (Table 8-29). Based on the overall percentage of potential habitat in RMZs, we estimate that about 1,860 acres of unoccupied potential murrelet nesting habitat could be affected by forest practices in RMZs per decade (i.e., 3 percent of 62,000 acres = 1,860 acres). Of the 1,860 acres of potential habitat affected, 52 percent (960 acres) would be directly affected (i.e., removed) by stand-replacing timber harvest (Table 8-34).

Table 8-34. Estimated acres of marbled murrelet (MAMU) habitat affected per decade by forest practice activities in RMZs in Conservation Zone 2.

RMZ Type	Total RMZ acres managed per year	MAMU habitat acres retained in protected portions of RMZs	MAMU habitat acres removed by timber harvest in RMZs	Total MAMU habitat acres affected in RMZs (3 percent)
Type S or F (83 percent)	51,500 acres	850 acres (55 %)	700 acres (45 %)	1,550 acres
Type Np (17 percent)	10,500 acres	50 acres (16 %)	260 acres (84 %)	310 acres
Totals	62,000 acres	900 acres (48 %)	960 acres (52%)	1,860 acres

Notes: All figures are approximate values derived from GIS data. Area estimates for RMZs along different water types are from Table 8-29. Marbled murrelet habitat estimates represent approximate conditions in 2003, as depicted by Raphael et al. (2005) map data, Expert Judgment Model Class 3 and Class 4, and account for stand-replacing timber harvest and fire losses that occurred from 1992 to 2002 (Healey et al. 2003). Riparian area estimates for RMZ widths along Type S, F, and Np stream types based on the average 100-year site-potential tree height for site index 2 and 3.

Approximately 48 percent (900 acres) of the potential habitat acres affected would be retained in protected Core Zones and the unharvested portions of Inner Zones (Table 8-34). These acres would continue to provide potential murrelet habitat, but the quality of the habitat would be degraded by the indirect effects associated with reduced patch size, edge effects, and the increased risk of windthrow.

There are currently about 2,500 acres of potential marbled murrelet nesting habitat in RMZs that are associated with occupied murrelet sites. This represents about 21 percent of the total habitat acres in RMZs. We expect that these acres will be protected from harvest through the life of the FPHCP.

We have no reliable way of estimating how much murrelet habitat could be recruited in the RMZs over the next 50 years due to forest growth and maturation. Our analysis of the western Washington RMZs indicated that about 5 percent of the RMZs are in mature conifer habitat that is not yet suitable as murrelet habitat. If we assume that about 1 percent of the RMZ acres would eventually develop old-forest characteristics (i.e., mistletoe infections, etc.), we could expect a recruitment of perhaps 4,000 acres of murrelet habitat within 50 years in the RMZs in Conservation Zone 2.

8.3.3.11 Summary of the Effects of RMZ Management to Marbled Murrelet Habitat

Considering both Zone 1 and Zone 2 combined, we estimate that approximately 92,000 acres of RMZs would be managed per decade, resulting in a potential loss of 2,200 acres of unoccupied murrelet nesting habitat in RMZs per decade. Over the next 50 years, a total of approximately 11,000 acres of unoccupied potential murrelet nesting habitat could be removed by stand-replacing timber harvest in the RMZs. These effects would be distributed across over 730,000 acres of RMZs from the Olympic Peninsula to the western Cascades, which in turn are distributed across 5.4 million acres of FPHCP covered lands over a period of 50 years.

We do not anticipate that murrelets would be directly killed or displaced from potential nesting habitat in RMZs on the FPHCP covered lands. Because there would be no loss of occupied habitat, and no adverse affects to individual murrelets, there would be no effect to the current distribution or survival of murrelet populations in Zone 1 or Zone 2.

We estimated that the amount of unoccupied potential nesting habitat that would be exposed to edge effects associated with RMZs would be approximately 2,060 acres per decade across both conservation zones, with a total of up to 10,300 acres of potential habitat exposed to edge effects over 50 years. Murrelets have a low nesting success rate, and nests that are located in edge habitats are presumed to be at greater risk to predation. RMZ management will create exposed edge habitats along protected Core and Inner Zone areas, but these effects would occur only in areas that are determined to be unoccupied by murrelets. Due to the widely distributed effects associated with timber harvest in RMZs, we do not anticipate that the risks to murrelet nesting success or predation rates associated with edge habitats will change on FPHCP covered lands.

As early- and mid-seral stands mature over time, the total amount of mature conifer habitat in the RMZs will increase, but relatively few acres are likely to develop the characteristics of suitable murrelet nesting habitat. We estimate that perhaps 1 percent (e.g., 7,000 acres) of the total RMZ acres could develop the characteristics of murrelet habitat within the next 50 years.

8.3.3.12 Effects of Disturbance to Nesting Marbled Murrelets Associated with Forest Practices Activities

Road building, maintenance, and repair; timber harvesting; and timber hauling require the use of heavy equipment, chainsaws, and large vehicles, all of which introduce an increased level of sound into the environment. The Washington Forest Practices Board recognized that noise disturbance might disrupt marbled murrelet breeding behavior; therefore, the Board adopted rules to protect marbled murrelets from disturbance by imposing an operating restriction during the daily peak activity periods within the murrelet critical nesting season (April 1 through August 31) (Washington Forest Practices Board 1996). The daily peak activity period for murrelets (as defined at WAC 222-16-010) is one hour before official sunrise to two hours after official sunrise and one hour before official sunset to one hour after sunset. Restricted activities include road construction, operation of heavy equipment, blasting, timber felling, yarding, helicopter operations, and slash disposal or prescribed burning. These activities are prohibited within 0.25 miles of occupied marbled murrelet sites during the daily peak activity periods within the critical nesting season (WACs 222-24-030 and 222-30-050, -060, -065, -070, -100).

We completed an analysis of the potential for injury associated with disturbance (visual and sound) to marbled murrelets (U.S. Fish and Wildlife Service 2003). In this analysis, we concluded that behaviors indicating potential injury to marbled murrelets are: flushing from the nest, aborted feeding, and postponed feeding. These disturbance responses could lead to an increased risk of egg or chick mortality at the nest site. Reduced feedings of the chick at the nest may increase the risk of fledging mortality as they attempt to reach the ocean. During the incubation and brooding periods, we concluded that activities that generate loud noises within certain threshold distances may cause a disturbance response resulting in potential injury to murrelets. The potential injury threshold distances are based on anecdotal observations documented by murrelet researchers of murrelet flush responses to the presence of people, loud sounds, etc. (U.S. Fish and Wildlife Service 2003). Based on these observations of nesting murrelets, we determined the potential injury threshold distance for chainsaws falling trees is 45 yards, and the threshold distance for heavy equipment (e.g., excavators) is 35 yards. The FWS notes that scientific data related to injury threshold distances associated with sound and visual disturbance is limited, and we continue to collect pertinent data related to the issue.

Because the 0.25-mile buffer restriction for occupied murrelet sites is substantially larger than the distances where we anticipate marbled murrelets are at risk to potential injury from disturbance, we expect that the existing Washington Forest Practice Rules will protect most nesting murrelets associated with known occupied sites. One exception is blasting. We consider blasting within 1 mile of occupied murrelet habitat during the early nesting season (April 1st to August 5) to be an activity that may result in potential injury to marbled murrelets. However, we do not have decibel data for blasting on which to determine potential injury threshold distances for these activities. For blasting with charges of 2 pounds or larger, we continue to use the conventional 1-mile potential injury threshold distances due to lack of decibel information to more accurately address these distances (U.S. Fish and Wildlife Service 2003).

The murrelet breeding and fledging period is asynchronous and spread over a prolonged season. Egg laying and incubation occur from April to early August and chick rearing occurs between late May and late August, with all chicks fledging by early September (Hamer et al. 2003). In Washington, Hamer et al. (2003) found that 100 percent of murrelets fledged by August 27, but cautioned that this was based on a small sample of observations. Hamer et al. (2003) suggest that the breeding season in Washington is probably similar to the breeding season in British Columbia, which extends into mid-September. Based on these data, we assume that the nesting season for murrelets in Washington is April 1 to September 15. This varies from the critical nesting season defined by the Washington Forest Practices Rules (April 1 to August 31) by 15 days. Based on the data presented by Hamer et al. (2003), we assume that over 99 percent of murrelet chicks have fledged by August 31. However, there may be a few individuals that do not fledge until mid-September. These individuals could be exposed to potential injury from missed or postponed feedings due to disturbance associated with forest practice activities, because the Washington Forest Practices Rules do not prohibit forest practices adjacent to occupied murrelet sites after August 31.

Adult murrelets typically incubate for a 24-hour period, then exchange duties with their mate at dawn. Hatchlings appear to be brooded by an adult for 1-2 days and are then left alone at the nest for the remainder of the rearing period, except during feedings. Both parents feed the chick, which receives 1-8 meals per day (Nelson 1997). Most meals are delivered early in the morning, while about a third are delivered at dusk and a few meals are sometimes scattered throughout the day (Nelson and Hamer 1995a). Based on the data presented by Nelson and Hamer (1995a), approximately 80 percent of the feedings occur during the daily peak activity periods defined by the Washington Forest Practices Rules (Washington Forest Practices Board 1996). Approximately 20 percent of feedings occur during the day, when forest practice activities are not restricted, so there is a potential for some missed or post-poned feedings during the unrestricted hours (Washington Forest Practices Board 1996).

Based on the information presented above, we expect that some sound and activity- related disturbances to nesting murrelets may occur on the FPHCP covered lands, but the risk for potential injury to murrelets is low due to the 0.25-mile disturbance buffers and daily activity restrictions required by the Washington Forest Practices Rules. The Washington Forest Practices Rules minimize the potential for adverse effects from disturbance associated with forest practices to nesting murrelets, but they do not ensure that all murrelets will be protected from disturbance under all circumstances. Blasting within a mile of an occupied murrelet site, unrestricted activities during the mid-day hours, and forest practices during the late nesting season (September) are all situations which may result in murrelets flushing from a nest, aborted feedings, or postponed feedings.

Forest practice activities that occur adjacent to suitable murrelet habitat on Federal lands may also result in disturbances to nesting marbled murrelets. Most of the suitable murrelet habitat that occurs on Federal lands has not been surveyed to determine murrelet occupancy. The Washington Forest Practices Rules that minimize disturbance to murrelets only apply in locations where surveys have documented an occupied murrelet site. For example, timber harvesting in second-growth (non-habitat) that borders suitable murrelet habitat on Federal lands would not be restricted unless the Federal land habitat contained a known, occupied site. Because most suitable murrelet habitat on Federal lands has not been surveyed for murrelets, the Washington Forest Practices Rules that apply to occupied murrelet sites do not apply to unsurveyed habitat on Federal lands. Non-Federal landowners are not required to survey adjacent ownerships for murrelets, therefore it is likely that forest practices activities that occur along Federal land boundaries could result in potential injury disturbance to murrelets. For the purposes of this analysis, we expect that WDNR will identify suitable murrelet habitat along Federal or State boundary areas through the SEPA review process, and apply the murrelet critical nesting season and managed buffer rules to areas where forest practices activities could result in adverse effects to murrelets on adjacent lands.

8.3.3.13 Effects of Forest Road Management to Marbled Murrelets

Under the FPHCP, forest roads will be managed over time to reduce road-related effects to the aquatic environment and to improve fish passage at road-stream crossings. In western Washington, there are over 45,000 miles of roads on the FPHCP covered lands, and over 14,000 crossings on Type F streams. Many of these roads will be decommissioned over time, and other roads may be constructed to avoid riparian areas or high-hazard soils areas. Many existing stream crossings on fish-bearing streams will be replaced and upgraded to provide fish passage for all life stages of fish. We did not analyze how many roads or stream crossings occur in marbled murrelet suitable habitat. However, about 4 percent of the FPHCP covered lands within the range of the marbled murrelet contain potential murrelet nesting habitat, so it is not unreasonable to expect that about 4 percent of roads and stream crossings on FPHCP covered lands could occur in or adjacent to potential marbled murrelet habitat. Under the Washington Forest Practices Rules, road construction in occupied murrelet sites, a murrelet detection area, or in suitable habitat with a high-probability of occupancy that occurs outside of murrelet detection areas are considered Class-IV special activities.

The effects of roads to marbled murrelets include the long-term loss of potential nesting habitat that would have otherwise been available for murrelet nesting; edge effects associated with road corridors, particularly the increased risk of avian predation on murrelet nests; and the potential for noise disturbance to nesting individuals associated with logging trucks, vehicle traffic, or other heavy equipment. Minor habitat losses associated with hazard tree removal and/or culvert/bridge replacement projects may also occur. When culverts are replaced, it is sometimes necessary to clear trees adjacent to the stream crossing, thus creating a larger gap in the forest canopy. These types of habitat effects are generally minor due to the low risk that murrelets would be nesting in these areas. Although the risk to murrelets is low in these areas, adverse effects associated with the loss of individual trees with nest platforms could occur. However, the loss of a few individual roadside trees usually does not pose a substantial risk to murrelets unless the habitat loss occurs during the nesting season in unsurveyed suitable habitat (e.g., there is a risk of cutting down a potential nest tree that is occupied). The greatest risk to marbled murrelets associated with road management is the edge effects associated with road corridors, particularly the increased risk of avian predation on murrelets nests.

We have no reliable way of quantifying the amount of potential disturbance to murrelets associated with road-related activities on the FPHCP covered lands. To do so would require an assumption regarding the density of nesting marbled murrelets per acre of suitable habitat, and we have no data to support such assumptions at the scale of the FPHCP covered lands. In general, we expect that the existing Washington Forest Practices Rules which prohibit timber harvesting and road construction in occupied murrelet sites, and restrict forest practice activities within 0.25 miles of occupied murrelet sites will minimize disturbance effects to over 99 percent of the potential nesting/fledging murrelets on the FPHCP covered lands.

8.3.3.14 Effects to Federally Designated Marbled Murrelet Critical Habitat

The effects analysis for the marbled murrelet includes only those effects that would be expected to occur as a result permit issuance, such as effects of timber-harvest activities in the Riparian Zone (of influence) and road-related activities. We do not anticipate any direct effects associated with the loss of suitable murrelet habitat due to timber harvesting in RMZs or road construction in designated critical habitat. There are approximately 2,500 acres designated critical habitat that occur on private lands, including about 2,300 acres on the FPCHP covered lands. Under the Washington Forest Practices Rules, federally designated critical habitat on non-Federal lands is managed under the provisions of the State's marbled murrelet rule (WAC 222-16-080(2)). The designated private lands occur primarily in coastal Zone 2, in southwest Washington. All of the private lands that are within designated critical habitat occur within the 1.5-mile radius circles surrounding status 1-3 occupied murrelet sites. Therefore, all occupied murrelet habitat within these non-Federal Critical Habitat Units is protected under the existing Washington Forest Practices Rules for occupied marbled murrelet sites.

We anticipate that some edge effects to designated critical habitat on Federal lands are likely to occur. These effects are associated with timber harvest practices in upland areas. Therefore, these activities and their effects to marbled murrelet critical habitat are not analyzed in this section, but will be addressed in the analysis of cumulative effects.

8.3.4 CUMULATIVE EFFECTS – Marbled Murrelet and Marbled Murrelet Critical Habitat

Cumulative effects include the effects of future State, Tribal, local, or private actions that are reasonably certain to occur in the action area considered in this Opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to ESA section 7.

8.3.4.1 Cumulative Effects to Marbled Murrelets

The cumulative effects analysis for the marbled murrelet and its designated critical habitat include the effects of activities that are not directly associated with permit issuance, such as the effects of future timber harvest activities in upland areas. These activities are essentially unchanged by the issuance of the FPHCP permit, and will occur regardless of permit issuance.

In the range of the marbled murrelet, there are over 5.4 million acres of private lands. Only about 13 percent of these lands are located in the RMZs. The other 4.7 million acres of private lands are upland areas that are expected to be managed on a 40 to 80-year harvest rotation. Active management in RMZs is not likely to occur without some harvest activities occurring in the adjacent uplands.

As summarized in the environmental baseline section, marbled murrelet habitat on private lands is managed under specific standards. Approved HCPs that include marbled murrelets would have unique conservation measures for murrelets specific to that HCP. However, most private forestlands would fall under the Washington Forest Practices Rules. Under these rules, marbled murrelet habitat is managed depending on whether or not the habitat occurs within an occupied marbled murrelet site or in a marbled murrelet detection area. Suitable murrelet habitat that occurs in occupied murrelet sites is protected from timber harvest. In marbled murrelet detection areas all suitable murrelet habitat that meets the minimum stand definitions (i.e., ≥ 7 acres, with ≥ 2 nest platforms/acre) requires a protocol survey prior to harvest to determine murrelet occupancy. Outside murrelet detection areas, only habitat that has a high probability of murrelet occupancy (i.e., ≥ 5-7 nest platforms/acre, depending on the location) is required to be surveyed prior to harvest. In the absence of a federally-approved HCP or a State-approved special wildlife management plan, suitable murrelet habitat on non-Federal lands is only protected if protocol surveys document an occupied murrelet site. Suitable habitat outside of occupied sites that is determined to be unoccupied may be harvested. Outside murrelet detection areas, suitable habitat that has a lower probability of occupancy (i.e., ≤ 5-7 platforms/acre) is not protected on non-Federal lands and potential habitat that is located beyond 50 miles from marine waters is not protected. Additionally, landowners who own less than 500 acres are exempted from these particular Washington Forest Practices Rules unless their lands contain an occupied murrelet site. However, the prohibitions against "take" in section 9 of the ESA still apply in all of these situations.

Cumulative Effects to Marbled Murrelet Habitat in Conservation Zone 1

The environmental baseline analysis indicates there is over 1 million acres of potential marbled murrelet nesting habitat in Zone 1. About 68 percent (727,700 acres) is located on Federal lands, and 32 percent is located on non-Federal lands. Approximately 16 percent of the potential habitat (172,700 acres) in Zone 1 is located on private lands, while the other 16 percent is located primarily on State lands, managed under WDNR HCP for State lands (WDNR 1997c).

There are approximately 2.9 million acres of private lands in Zone 1, distributed across a large landscape that encompasses portions of the Olympic Peninsula, the Puget Trough lowlands, and the western Cascades. The majority of the private lands (94 percent) in Zone 1 contain second-growth forests that are not suitable for murrelet nesting habitat. Potential murrelet habitat that does occur on the private lands is highly fragmented and occurs in small, isolated patches. Of the 172,700 acres of potential murrelet habitat on private lands, about 17 percent (29,200 acres) is located in murrelet detection areas, and about 8 percent (14,300 acres) is associated with the status 1-3 occupied site buffers. Due to the high level overlap between occupied site buffers and detection areas, we estimate that about 31,000 acres of the potential murrelet habitat is associated with murrelet detection areas or occupied sites (18 percent). Due to the requirement for pre-harvest surveys in all stands that meet minimum suitable habitat criteria, we expect that occupied stands in murrelet detections areas are likely to be documented and protected as occupied marbled murrelet sites.

The other 82 percent (142,000 acres) of potential murrelet habitat on the private lands in Zone 1 is not associated with detection areas or occupied sites, and is therefore at a higher risk of harvest. Only stands that have a high probability of murrelet occupancy (i.e., ≥ 7 platforms/acre) are protected with a pre-harvest survey requirement. We have no way of determining the number of nesting platforms per acre from the existing GIS maps, but we expect that relatively few locations on the private lands outside of detection areas will meet this criteria. For example, there are over 148,000 acres of potential murrelet nesting habitat in the Puget Trough lowlands of Zone 1 (all ownerships), yet there are only 2 occupied sites documented in this region. Of the 9,351 murrelet observations documented in Zone 1, only 35 (0.03 percent) are located in the Puget Trough lowlands, indicating a low occurrence of murrelets in this area. This observation is likely biased by the lack of survey effort in the Puget lowlands, but it is also likely an indicator of the highly fragmented and/or marginal quality of potential habitat in this region.

Other areas, such as the west slope of the north Cascades, have many patches of potential habitat that are not currently associated with known detection areas or occupied sites. Due to their proximity to marine waters and proximity to adjacent detection areas, many of these locations may support nesting murrelets, but have not yet been surveyed to determine occupancy. Potential nest habitat that has less than 7 nesting platforms per acre could support nesting murrelets in these areas. Whether or not these areas will be surveyed prior to harvest is unknown, but there is a risk that occupied murrelet habitat outside of detection areas could be harvested.

Another area of concern is the inland zone, beyond 50 miles from marine waters, since potential habitat in this area is not protected by the Washington Forest Practices Rules. Few murrelets have been documented this far from marine waters, but occasional sightings have been reported. Of the 4,922 status 1-3 sites documented in Washington, only 1 site is located farther than 50 miles from marine waters. This particular site is located on Federal lands. Although there is substantial habitat on Federal lands beyond 50 miles from marine waters, there are relatively few acres on private lands. We estimated there were 800 acres of potential habitat on private lands located 50 to 55 miles from marine waters, and half of these acres were located east of the Cascade crest, so we expect that the risk of harvesting occupied habitat on private lands in these areas is low. We have not identified these far inland areas as important for recovery (U.S. Fish and Wildlife Service 1997a). The majority of suitable murrelet habitat that occurs beyond 50 miles from marine waters is located on Federal lands and is protected by the standards and guidelines for land management under the Northwest Forest Plan.

The environmental analysis for Zone 1 indicates that over 40,000 acres of potential marbled murrelet nesting habitat was harvested between 1992 and 2002 on all ownerships, representing a decadal loss of about 3.6 percent. Timber harvest on private lands accounted for about 75 percent of the total habitat acres removed (30,000 acres). Harvest on Federal, tribal, or other HCP-covered lands accounted for the remaining 25 percent of habitat loss. Timber harvest on the private lands removed about 15 percent of the potential murrelet habitat that was present in 1992-1996. These data suggest that potential murrelet habitat on the private lands has been harvested at a rate of about 3,000 acres per year, or a rate of about 1.5 percent annually. It is unlikely that future rates of habitat loss due to timber harvest on the FPHCP covered lands would be as high as rates documented for the period 1992-2002. The first 3 years of that period (1992-1995) preceded implementation of the marbled murrelet habitat rules under the 1996 Washington Forest Practices Rules. Following rule implementation (July 1, 1996), landowners proceeded to harvest finite amounts of older habitat as permitted by the rules. Opportunities for harvesting marbled murrelet habitat have steadily diminished as more and more of the habitat available for harvest under the 1996 rules has been depleted. Opportunities were further diminished in 2001, when new restrictions were placed on timber harvest on unstable slopes, groundwater recharge areas of glacial deep-seated landslides, channel migration zones, and other areas.

Cumulative Effects to Marbled Murrelet Habitat in Conservation Zone 2

The environmental baseline analysis indicates that there is over 497,000 acres of potential marbled murrelet nesting habitat in Zone 2. About 67 percent (332,400 acres) is located on Federal lands, and 33 percent is located on non-Federal lands. Approximately 14 percent of the potential habitat (69,400 acres) in Zone 2 is located on the private lands, while the other 19 percent is located primarily on State lands, managed under the WDNR HCP for spotted owls and marbled murrelets (WDNR 1997c).

There are over 2.5 million acres of private lands in Zone 2, distributed across a large landscape that encompasses portions of the western Olympic Peninsula, southwest Washington, the Puget Trough lowlands, and the western Cascades. The majority of the private lands (97 percent) in Zone 2 contain second-growth forests that are not suitable for murrelet nesting habitat. Potential murrelet habitat that does occur on the private lands is highly fragmented and occurs in small, isolated patches. Of the 69,400 acres of potential murrelet habitat on the private lands, about 27 percent (18,650 acres) is located in murrelet detection areas, and about 16 percent (11,400 acres) is associated with the status 1-3 occupied site buffers. Due to the high level overlap between occupied site buffers and detection areas, we estimate that about 20,000 acres of the potential murrelet habitat is associated with murrelet detection areas or occupied sites (29 percent). Due to the requirement for pre-harvest surveys in all stands that meet minimum suitable habitat criteria, we expect that occupied stands in detections areas are likely to be documented and protected as occupied marbled murrelet sites.

The other 71 percent (49,000 acres) of potential murrelet habitat on the private lands in Zone 2 is not associated with detection areas or occupied sites, and is therefore at a higher risk of harvest. Only stands that have a high probability of murrelet occupancy are protected with a pre-harvest survey requirement. Suitable murrelet habitat with a high probability of occupancy is defined as having ≥ 5 platforms/acre in the southwest Washington marbled murrelet special landscape (WAC 222-16-087), and/or ≥ 7 platforms/acre elsewhere. We have no way of determining the number of nesting platforms per acre from the existing GIS maps, but we expect that relatively few locations on the private lands outside of existing detection areas will meet this criteria. For example, there are over 35,000 acres of potential murrelet nesting habitat in the Puget Trough lowlands of Zone 2 that occur inland from the southwest Washington special landscape area (all ownerships), yet there are no occupied sites documented in this region. Of the 20,791 murrelet observations documented in Zone 2, only 4 are located in the Puget Trough lowlands, indicating a low occurrence of murrelets in this area. This observation is likely biased by a lack of survey effort in the Puget lowlands, but is also likely an indicator of the highly fragmented and/or marginal quality of habitat in this region.

Other areas, such as the southwest Washington marbled murrelet special landscape, or the northwest Olympic Peninsula, have many patches of potential habitat that are not currently associated with known detection areas or occupied sites. Due to their proximity to marine waters and proximity to adjacent detection areas, many of these locations may support nesting murrelets, but have not yet been surveyed to determine occupancy. Potential nest habitat that has less than 5 nesting platforms per acre could be supporting nesting murrelets in these areas. Whether or not these areas will be surveyed prior to harvest is unknown, but there is a risk that occupied murrelet habitat outside of detection areas could be harvested.

The environmental baseline analysis for Zone 2 indicates that over 25,000 acres of potential marbled murrelet nesting habitat was harvested between 1992 and 2002 on all ownerships, representing a decadal loss of about 4.8 percent. Timber harvest on the private lands accounted for about 87 percent of the total habitat acres removed (21,800 acres). Harvest on Federal, tribal, or other HCP-covered lands accounted for the remaining 13 percent of habitat loss. Timber harvest on the private lands removed about 24 percent of the potential murrelet habitat that was present in 1992-1996. These data suggest that potential habitat on the private lands has been harvested at a rate of about 2,000 acres per year, or a rate of about 2.4 percent annually. It is unlikely that future rates of habitat loss due to timber harvest on the FPHCP covered lands would be as high as rates documented for the period 1992-2002. The first 3 years of that period (1992-1995) preceded implementation of the marbled murrelet habitat rules under the 1996 Washington Forest Practices Rules. Following rule implementation (July 1, 1996), landowners proceeded to harvest finite amounts of older habitat as permitted by the rules. Opportunities for harvesting marbled murrelet habitat have steadily diminished as more and more of the habitat available for harvest under the 1996 rules has been depleted. Opportunities were further diminished in 2001, when new restrictions were placed on timber harvest on unstable slopes, groundwater recharge areas of glacial deep-seated landslides, channel migration zones, and other areas.

Summary of Cumulative Effects of Private Timber Harvest to Marbled Murrelets

Only about 21 percent of the potential murrelet nesting habitat on the private lands is associated with occupied site buffers or murrelet detections areas. The other 79 percent (roughly 190,000 acres) is not associated with these areas, and is therefore at risk of being harvested for timber over the next 50 years. This represents approximately 12 percent of the existing potential marbled murrelet habitat in Washington. Not all of this habitat will be subject to harvest, as some areas will be protected for documented marbled murrelet sites or high-hazard soils areas. We did not calculate how much habitat would be protected for other conservation needs, but we suspect these areas represent a small percentage of the total acres that are at risk. Murrelet habitat on private lands in the southwest Washington, the Olympic Peninsula, and the northwest Cascades in particular, are of greatest concern, because these areas contain substantial habitat acres that are not currently located in murrelet detection areas. The quality of habitat in these areas will determine whether or not pre-harvest surveys are completed to determine occupancy.

The risk of habitat loss on the private lands appears to be substantial over the long-term. The potential loss of 190,000 acres of potential murrelet habitat on the private lands could result in the abandonment of some landscapes that are currently marginally suitable for murrelets. We assume that the majority of murrelets in both Zones 1 and 2 are nesting in high-quality habitat patches located on Federal lands, but relatively few surveys have been conducted on Federal lands to confirm this assumption.

We have no reliable way of estimating the number of individual murrelets that could be affected by timber harvest on the private lands. To do so would require an assumption of average murrelet density per acre of habitat, and we have no data to support such an assumption at the scale of the private lands. Although McShane et al. (2004) and others developed population viability models for murrelets, these models do not include habitat variables to test the effects of habitat loss on population viability. Several studies have examined the relationship between murrelet densities and available nesting habitat, but there are no clear thresholds of landscape viability from these studies. Rather, these studies have shown that murrelets are positively associated with total watershed area, positively associated with increasing amounts of late-seral forests in a watershed, and negatively associated with increasing edge and amounts of logged or unsuitable habitat (McShane et al. 2004.).

The adverse effects associated with habitat loss do not include direct adverse effects to nesting individuals, but rather a reduction in the overall potential nesting habitat that is available for the conservation and recovery of marbled murrelets on non-Federal lands in Washington.

8.3.4.2 Cumulative Effects to Federally Designated Marbled Murrelet Critical Habitat

We anticipate that activities that occur on private lands may affect marbled murrelet critical habitat where the private lands occur adjacent to Critical Habitat Units. Edge effects associated with clearcut timber harvest in the uplands could result in an increased risk of windthrow and microclimate changes to critical habitat on adjacent Federal and non-Federal lands. We anticipate that windthrow and edge effects are could occur for distances up to 400 feet into adjacent Critical Habitat Unit stands.

Windthrow Effects

Windthrow is a natural phenomenon affecting forests throughout the Pacific Northwest. Every year hundreds of acres of trees are blown over in natural stands and along clearcut boundaries and road corridors (Strathers et al. 1994). The factors that influence windthrow include individual tree characteristics, stand characteristics, root zone soil characteristics, topographic exposure characteristics, and meteorological conditions (Strathers et al. 1994; Harris 1999). Windthrow usually occurs in the first few years after harvesting, particularly where more susceptible trees are exposed to stronger winds as a result of harvesting. Trees can become more windfirm after a few years of exposure as they develop reaction wood in response to swaying (Strathers et al. 1994). Timber harvesting can increase the windthrow hazard by increasing the wind speed and turbulence along the downwind edge of clearcut boundaries. Winthrow damage and can extend into adjacent stands for hundreds of feet, although most damage is usually concentrated within the first 30 to 60 feet of the cutting boundary edge (Strathers et al 1994).

Microclimate Effects

When trees on adjacent private lands are felled, an opening in the canopy will be created, which can cause changes in the microclimate in the surrounding stand. Air temperature, humidity, soil temperature, soil moisture, solar radiation, and wind speed within a stand can be altered by clearings. Along clearcut edges, the amounts of windthrow and dead wood are more abundant because of exposure to strong winds and environmental stress (Chen et al. 1993). Changes between the interior of a stand and the clearing can be detected for air temperature, humidity, and wind speed up to and greater than 780 feet into a stand (Chen et al. 1995). Removal of conifers would be likely to create large openings in the canopy, thereby increasing the likelihood for microclimate changes to occur. While there are no data on the specific effects of microclimate changes on the availability of murrelet nesting habitat at the branch and tree scales, the penetration of solar radiation, wind, and warm temperatures into the forest could change the distribution of epiphytes or blow moss off nesting platforms.

Cumulative Effects to Marbled Murrelet Critical Habitat

We used GIS to estimate the Critical Habitat Unit areas that border private lands, and estimated that about 34,400 acres of critical habitat occurs adjacent (within 400 feet) to private lands (2.8 percent). This figure represents a gross estimate and includes some non-Federal acres that are embedded within the Critical Habitat Unit boundaries. There are approximately 10,900 acres of potential murrelet nesting habitat associated with these Critical Habitat Unit "edge" acres, which represents approximately 32 percent of the potentially affected Critical Habitat Unit acres. The other 68 percent of these acres are comprised of second-growth forests or other non-suitable habitat areas.

Assuming an annual harvest rate of about 12 percent per decade on private lands (Table 8-31), we anticipate that approximately 4,100 acres of designated critical habitat may be affected by clearcut edges on adjacent private lands per decade (i.e., 12 percent of 34,000 acres of Critical Habitat Unit edge areas ≈ 4,100 acres), for a total of up to 20,500 acres affected over 50 years. The amount of potential nesting habitat exposed will be substantially less than this figure, probably on the order of 1,300 acres per decade (i.e., 32 percent of the affected area). Over a 50-year period, approximately 6,500 acres of potential nesting habitat located along the edges of designated Critical Habitat Units would be exposed to edge effects and an increased risk of windthrow.

The potential effects of windthrow are highly variable and dependant on many site-specific factors. There are no reliable methods to estimate or quantify the effects that windthrow may have to potential murrelet habitat at the scale of the private lands. However, it is likely that potential murrelet nesting habitat in Critical Habitat Units will be adversely affected by the loss of individual trees with potential nesting platforms, and the loss of trees that provide cover to trees with platforms. For the purposes of this analysis, we are assuming that 15 percent of the potential nesting habitat along affected boundaries will be lost due to the windthrow. This assumption is based on the review by Strathers et al. (1994) who found that most windthrow damage occurs within 30 -60 feet of a clearcut boundary (i.e., 60 feet represents 15 percent of the 400-foot area of edge effects). Based on this assumption, we estimate that up to 1,000 acres of potential nesting habitat could be lost along Critical Habitat Unit boundaries due to windthow effects over a 50 year period.

The Washington Forest Practices Rules minimize edge effects to suitable murrelet habitat by protecting occupied sites with a 300-foot managed buffer zone adjacent to the occupied site. This rule protects occupied sites by prohibiting clearcut timber harvest within 300 feet of the occupied stand (WAC 222-16-080 (j)(v)). Under the managed buffer rule, trees within the managed buffer may be thinned to a density of 75 trees per acre. The primary consideration for the design of the managed buffer is to mediate edge effects to occupied murrelet sites. We did not calculate the habitat acres associated occupied sites along Critical Habitat Unit boundaries, but expect that the managed buffer rule could reduce the potential effects associated with clear cut edges. There are approximately 2,300 acres of designated Critical Habitat Units on the private lands that encompass several occupied murrelet sites. The managed buffer rules would apply to the occupied sites on these lands, and reduce the potential for edge effects on the non-Federal Critical Habitat Units. Federal Critical Habitat Units are less likely to receive protection from the managed buffer rules, because there are relatively few occupied murrelet sites documented on Federal lands, and non-Federal land owners are not obligated to conduct murrelet surveys on adjacent Federal lands.

Summary of Cumulative Effects to Marbled Murrelet Critical Habitat

Forest practices on the private lands that share boundaries with Critical Habitat Units could result in microclimate effects to 6,500 acres of potential nesting habitat, including the loss of up to 1,000 acres of potential murrelet nesting habitat due to windthrow damage. These effects will be distributed across 33 Critical Habitat Units which encompass over 1.2 million acres and contain over 401,000 acres of potential nesting habitat. We recognize that the loss of potential nesting habitat from a catastrophic windthrow event could be substantial at an individual site scale. However, we have no way of predicting the location or extent of such events.

Individual Critical Habitat Units in Washington vary in size from 200 acres to over 108,000 acres in size. Potential edge-affected areas in Critical Habitat Units range from 0 to 100 percent depending on the size of the Critical Habitat Unit. Critical Habitat Units on Federal lands are typically large (≥ 20,000 acres) and have a low amount of edge-affected area (≈ 2-3 percent). Critical Habitat Units on non-Federal lands are small (≤ 1,000 acres), and have a high potential for edge effects. Potential edge effects on the non-Federal Critical Habitat Units will be minimized by the managed buffer rules required under the Washington Forest Practices Rules. Edge effects to the larger Federal Critical Habitat Units will be confined to the boundary areas of these units, potentially affecting less than 1-2 percent of the nesting habitat in an individual unit.

The loss of potential nesting habitat could be substantial at an individual site scale, but we are unable to estimate the extent of such adverse effects. At the scale of individual Critical Habitat Units, there could be a loss of 1-2 percent of potential habitat. At the scale of Critical Habitat Units in Washington, the estimated loss of potential habitat would be 0.25 percent, over a 50 year period. The cumulative effects associated with private forest practices will be confined to the boundary areas of individual Critical Habitat Units and therefore should have only minor adverse effects to the overall function of the critical habitat. Each Critical Habitat Unit was designated to include large blocks of suitable habitat to support the successful nesting of marbled murrelets. Overall, the loss of up to 1,000 acres of potential nesting habitat due to windthrow over a 50 year period is not expected to have a substantial adverse effect on the function or conservation role of the critical habitat units in Washington.

8.3.4.3 Integration and Synthesis – Summary of the Status, Baseline, and Effects to Marbled Murrelets

Threats to marbled murrelet recovery include nesting habitat loss, mortality in the marine environment, and high rates of nest predation. These threats continue to contribute to murrelet population declines through adult and juvenile mortality and reduced reproduction. Lands considered essential for the recovery of the marbled murrelet within Conservation Zones 1 and 2 include all nesting habitat located within the range of the murrelet on Federal lands; nesting habitat on State lands within 40 miles of marine waters; and nesting habitat within occupied murrelet sites on private lands (U.S. Fish and Wildlife Service 1997a). Currently, about 68 percent (1,079,900 acres) of potential murrelet habitat is located on Federal lands in Washington, and there have been relatively few acres of habitat loss on these lands. Habitat on State lands is managed under the WDNR HCP (WDNR 1997c). Murrelet surveys conducted in support of this HCP have documented over 54 percent of the known, occupied murrelet sites on the WDNR HCP lands. These sites are currently protected from harvest through the provisions of the HCP (WDNR 1997c). About 25 percent (388,900 acres) of all potential nesting habitat in Washington is associated with 1.5 mile-radius buffers surrounding known, occupied murrelet sites.

Over 50 percent of the habitat-capable acres within the range of the marbled murrelet in Washington occur on private lands. Currently, only about 15 percent of the extant potential habitat acres (242,100 acres) are located on these lands, and about 7 percent of known occupied habitat (25,700 acres) is located on private lands. In areas with few Federal acres (e.g., southwest Washington), the conservation of marbled murrelets is almost entirely dependent upon conservation efforts on State or private lands. In southwest Washington, private lands comprise the majority of that landscape, and many stands have been identified as occupied by murrelets.

Timber harvest on the FPHCP covered land RMZs is likely to result in the long-term loss and degradation of unoccupied, potential marbled murrelet nesting habitat in RMZs. Considering both Zone 1 and Zone 2 combined, we estimate that approximately 92,000 acres of RMZs on FPHCP covered lands would be managed per decade, resulting in a potential loss of 2,200 acres of unoccupied murrelet nesting habitat in RMZs per decade. Over the next 50 years, a total of approximately 11,000 acres of unoccupied potential murrelet nesting habitat could be removed by stand-replacing timber harvest in the RMZs. These effects would be distributed over 730,000 acres of RMZs from the Olympic Peninsula to the western Cascades, which in turn are distributed across 5.4 million acres of FPHCP covered lands over a period of 50 years.

Unoccupied marbled murrelet nesting habitat on private lands is not considered to be essential to the recovery of the marbled murrelet (U.S. Fish and Wildlife Service 1997a).

This rate of loss is practically immeasurable at the scale of the conservation zones, and does not constitute a substantial effect to the distribution of potential murrelet habitat. We expect all habitat acres removed in RMZs will be unoccupied by murrelets, therefore, we do not anticipate murrelets will be directly killed or displaced from potential nesting habitat in RMZs. Because there would be no loss of occupied habitat, there would be no adverse effects to the current distribution or survival of murrelet populations in Zone 1 or Zone 2 resulting from RMZ management.

We expect that some sound- and activity- related disturbances to nesting murrelets may occur on the private lands, but the risk for potential injury to murrelets is low due to the 0.25-mile disturbance buffers and daily activity restrictions required by the Washington Forest Practices Rules. The Washington Forest Practices Rules minimize the potential for adverse effects from disturbance associated with forest practices to nesting murrelets, but they do not ensure that all murrelets will be protected from disturbance under all circumstances. Blasting within a mile of an occupied murrelet site, unrestricted activities during the mid-day hours, and forest practices during the late nesting season (September) are all situations which may result in murrelets flushing from a nest, aborted feedings, or postponed feedings.

We have no reliable way of quantifying the amount of potential disturbance to murrelets associated with forest practice activities on the private lands. To do so would require an assumption regarding the density of nesting marbled murrelets per acre of suitable habitat, and we have no data to support such assumptions at the scale of the private lands. We expect that the existing Washington Forest Practices Rules which prohibit timber harvesting and road construction in occupied murrelet sites, and restrict forest practice activities within 0.25 miles of occupied murrelet sites will minimize disturbance effects to over 99 percent of the potential nesting/fledging murrelets on the private lands.

Cumulative effects associated with forest practice activities on the uplands particularly in areas not associated with murrelet detection areas or occupied sites may pose a risk to marbled murrelets. Only about 21 percent of the potential murrelet nesting habitat on the private lands is associated with occupied site buffers or murrelet detections areas. The other 79 percent (roughly 190,000 acres) is not associated with these areas, and is therefore at a higher risk of being harvested for timber over the next 50 years. This represents approximately 12 percent of the existing potential marbled murrelet habitat in Washington. Not all of this habitat will be subject to harvest, as some areas will be protected for documented marbled murrelet sites or high-hazard soils areas. We did not calculate how much habitat would be protected for other conservation needs, but we suspect these areas represent a small percentage of the total acres that are at risk.

Murrelet habitat on private lands in southwest Washington, the Olympic Peninsula, and the northwest Cascades in particular are of concern because these areas contain substantial habitat acres that are not currently located in murrelet detection areas. The quality of habitat in these areas will determine whether or not pre-harvest surveys are completed to determine occupancy.

The risk of habitat loss on private lands appears to be substantial over the long-term. The potential loss of 190,000 acres of potential murrelet habitat on private lands could result in the abandonment of some landscapes that are currently marginal for murrelets. We assume that the majority of murrelets in both Zones 1 and 2 are nesting in high-quality habitat patches located on Federal lands, but relatively few surveys effort have been conducted on Federal lands to confirm this assumption.

During the period of 1992 to 2002, there were over 51,000 acres of potential murrelet nesting habitat removed by timber harvest on private lands, representing a loss of 18 percent of the habitat on these lands. We assume that most of these acres were documented as unoccupied, or had a low probability of occupancy due to their location or marginal habitat conditions. We have no reliable way estimating how much potentially occupied habitat has been lost on non-Federal lands. However, due to error rates associated with early survey protocols it is likely that some occupied habitat was lost during this period. Additionally, potential occupied sites located in habitat with a low probability of occupancy (i.e., ≤ 5-7 platforms/acre) or habitat on small landownership (≤ 500 acres), may have been lost as well. These threats to potential occupied murrelet habitat on private lands still exist under the current Washington Forest Practices Rules. Given the current rates of timber harvest on private lands, it is probable that all potential habitat that is not associated with documented occupied sites could be lost to timber harvest in the next 50 years, resulting in a substantial reduction in the distribution of potential habitat and potentially some loss of reproductive success of murrelet populations in both conservation Zones 1 and Zone 2.

We recognize that much of the potential habitat that occurs on private lands is highly fragmented and of marginal quality for murrelet nesting; and likely has little value for the long-term recovery of marbled murrelets. Substantial areas associated with the Puget Trough lowlands are not likely to support murrelets due to the extensive loss of old-growth habitat in these areas. However, suitable habitat patches that occur on private lands that are adjacent (i.e., within 5 miles) to known occupied sites or are adjacent to large blocks of suitable habitat on Federal or State lands may contribute to the conservation and recovery of the marbled murrelet in Washington.

We anticipate that current management strategies could result in a significant loss (i.e., > 10%) of potential marbled murrelet habitat on private lands. As habitat loss continues on the non-Federal lands, an increasing proportion of marbled murrelets will remain within the habitat blocks on State and Federal lands, where they are also subjected to the negative effects associated with increased corvid populations and a high risk of nest predation.

8.3.5 CONCLUSION – Marbled Murrelet and Marbled Murrelet Critical Habitat

8.3.5.1 Conclusion for Marbled Murrelet in Conservation Zone 1 and Conservation Zone 2

After reviewing the current status of the marbled murrelet, the environmental baseline, the effects of the proposed action on marbled murrelets, and the cumulative effects, it is our biological opinion that implementation of the proposed action discussed herein is not likely to jeopardize the continued existence of the marbled murrelet.

The marbled murrelet is not a covered species under the FPHCP; therefore, we do not anticipate or authorize any incidental take of marbled murrelets associated with the implementation of the FPHCP. Any "take" would violate the prohibitions in Section 9 of the ESA, and would therefore invalidate the FPHCP Permit with respect to all listed covered species for that forest practices application that resulted in unauthorized "take."

Although the proposed action would result in the loss of up to 11,000 acres unoccupied, potential nesting habitat in RMZs, we conclude that these activities pose a low risk to murrelet reproduction and nesting success because no occupied murrelet habitat would be harvested in RMZs, and therefore no direct effects to nesting murrelets are anticipated. Lands considered essential for the recovery of the marbled murrelet within Conservation Zones 1 and 2 include all nesting habitat located within the range of the murrelet on Federal lands; nesting habitat on State lands within 40 miles of marine waters; and nesting habitat within occupied murrelet sites on private lands (U.S. Fish and Wildlife Service 1997a). Under the proposed action, no habitat considered essential for the recovery of the marbled murrelet would be removed. Due to the widely distributed effects associated with harvest in RMZs, we conclude that the issuance of a Permit for the FPHCP for covered aquatic species would not be expected to appreciably affect the overall reproduction, numbers, and distribution of marbled murrelets in Washington.

8.3.5.2 Conclusion for Marbled Murrelet Critical Habitat

After reviewing the current status of marbled murrelet critical habitat, the environmental baseline for the FPHCP Action Area, the effects of the proposed action, and the cumulative effects, it is our biological opinion that the proposed action is not likely to destroy or adversely modify designated critical habitat for the marbled murrelet.

The effects associated with private forest practices will be confined to the boundary areas of individual Critical Habitat Units and therefore should have only minor adverse effects to the overall function of the critical habitat. At the scale of individual subunits, there could be a loss of 1-2 percent of potential habitat. At the scale of Critical Habitat Units in Washington, the estimated loss of potential habitat would be 0.25 percent, over a 50 year period. Each Critical Habitat Unit was designated to include large blocks of suitable habitat to support the successful nesting of marbled murrelets. Overall, the loss of up to 1,000 acres of potential nesting habitat dispersed across the landscape due to windthrow over a 50 year period is not expected to have a substantial adverse effect on the function or conservation role of the critical habitat units in Washington.

8.4 AMPHIBIANS

8.4.1 CASCADE TORRENT SALAMANDER (*Rhyacotriton cascadae*)

8.4.1.1 STATUS OF THE SPECIES

Description of Species

The Cascade torrent salamander is a small salamander with a snout to vent length of 2.2 inches (56 millimeters) for adults (Jones et al. 2005). Total length of adults is about 4 inches (105 millimeters) (Jones et al. 2005). Females are slightly larger than males (Nussbaum et al. 1983). Nomenclature follows Crother (2001).

Historical and Current Range

The Cascade torrent salamander occurs on the western slopes of the Cascade Range from the Middle Fork of the Willamette River in Oregon north to the south side of the Skookumchuck River in Washington (Good and Wake 1992; McAllister 1995; Dvornich et al. 1997). Over their range, the Cascade torrent salamander can be found from 164 feet (50 meters) to 4,429 feet (1,350 meters) in elevation (Jones et al. 2005). In Oregon, the Cascade torrent salamanders are known to range in elevations to above 4,000 feet (1,219 meters), with probability of occurrence peaking at around 2,850 feet (869 meters). Downstream, where gradients are lower, their occurrence is less frequent (Hunter 1998). In Washington, the upper limit of elevation is poorly understood, but anchor ice (i.e., ice that develops from the substrate rather than capping flowing waters) may limit their distribution in smaller, higher-elevation streams. Historical versus current range, abundance, and density is unknown at this time, but the Cascade torrent salamander can be locally abundant (Marc Hayes, Personal Communication, 2005; Lannoo 2005).

Essential Habitat Components

Adult Cascade torrent salamanders are often found in an underground matrix of small water courses in the rock rubble and stream banks, and in cracks and fissures in stream banks and cliffs (Nussbaum and Tait 1977). Larvae have been observed more abundantly under sheltering rocks along the lower flow margins of stream channels and in the network of fissures within the streambed and banks (Nussbaum and Tait 1977), and can be common in the headwater landscape (Steele et al. 2003). General habitat information on *Rhyacotriton* describes them to be in riffles of cold, permanent streams with small water-washed or moss-covered rocks (Bury et al. 1991a) with substantial canopy and abundant understory vegetation (Stebbins and Lowe 1951). Constantly in contact with water, *Rhyacotriton* is among the most desiccation-intolerant salamander genera known (Ray 1958), probably due to a dependence on the skin surface for oxygen exchange because of reduced lung capacity (Whitford and Hutchinson 1966). The Cascade torrent salamander is rarely found more than 3.3 feet (1 meter) from water, except during major rain events when the salamander may be found greater than 32.8 feet (10 meters) from water (Jones et al. 2005). Based on southern torrent salamander data, metamorphosed juveniles and adults probably feed on invertebrates in moist, forested habitats along stream margins—notably amphipods, fly larvae, springtails and stonefly nymphs (Bury and Martin 1967; Bury 1970). Larvae diet is unknown.

Reproductive Ecology

Cascade torrent salamanders require five to six years to reach reproductive maturity (Nussbaum and Tait 1977). Reproduction occurs in low-flow aquatic habitats. The description of the one observed Cascade torrent salamander nest was that it was under a cobble within a glide of a second-order headwater stream, 1,500 feet (4572 meters) below the stream origin (MacCracken 2004). Variation in nest location is presumed to be similar to those of the Columbia torrent salamander that place their unattached eggs among the substrate spaces of low-velocity headwater streams and seeps. Female Cascade torrent salamanders have a small clutch size (2 to 14 eggs) and do not tend the eggs during prehatching development (Lannoo 2005). Larval life is thought to be three to four years, with metamorphosis typically occurring in late summer to early fall (Nussbaum and Tait 1977). Neoteny is unknown in this genus (Lannoo 2005). Metamorphosis can take place any time of the year, but occurs most often in late summer to early autumn (Lannoo 2005). Longevity is poorly understood, but they are thought to live at least ten years after metamorphosing (Nussbaum and Tait 1977).

Movements and Habitat Use

Cascade torrent salamanders are thought to be sedentary, with typical movements on the scale of a few meters (Nussbaum and Tait 1977; Nijhius and Kaplan 1998), but movement studies are limited due to sampling across a highly restricted landscape, so the true extent of movements is unknown. No breeding or seasonal migrations have been documented for this species (Lannoo 2005).

Threats to Survival and Conservation Needs of the Species

The Cascade torrent salamander is a Washington State Candidate species. Concern centers on their limited distribution, narrow range of tolerance for environmental conditions, and the associated risk of local extirpation following clearcut timber harvest and the subsequent increase in microhabitat temperatures and sedimentation (Bury and Corn 1988; Blaustein et al. 1995; Hallock and McAllister 2002). Another historical concern has been the lack of protection for headwater streams, seeps, and springs (Wilkins and Peterson 2000). A recent study found Cascade torrent salamanders to have the highest densities at mid-rotation in the managed landscape (Steele et al. 2003), but the site-selection constraint of minimal sedimentation makes the study ambiguous as to how representative it may be of the managed landscape. Cascade torrent salamanders survived in areas affected by the 1980 eruption of Mount St. Helens. These populations persisted in locations where the vegetation was severely affected by the eruption (Jones et al. 2005). This suggests that forest cover may not be a critical habitat feature at higher elevations (Jones et al. 2005), as long as cool, wet environments persist.

Based on the above information, the conservation needs of the Cascade torrent salamander are: (1) to maintain or expand their current distribution; and (2) to avoid and minimize adverse changes to the wetted margins of headwater streams and also seeps, springs, and waterfall splash zones.

8.4.1.2 ENVIRONMENTAL BASELINE

Although a portion of the range of the Cascade torrent salamander occurs on Federal (i.e., Gifford Pinchot National Forest and Mount St. Helens National Monument) and State (mostly WDNR) lands, a significant portion (at least 70 percent; compare maps in Dvornich et al. 1997 with Atterbury Consultants, Inc. 2003) of its distribution is within privately managed landscapes, the largest segment being under industrial ownership in Washington. The Cascade torrent salamander is known to occur in parts or all of the following Water Resource Inventory Areas (WRIAs): 11, 23, 26, 27, 28, and 29 (USFWS and NMFS 2006; Appendix A Regional Summaries).

Conservation Needs of the Species in the FPHCP Action Area

Cascade torrent salamanders are restricted to the westside of the Cascade Mountains in Washington and Oregon. They inhabit the wetted margins of headwater streams and also seeps, springs, and waterfall splash zones. They seem to be dependent on cool, clear stream margin habitat. Because the Cascade torrent salamander has a limited range in Washington and Oregon and because the FPHCP Action Area overlaps a large portion of their range in Washington, maintaining the physical and ecological integrity of the wetted margins of headwater streams, seeps, springs, and waterfall splash zones in the FPHCP Action Area is essential to the long-term conservation of the Cascade torrent salamander.

8.4.1.3 EFFECTS OF THE ACTION

The effects from the proposed action on the Cascade torrent salamander are described in detail in the Effects to Guilds – Headwater Guild section of this Opinion. The Cascade torrent salamander would be adversely affected by changes in overstory riparian canopy, through timber harvest, that are expected to increase solar radiation along non-buffered portions of Type Np and Ns streams, thus warming the water in shallow stream margins. Direct damage to streambank conditions through yarding timber within riparian yarding corridors is expected on occasion and would also adversely affect the Cascade torrent salamander. These effects are expected to reduce the quality of habitat, reduce the numbers, and reduce the reproductive potential of the Cascade torrent salamander at times throughout the proposed 50-year term of the Permit. However, the distribution of the Cascade torrent salamander is not expected to be altered because the above effects will be localized and temporally and spatially staggered across its range within the FPHCP Action Area during the proposed 50-year term of the Permit.

Riparian timber harvest along Type Np and Ns streams, especially non-buffered portions, is expected to reduce the amount of wood recruited to streams. This would reduce the capacity for sediment storage, reduce substrate for aquatic invertebrate production, and possibly alter stream channel morphology. Increased sedimentation is expected to reduce the habitat quality for Cascade torrent salamanders by filling interstitial spaces in stream substrate that impairs movement, egg deposition, and larval development. A reduction in aquatic invertebrate production would reduce food for Cascade torrent salamanders. Possible changes in stream channel morphology could degrade stream margins and thus Cascade torrent salamander habitat. Increased sedimentation, decreased invertebrate production, and possibly changes in channel morphology are expected to reduce the quality of habitat, reduce the numbers, and reduce the reproductive potential of the Cascade torrent salamander at times throughout the proposed 50-year term of the Permit. However, the distribution of the Cascade torrent salamander is not expected to be altered because the above effects will be localized and temporally and spatially staggered across its range within the FPHCP Action Area during the proposed 50-year term of the Permit.

Increased sediment inputs from hydrologically connected forest roads or from road construction across Type Np and Ns streams would adversely affect the Cascade torrent salamander by filling interstitial spaces in stream substrate that impairs movement, egg deposition, and larval development. Electrofishing (related to adaptive management research and instream fish salvage for culvert and bridge maintenance and installation) would adversely affect the Cascade torrent salamander in the form of stress, wounding, or mortality. Also, culvert and bridge maintenance and installation could adversely affect the Cascade torrent salamander through short-term (i.e., days to weeks) sediment inputs and riparian and instream heavy equipment use. Increased sediment inputs from forest roads, road crossings, and culvert and bridge maintenance and installation is expected to reduce the quality of habitat, reduce the numbers, and reduce the reproductive potential of the Cascade torrent salamander at times throughout the proposed 50-year term of the Permit. However, the distribution of the Cascade torrent salamander is not expected to be altered because the above effects will be localized and temporally and spatially staggered across its range within the FPHCP Action Area during the proposed 50-year term of the Permit. Electrofishing is expected to affect few individual Cascade torrent salamanders through stress, wounding, and direct mortality over the proposed 50-year Permit term for the FPHCP.

The probability of adverse effects to Cascade torrent salamanders (especially those effects that would directly injure or kill salamanders) is low for any particular forest practice activity in a single location. However, the probability that habitat quality, numbers of individuals, and reproductive potential would be reduced across the FPHCP covered lands during the proposed 50-year Permit term is reasonably certain to occur many times in many locations.

The Cascade torrent salamander is known to occur in parts of all of the following Water Resource Inventory Areas (WRIAs): 11, 23, 26, 27, 28, and 29 (USFWS and NMFS 2006; Appendix A Regional Summaries). Because survey information for Cascade torrent salamanders does not exist for most WRIAs, it is impossible to determine how many individual Cascade torrent salamanders would be injured, killed, or affected by habitat degradation that disrupts breeding, feeding, and sheltering behaviors. Therefore, the amount of riparian harvest, the number of road crossing structures, and the miles of stream-adjacent roads are used as surrogates for quantifying the adverse affects on Cascade torrent salamanders. Thus, it is estimated that harvest of riparian timber for up to 42,170 acres along Type Np streams and 275,140 acres along Type Ns streams could adversely affect Cascade torrent salamanders over the life of the proposed 50-year Permit term. These numbers represent the maximum amount of habitat that is expected to be affected during the proposed 50-year Permit term and likely overestimate the actual habitat would be affected as habitat surrogates lack precision. These numbers are derived from a GIS analysis described in Appendix G.

Further, it is estimated that culvert and bridge maintenance and installation, and sediment from hydrologically-connected roads, could result in adverse effects to Cascade torrent salamanders from up to 2,829 Type Np stream crossings and 41,174 Type Ns stream crossings, and 289 miles of Type Np stream-adjacent roads, over the life of the proposed 50-year Permit term within WRIAs 11, 23, 26, 27, 28, and 29 that intersect FPHCP covered lands. These numbers are derived from a GIS analysis described in Appendix G.

The conservation measures in the FPHCP minimize and mitigate adverse effects to Cascade torrent salamanders described above. These measures include: (1) no-harvest RMZs on at least 50 percent of Type Np streams; (2) sensitive site protections (e.g., seeps, springs, Type Np intersections, perennial initiation points; and (3) unstable slope protections.

8.4.1.4 CUMULATIVE EFFECTS

Cumulative effects are those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR §402.02). Cumulative effects were addressed in the Comprehensive Cumulative Effects section of this Opinion, with respect to the aquatic and riparian environment in Washington State. It is assumed that most land surrounding and upstream of the headwater habitat of the Cascade torrent salamander would be forestland since most agricultural and developed land occurs much lower in watersheds. The cumulative effects of future State or private activities in these headwater areas would include likely include upland timber harvest under the FPHCP and recreation activities. These reasonably expected future State and private activities are not expected to substantially change the overall effects of the action, described above, on the Cascade torrent salamander.

8.4.1.5 CONCLUSION

The aggregate effects of the factors analyzed under the environmental baseline, the effects of the action, and the cumulative effects in the FPHCP Action Area, when viewed against the status of the species is not likely to jeopardize the continued existence of the Cascade torrent salamander.

8.4.2 COLUMBIA TORRENT SALAMANDER (*Rhyacotriton kezeri*)

8.4.2.1 STATUS OF THE SPECIES

Description of Species

The Columbia torrent salamander is a small salamander with a snout to vent length of 2.6 inches (66 millimeters) for adults (Jones et al. 2005). Total length of adults is about 4 inches (100 millimeters). Females are slightly larger than males (Nussbaum et al. 1983). Nomenclature follows Crother (2001).

Historical and Current Range

The Columbia torrent salamander is distributed in the Coast Range of southwest Washington and northwest Oregon from the Little Nestucca River in the south to the Chehalis River in the north (Good and Wake 1992; McAllister 1995; Dvornich et al. 1997). In Washington, the salamander occurs in the extreme southwest corner of the State. Columbia torrent salamanders can be found from near sea level to

3,110 feet (948 meters) in Washington and from near sea level to 3,283 feet (1,001 meters) in Oregon (Lannoo 2005). Historical versus current range, abundance, and density is unknown at this time, but the Columbia torrent salamander can be locally abundant (Marc Hayes, Personal Communication, 2005; Lannoo 2005).

Essential Habitat Components

Juvenile and adult habitat preferences are assumed to be similar, although definitive studies have not been undertaken. Adults prefer cold, permanent streams with small, water-washed or moss-covered rocks/rubble, seeps and small trickling tributary streams with substantial canopy and abundant understory vegetation. Likelihood of occupancy increases from low to high elevations; headwaters appear to be preferred (Wilkins and Peterson 2000). The likelihood of occurrence also increases on basalt formations as opposed to marine sediments and on northerly exposures as opposed to southerly aspects (Russell et al. 2004). The salamander is rarely found out of contact with water since *Rhyacotriton* is among the most desiccation-intolerant salamander genera known (Ray 1958), possibly due to the dependence of oxygenation through the skin rather than through its small lung capacity (Whitford and Hutchinson 1966). Based on southern torrent salamander data, metamorphosed juveniles and adults probably feed on invertebrates in moist, forested habitats along stream margins; notably they feed on amphipods, fly larvae, springtails, and stonefly nymphs (Bury and Martin 1967; Bury 1970). Larvae diet is unknown.

Reproductive Ecology

Age at maturity in Columbia torrent salamanders is unknown, but if similar to the southern torrent salamander (their most-proximate congener), they may require five to six years to reach maturity, with a total life span that probably exceeds 10 years (Nussbaum and Tait 1977). Nests have been found under rocks or moss in sandstone substrates, headwater springs and side-slope seeps, with cold (47-49 ° F (8.3-9.4 ° C)) slow-moving water trickling over loose, unattached eggs (Russell et al. 2002). Unattached eggs are at risk from scour at higher flows. Parental care of the eggs is unknown (Jones et al. 2005). Based on two nests, clutch size is 7 to 11 eggs (Lannoo 2005). Communal nesting may also take place, based on additional nest observations with reported clutches up to 75 eggs, which is more than any one female could lay (Jones et al. 2005; Lannoo 2005). Columbia torrent salamanders probably remain larvae for more than two years, preferably in stable, slow-moving stream microhabitats with loose gravel and cobble, open interstitial spaces and reduced levels of fine sediments (Lannoo 2005). Neoteny is unknown in this genus (Lannoo 2005). Metamorphosis typically occurs in late summer to early fall, but it can occur throughout the year (Nussbaum and Tait 1977).

Movements and Habitat Use

Individuals are thought to be highly sedentary; similar to Columbia torrent salamanders (Nussbaum and Tait 1977; Nijius and Kaplan 1998), but definitive movement studies of this torrent salamander have not been conducted. No breeding or seasonal migrations have been documented for this species (Lannoo 2005).

Threats to Survival and Conservation Needs of the Species

The Columbia torrent salamander is a Federal species of concern and a Washington State candidate species. Concern centers on their limited distribution, narrow range of tolerance for environmental conditions, and the associated risk of local extirpation following clearcut timber harvest (Bury and Corn 1988; Blaustein et al. 1995; Hallock and McAllister 2002). The presence of fine sediments reduces instream habitat quality for torrent salamanders by filling interstitial spaces critical for movement, egg deposition, and larval development (Corn and Bury 1989; Diller and Wallace 1996). However, a recent study has shown Columbia torrent salamanders to be widespread and abundant in the managed landscape of northwestern Oregon (Russell et al. 2004) and parallel data exist for southwestern Washington (Marc Hayes, Personal Communication, 2003), which has reduced the level of concern for this species.

Based on the above information, the conservation needs of the Columbia torrent salamander are: (1) to maintain or expand their current distribution; and (2) to avoid and minimize adverse changes to headwater streams, including stream margins, seeps, springs, and waterfall splash zones.

8.4.2.2 ENVIRONMENTAL BASELINE

The range of the Columbia torrent salamander primarily overlaps privately managed, industrial forestlands from sea level to the highest elevations within their range.

The Columbia torrent salamander is known to occur in parts or all of the following Water Resource Inventory Areas (WRIAs): 22, 23, 24, 25, and 26 (USFWS and NMFS 2006; Appendix A Regional Summaries).

Conservation Needs of the Species in the FPHCP Action Area

Columbia torrent salamanders are restricted to coastal and near-coastal areas in southwestern Washington and northwestern Oregon. They inhabit the wetted margins of headwater streams and also seeps, springs, and waterfall splash zones. They seem to be dependent on cool, clear stream margin habitat and these other wetted sites. Because the Columbia torrent salamander has a limited range in Washington and Oregon and because the FPHCP Action Area overlaps a large portion of their range in Washington, maintaining the physical and ecological integrity of the wetted margins of headwater streams, seeps, springs, and waterfall splash zones in the FPHCP Action Area is essential to the long-term conservation of the Columbia torrent salamander.

8.4.2.3 EFFECTS OF THE ACTION

The effects from the proposed action are described in detail in the Effects to Guilds – Headwater Guild section in this Opinion. The Columbia torrent salamander would be adversely affected by changes in overstory riparian canopy, through timber harvest, that are expected to increase solar radiation along non-buffered portions of Type Np and Ns streams, thus warming the water in shallow stream margins. Direct damage to streambank conditions through yarding timber within riparian yarding corridors is expected on occasion and would also adversely affect the Columbia torrent salamander. These effects are expected to reduce the quality of habitat, reduce the numbers, and reduce the reproductive potential of the Columbia torrent salamander at times throughout the proposed 50-year term of the Permit. However, the distribution of the Columbia torrent salamander is not expected to be altered because the above effects will be localized and temporally and spatially staggered across its range within the FPHCP Action Area during the proposed 50-year term of the Permit.

Riparian timber harvest along Type Np and Ns streams, especially non-buffered portions, is expected to reduce the amount of wood recruited to streams. This would reduce the capacity for sediment storage, reduce substrate for aquatic invertebrate production, and possibly alter stream channel morphology. Increased sedimentation is expected to reduce the habitat quality for Columbia torrent salamanders by filling interstitial spaces in stream substrate that impairs movement, egg deposition, and larval development. A reduction in aquatic invertebrate production would reduce food for Columbia torrent salamanders. Possible changes in stream channel morphology could degrade stream margins and thus Columbia torrent salamander habitat. Increased sedimentation, decreased invertebrate production, and possibly changes in channel morphology are expected to reduce the quality of habitat, reduce the numbers, and reduce the reproductive potential of the Columbia torrent salamander at times throughout the proposed 50-year term of the Permit. However, the distribution of the Columbia torrent salamander is not expected to be altered because the above effects will be localized and temporally and spatially staggered across its range within the FPHCP Action Area during the proposed 50-year term of the Permit.

Increased sediment inputs from hydrologically connected forest roads or from road construction across Type Np and Ns streams would adversely affect the Columbia torrent salamander by filling interstitial spaces in stream substrate that impairs movement, egg deposition, and larval development. Electrofishing (related to adaptive management research and instream fish salvage for culvert and bridge maintenance and installation) would adversely affect the Columbia torrent salamander in the form of stress, wounding, or mortality. Also, culvert and bridge maintenance and installation could adversely affect the Columbia torrent salamander through short-term (i.e., days to weeks) sediment inputs and riparian and instream heavy equipment use. Increased sediment inputs from forest roads, road crossings, and culvert and bridge maintenance and installation is expected to reduce the quality of habitat, reduce the numbers, and reduce the reproductive potential of the Columbia torrent salamander at times throughout the proposed 50-year term of the Permit. However, the distribution of the Columbia torrent salamander is not expected to be altered because the above effects will be localized and temporally and spatially staggered across its range within the FPHCP Action Area during the proposed 50-year term of the Permit. Electrofishing is expected to affect few individual Columbia torrent salamanders through stress, wounding, and direct mortality over the proposed 50-year Permit term for the FPHCP.

The probability of adverse effects to Columbia torrent salamanders (especially those effects that would directly injure or kill salamanders) is low for any particular forest practice activity in a single location. However, the probability that habitat quality, numbers of individuals, and reproductive potential would be reduced across the FPHCP covered lands during the proposed 50-year Permit term is reasonably certain to occur many times in many locations.

The Columbia torrent salamander is known to occur in parts of all of the following Water Resource Inventory Areas (WRIAs): 22, 23, 24, 25, and 26 (USFWS and NMFS 2006; Appendix A Regional Summaries). Because survey information for Columbia torrent salamanders does not exist for most WRIAs, it is impossible to determine how many individual Columbia torrent salamanders would be injured, killed, or affected by habitat degradation that disrupts breeding, feeding, and sheltering behaviors. Therefore, the amount of riparian harvest, the number of road crossing structures, and the miles of stream-adjacent roads are used as surrogates for quantifying the adverse affects on Columbia torrent salamanders. Thus, it is estimated that harvest of riparian timber for up to 49,881 acres along Type Np streams and 399,843 acres along Type Ns streams could adversely affect Columbia torrent salamanders over the life of the proposed 50-year Permit term. These numbers represent the maximum amount of habitat that is expected to be affected during the proposed 50-year Permit term and likely overestimate the actual habitat would be affected as habitat surrogates lack precision. These numbers are derived from a GIS analysis described in Appendix G.

Further, it is estimated that culvert and bridge maintenance and installation, and sediment from hydrologically-connected roads, could result in adverse effects to Columbia torrent salamanders from up to 2,673 Type Np stream crossings and 44,994 Type Ns stream crossings, and 265 miles of Type Np stream-adjacent roads, over the life of the proposed 50-year Permit term within WRIAs 22, 23, 24, 25, and 26 that intersect FPHCP covered lands. These numbers are derived from a GIS analysis described in Appendix G.

The conservation measures in the FPHCP minimize and mitigate adverse effects to Columbia torrent salamanders described above. These measures include: (1) no-harvest RMZs on at least 50 percent of Type Np streams; (2) sensitive site protections (e.g., seeps, springs, Type Np intersections, perennial initiation points; and (3) unstable slope protections.

8.4.2.4 CUMULATIVE EFFECTS

Cumulative effects are those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR §402.02). Cumulative effects were addressed in the Comprehensive Cumulative Effects section of this Opinion, with respect to the aquatic and riparian environment in Washington State. It is assumed that most land surrounding and upstream of the headwater habitat of the Columbia torrent salamander would be forestland since most agricultural and developed land occurs much lower in watersheds. The cumulative effects of future State or private activities in these headwater areas would likely include upland timber harvest under the FPHCP and recreation activities. These reasonably expected future State and private activities are not expected to substantially change the overall effects of the action, described above, on the Columbia torrent salamander.

8.4.2.5 CONCLUSION

The aggregate effects of the factors analyzed under the environmental baseline, the effects of the action, and the cumulative effects in the FPHCP Action Area, when viewed against the status of the species is not likely to jeopardize the continued existence of the Columbia torrent salamander.

8.4.3 OLYMPIC TORRENT SALAMANDER (*Rhyacotriton olympicus*)

8.4.3.1 STATUS OF THE SPECIES

Description of Species

The Olympic torrent salamander is a small salamander with a snout to vent length of 2.4 inches (60 millimeters) for adults (Leonard et al. 1993). Total length of adults is about 4 inches (100 millimeters). Females are slightly larger than males (Nussbaum et al. 1983). Nomenclature follows Crother (2001).

Historical and Current Range

Olympic torrent salamanders are endemic to Washington State and are known to occur only on the Olympic Peninsula south to the Chehalis River (Good and Wake 1992; McAllister 1995; Dvornich et al. 1997). The salamander can be found as high 3,937 feet (1,200 meters), but most are found below 3,281 feet (1,000 meters) (Jones et al. 2005). Historical versus current range, abundance, and density is unknown at this time (Marc Hayes, Personal Communication, 2005; Lannoo 2005).

Essential Habitat Components

Olympic torrent salamanders have been observed in 41 percent of 168 streams, and in 47 percent of 235 seeps surveyed within the Olympic National Park (Bury and Adams 2000). They are less abundant along the eastern slope of the Olympics, perhaps due to the warmer, drier climate of the "rainshadow," and are more abundant in streams with northerly aspects, steep gradients, reduced fine sediments, and fewer undercut banks (Bury and Adams 2000). Juveniles and adults probably share the same habitat requirements of cold, clear streams, seeps or waterfalls, and splash zones where a thin film of water runs between or under rocks (Leonard et al 1993). As with other torrent salamanders, Olympic torrent salamanders are desiccation intolerant (Whitford and Hutchinson 1996), requiring a moist to wet microenvironment with substantial shading canopy and abundant understory vegetation (Stebbins and Lowe 1951). Due to the wet microhabitat, Olympic torrent salamanders have been observed as surface-active in winter, so overwintering in these areas may not occur (Jones and Raphael 2000). Based on southern torrent salamander data, metamorphosed juveniles and adults probably feed on invertebrates in moist, forested habitats along stream margins; notably they feed on amphipods, fly larvae, springtails, and stonefly nymphs (Bury and Martin 1967; Bury 1970). Larvae diet is unknown.

Reproductive Ecology

Reproduction is presumed to be aquatic, but nests of Olympic torrent salamander have not yet been found (Lannoo 2005). Age at maturity in Olympic torrent salamanders is unknown, but if similar to the southern torrent salamander, they may require five to six years to reach maturity, with a total life span that undoubtedly exceeds 10 years (Nussbaum and Tait 1977). Nest sites are suspected to be similar to those known for their congeners, i.e., low flow sites such as seeps, springs, or headwater streams with mixed substrates, sometimes under a layer of moss (Nussbaum 1969; Russell et al. 2002). Clutch size is unknown, but fecundity is likely low as gravid females carry relatively few eggs (an average of eight eggs, Good and Wake 1992). Little is known of the larval stage but, based on data from other *Rhyacotriton*, duration is probably greater than two years, and cover requirements include stable, low-flowing microhabitats with loose gravel and cobble and open interstitial spaces with limited fine sediments. Neoteny is unknown in this genus (Lannoo 2005).

Movements and Habitat Use

Olympic torrent salamanders are probably highly sedentary, like other members of the genus, but they may move several meters from the stream during rain events (Jones et al. 2005). No breeding or seasonal migrations have been documented for this species (Lannoo 2005).

Threats to Survival and Conservation Needs of the Species

The Olympic torrent salamander is a Federal species of concern and is on the Washington State monitor list. Concern centers on their limited distribution, narrow range of tolerance for environmental conditions, and the associated risk of local extirpation following clearcut timber harvest (Bury and Corn 1988; Blaustein et al. 1995; Hallock and McAllister 2002). The presence of fine sediments reduces instream habitat quality for torrent salamanders by filling interstitial spaces critical for movement, egg deposition, and larval development (Corn and Bury 1989; Diller and Wallace 1996). The Olympic torrent salamander may be negatively affected by timber harvest practices, under certain environmental conditions (Jones et al. 2005).

Based on the above information, the conservation needs of the Olympic torrent salamander are: (1) to maintain or expand their current distribution; and (2) to avoid and minimize adverse changes to the wetted margins of headwater streams and also seeps, springs, and waterfall splash zones.

8.4.3.2 ENVIRONMENTAL BASELINE

The range of the Olympic torrent salamander primarily occurs on Federal or State-managed lands in western Washington.

The Olympic torrent salamander is known to occur in parts or all of the following Water Resource Inventory Areas (WRIAs): 16, 17, 18, 19, 20, 21, 22, 23, and 24 (USFWS and NMFS 2006; Appendix A Regional Summaries).

Conservation Needs of the Species in the FPHCP Action Area

Olympic torrent salamanders are restricted to coastal and near-coastal areas in western Washington and on the Olympic Peninsula. They inhabit the wetted margins of headwater streams and also seeps, springs, and waterfall splash zones. They seem to be dependent on cool, clear stream habitat and these other wetted sites. Because the Olympic torrent salamander has a limited range in Washington and Oregon and because the FPHCP Action Area overlaps a large portion of their range in Washington, maintaining the physical and ecological integrity of the wetted margins of headwater streams, seeps, springs, and waterfall splash zones in the FPHCP Action Area is essential to the long-term conservation of the Olympic torrent salamander.

8.4.3.3 EFFECTS OF THE ACTION

The effects from the proposed action are described in detail in the Effects to Guilds – Headwater Guild section in this Opinion. The Olympic torrent salamander would be adversely affected by changes in overstory riparian canopy, through timber harvest, that are expected to increase solar radiation along non-buffered portions of Type Np and Ns streams, thus warming the water in shallow stream margins. Direct damage to streambank conditions through yarding timber within riparian yarding corridors is expected on occasion and would also adversely affect the Olympic torrent salamander. These effects are expected to reduce the quality of habitat, reduce the numbers, and reduce the reproductive potential of the Olympic torrent salamander at times throughout the proposed 50-year term of the Permit. However, the distribution of the Olympic torrent salamander is not expected to be altered because the above effects will be localized and temporally and spatially staggered across its range within the FPHCP Action Area during the proposed 50-year term of the Permit.

Riparian timber harvest along Type Np and Ns streams, especially non-buffered portions, is expected to reduce the amount of wood recruited to streams. This would reduce the capacity for sediment storage, reduce substrate for aquatic invertebrate production, and possibly alter stream channel morphology. Increased sedimentation is expected to reduce the habitat quality for Olympic torrent salamanders by filling interstitial spaces in stream substrate that impairs movement, egg deposition, and larval development. A reduction in aquatic invertebrate production would reduce food for Olympic torrent salamanders. Possible changes in stream channel morphology could degrade stream margins and thus Olympic torrent salamander habitat. Increased sedimentation, decreased invertebrate production, and possibly changes in channel morphology are expected to reduce the quality of habitat, reduce the numbers, and reduce the reproductive potential of the Olympic torrent salamander at times throughout the proposed 50-year term of the Permit. However, the distribution of the Olympic torrent salamander is not expected to be altered because the above effects will be localized and temporally and spatially staggered across its range within the FPHCP Action Area during the proposed 50-year term of the Permit.

Increased sediment inputs from hydrologically connected forest roads or from road construction across Type Np and Ns streams would adversely affect the Olympic torrent salamander by filling interstitial spaces in stream substrate that impairs movement, egg deposition, and larval development. Electrofishing (related to adaptive management research and instream fish salvage for culvert and bridge maintenance and installation) would adversely affect the Olympic torrent salamander in the form of stress, wounding, or mortality. Also, culvert and bridge maintenance and installation could adversely affect the Olympic torrent salamander through short-term (i.e., days to weeks) sediment inputs and riparian and instream heavy equipment use. Increased sediment inputs from forest roads, road crossings, and culvert and bridge maintenance and installation is expected to reduce the quality of habitat, reduce the numbers, and reduce the reproductive potential of the Olympic torrent salamander at times throughout the proposed 50-year term of the Permit. However, the distribution of the Olympic torrent salamander is not expected to be altered because the above effects will be localized and temporally and spatially staggered across its range within the FPHCP Action Area during the proposed 50-year term of the Permit. Electrofishing is expected to affect few individual Olympic torrent salamanders through stress, wounding, and direct mortality over the proposed 50-year Permit term for the FPHCP.

The probability of adverse effects to Olympic torrent salamanders (especially those effects that would directly injure or kill salamanders) is low for any particular forest practice activity in a single location. However, the probability that habitat quality, numbers of individuals, and reproductive potential would be reduced across the FPHCP covered lands during the proposed 50-year Permit term is reasonably certain to occur many times in many locations.

The Olympic torrent salamander is known to occur in parts of all of the following Water Resource Inventory Areas (WRIAs): 16, 17, 18, 19, 20, 21, 22, 23, and 24 (USFWS and NMFS 2006; Appendix A Regional Summaries). Because survey information for Olympic torrent salamanders does not exist for most WRIAs, it is impossible to determine how many individual Olympic torrent salamanders would be injured, killed, or affected by habitat degradation that disrupts breeding, feeding, and sheltering behaviors. Therefore, the amount of riparian harvest, the number of road crossing structures, and the miles of stream-adjacent roads are used as surrogates for quantifying the adverse affects on Olympic torrent salamanders. Thus, it is estimated that harvest of riparian timber for up to 41,002 acres along Type Np streams and 317,720 acres along Type Ns streams could adversely affect Olympic torrent salamanders over the life of the proposed 50-year Permit term. These numbers represent the maximum amount of habitat that is expected to be affected during the proposed 50-year Permit term and likely overestimate the actual habitat would be affected as habitat surrogates lack precision. These numbers are derived from a GIS analysis described in Appendix G.

Further, it is estimated that culvert and bridge maintenance and installation, and sediment from hydrologically-connected roads, could result in adverse effects to Olympic torrent salamanders from up to 1,938 Type Np stream crossings and 29,107 Type Ns stream crossings, and 187 miles of Type Np stream-adjacent roads, over the life of the proposed 50-year Permit term within WRIAs 16, 17, 18, 19, 20, 21, 22, 23, and 24 that intersect FPHCP covered lands. These numbers are derived from a GIS analysis described in Appendix G.

The conservation measures in the FPHCP minimize and mitigate adverse effects to Olympic torrent salamanders described above. These measures include: (1) no-harvest RMZs on at least 50 percent of Type Np streams; (2) sensitive site protections (e.g., seeps, springs, Type Np intersections, perennial initiation points; and (3) unstable slope protections.

8.4.3.4 CUMULATIVE EFFECTS

Cumulative effects are those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR §402.02). Cumulative effects were addressed in the Comprehensive Cumulative Effects section of this Opinion, with respect to the aquatic and riparian environment in Washington State. It is assumed that most land surrounding and upstream of the headwater habitat of the Olympic torrent salamander would be forestland since most agricultural and developed land occurs much lower in watersheds. The cumulative effects of future State or private activities in these headwater areas would likely include upland timber harvest under the FPHCP and recreation activities. These reasonably expected future State and private activities are not expected to substantially change the overall effects of the action, described above, on the Olympic torrent salamander.

8.4.3.5 CONCLUSION

The aggregate effects of the factors analyzed under the environmental baseline, the effects of the action, and the cumulative effects in the FPHCP Action Area, when viewed against the status of the species is not likely to jeopardize the continued existence of the Olympic torrent salamander.

8.4.4 DUNN'S SALAMANDER (*Plethodon dunni*)

8.4.4.1 STATUS OF THE SPECIES

Description of Species

The Dunn's salamander is a medium-sized, secretive, and lungless (plethodontid) salamander (Stebbins 1985). The salamander can attain a maximum size of 6 inches (152 millimeters) in total length (Nussbaum et al. 1983; Leonard et al. 1993). Females are slightly larger than males (Nussbaum et al. 1983; Jones et al. 2005). Nomenclature follows Crother (2001).

Historical and Current Range

The Dunn's salamander occurs west of the Cascade Range from southwest Washington to extreme northwest California (Leonard et al. 1993; Lannoo 2005). It is a strong riparian associate and, within the Washington, occurs exclusively in the Willapa Hills in southwestern Washington (Nussbaum et al. 1983; Leonard et al. 1993; Petranka 1998). Washington encompasses the northern end of this species' range, and the Chehalis River appears to represent the northernmost limit of this species' range in Washington (Leonard et al. 1993). The salamander ranges from sea level to 3,300 feet (1,006 meters) in Oregon and sea level to 2,000 feet (610 meters) in Washington (Nussbaum et al. 1983; Leonard et al. 1993). Historical versus current range, abundance, and density is unknown at this time (Marc Hayes, Personal Communication, 2005; Lannoo 2005). There is no evidence of a population decline (Lannoo 2005).

Essential Habitat Components

Dunn's salamanders occur in heavily shaded, wet, rocky substrates such as seeps, moist talus slopes, and stream edges in forested areas (Leonard et al. 1993; Nordstrom and Milner 1997). Availability of rocky cover, as with talus or steeper sideslopes, appears to be a common denominator of Dunn's salamander habitat (Corn and Bury 1991; Wilkins and Peterson 2000), but down logs and woody debris may also represent important refuge and foraging habitat (Leonard et al. 1993; Corkran and Thoms 1996). They have been found near streams associated with sandstone and shale outcrops in the Coast Range and basalt talus in the Cascade Range (Jones et al. 2005). The salamander forages (usually on wet nights) on the forest floor for a variety of invertebrates, such as springtails, annelid worms, snails, and insects (Jones et al. 2005; Lannoo 2005). Dunn's salamanders are not considered aquatic, but instead are considered to be riparian associates (Corkran and Thoms 1996; Gomez and Anthony 1996). Most Dunn's salamanders have been found in streambank habitats within a few meters of stream channels, as opposed to riffle or pool habitat (Bury et al. 1991b) or more remote uplands (Wilkins and Peterson 2000).

Reproductive Ecology

Reproduction occurs in terrestrial habitats. Life history data on Dunn's salamanders are sparse, only two nesting record exists (Dumas 1955; Jones et al. 2005). The first nest was a grape-like cluster of 9 eggs found in a crevice in shale (Jones et al. 2005). The second nest was an adult coiled around a cluster of 12 eggs found in a decaying log along a stream (Jones et al. 2005). The breeding season of the salamander is unknown, gravid females have been found throughout the year (Lannoo 2005), but courtship probably occurs in the spring or fall (Jones et al. 2005). Eggs (4 to 15 per clutch) are probably laid underground in rocky areas or within suitably decayed woody debris during spring, and hatch in late summer or fall. There is probably parental protection of the eggs (Lannoo 2005). Juveniles (there is no larval stage), which may take two to four years to reach sexual maturity, have been found in the same habitats as adults (Petranka 1998).

Movements and Habitat Use

There is no evidence of breeding migrations of Dunn's salamanders, but movement from forest floor habitat to underground brood sites probably occurs (Lannoo 2005). They may also move underground to escape freezing or drought conditions (Jones et al. 2005). The Dunn's salamander appears to be most active on the forest floor in April (Jones et al. 2005). There is some evidence that the salamander may be territorial, but more research is needed (Lannoo 2005).

Threats to Survival and Conservation Needs of the Species

The Dunn's salamander is a Washington State candidate species. Concern for this species in the State is prompted by its distribution in presumably small fragmented populations, and by Washington's position at the northernmost tip of the salamander's range (Nordstrom and Milner 1997). Nordstrom and Milner (1997) noted that Dunn's salamanders depend on moist, well-shaded substrates with stable microclimates. Timber harvest can remove canopy cover that maintains microclimatic conditions favored by this species, including cool substrate temperatures and high relative humidity (Chen et al. 1993, 1995; Ledwith 1996; Nordstrom and Milner 1997). Populations can persist in logged areas, but are more likely to do so when mature timber is present upstream than when stands upstream have been cut (Corn and Bury 1989). Vesely and McComb (2002) found that Dunn's salamanders were sensitive to forest practices in riparian areas, and concluded that riparian buffer strips may reduce local declines in abundance. Similarly, West and O'Connell (1998) observed that riparian buffers can promote persistence of amphibians following timber harvest. Several studies have demonstrated a direct relationship between buffer width and the maintenance of cool microclimate and high humidity (Brown and Krygier 1970; Ledwith 1996).

Based on the above information, the conservation needs of the Dunn's salamander are: (1) to maintain or expand their current distribution; and (2) to avoid and minimize adverse changes to moist, riparian and stream edge habitats and talus slopes.

8.4.4.2 ENVIRONMENTAL BASELINE

Dunn’s salamanders are relatively common in the Oregon Coast Range, but are less common in Washington headwater streams (Jackson et al. 2003). Most of this species’ range in southwestern Washington is currently dominated by privately managed industrial forestlands.

The Dunn’s salamander is known to occur in parts or all of the following Water Resource Inventory Areas (WRIAs): 22, 23, 24, 25, and 26 (USFWS and NMFS 2006; Appendix A Regional Summaries).

Conservation Needs of the Species in the FPHCP Action Area

Dunn’s salamanders are restricted to the southwestern corner of Washington, western Oregon from the coast to the Cascades, and into Del Norte County, California. They inhabit riparian areas, primarily stream edges, seeps, and moist talus areas. They seem to be dependent on moist riparian areas and are often associated with rocky substrate. Because the Dunn’s salamander has a limited range in Washington and because the FPHCP Action Area overlaps a large portion of their range in Washington, maintaining the physical and ecological integrity of riparian areas, stream edges, and moist talus in the FPHCP is essential to the long-term conservation of the Dunn’s salamander in Washington.

8.4.4.3 EFFECTS OF THE ACTION

The effects from the proposed action are described in detail in the Effects to Guilds – Headwater Guild section in this Opinion. The Dunn’s salamander would be adversely affected by changes in overstory riparian canopy, through timber harvest, that are expected to increase solar radiation that reaches the riparian ground surface, especially along non-buffered portions of Type Np and Ns streams. Direct damage to riparian ground conditions through yarding timber and yarding corridors within RMZs along Type S, F, and Np streams and also along non-buffered Type Np and Ns streams would also adversely affect the Dunn’s salamander. These effects are expected to reduce the quality of habitat, reduce the numbers, and reduce the reproductive potential of the Dunn’s salamander at times throughout the proposed 50-year term of the Permit. However, the distribution of the Dunn’s salamander is not expected to be altered because the above effects will be localized and temporally and spatially staggered across its range within the FPHCP Action Area during the proposed 50-year term of the Permit.

Riparian timber harvest along Type S, F, Np, and Ns streams, especially non-buffered portions of Type Np and Ns streams, is expected to reduce the amount of wood recruited to the Riparian Zone of influence. This would reduce the amount of habitat available for Dunn’s salamanders. These adverse effects are expected to reduce the quality of habitat, reduce the numbers, and reduce the reproductive potential of the Dunn’s salamander at times throughout the proposed 50-year term of the Permit. However, the distribution of the Dunn’s salamander is not expected to be altered because the above effects will be localized and temporally and spatially staggered across its range within the FPHCP Action Area during the proposed 50-year term of the Permit.

Culvert and bridge maintenance and installation, and road construction and maintenance, could adversely affect the Dunn’s salamander through direct mortality from equipment or degradation to riparian habitat adjacent to work areas. These adverse effects are expected to reduce the quality of habitat, reduce the numbers, and reduce the reproductive potential of the Dunn’s salamander at times throughout the proposed 50-year term of the Permit. However, the distribution of the Dunn’s salamander is not expected to be altered because the above effects will be localized and temporally and spatially staggered across its range within the FPHCP Action Area during the proposed 50-year term of the Permit.

The probability of adverse effects to Dunn's salamanders (especially those effects that would directly injure or kill salamanders) is low for any particular forest practice activity in a single location. However, the probability that habitat quality, numbers of individuals, and reproductive potential would be reduced across the FPHCP covered lands during the proposed 50-year Permit term is reasonably certain to occur many times in many locations.

The Dunn's salamander is known to occur in parts of all of the following Water Resource Inventory Areas (WRIAs): 22, 23, 24, 25, and 26 (USFWS and NMFS 2006; Appendix A Regional Summaries). Because survey information for Dunn's salamanders does not exist for most WRIAs, it is impossible to determine how many individual Dunn's salamanders would be injured, killed, or affected by habitat degradation that disrupts breeding, feeding, and sheltering behaviors. Therefore, the amount of riparian harvest, the number of road crossing structures, and the miles of stream-adjacent roads are used as surrogates for quantifying the adverse affects on Dunn's salamanders. Thus, it is estimated that harvest of riparian timber for up to 55,053 acres along Type S streams, 133,453 acres along Type F streams, 49,881 acres along Type Np streams, and 339,843 acres along Type Ns streams could adversely affect Dunn's salamanders over the life of the proposed 50-year Permit term. These numbers represent the maximum amount of habitat that is expected to be affected during the proposed 50-year Permit term and likely overestimate the actual habitat would be affected as habitat surrogates lack precision. These numbers are derived from a GIS analysis described in Appendix G.

It is estimated that culvert and bridge maintenance and installation could result in adverse effects to Dunn's salamanders from up to 665 Type S stream crossings, 6,137 Type F stream crossings, 2,673 Type Np stream crossings, and 29,107 Type Ns stream crossings. Further, it is estimated that road construction and maintenance could result in adverse effects to Dunn's salamanders from up to 552 miles of road along Type S streams, 1,033 miles of road along Type F streams, and 265 miles of road along Type Np streams. These effects would occur over the life of the proposed 50-year Permit term within WRIAs 22, 23, 24, 25, and 26 that intersect FPHCP covered lands. These numbers are derived from a GIS analysis described in Appendix G.

The conservation measures in the FPHCP minimize and mitigate adverse effects to Dunn's salamanders described above. These measures include: (1) no-harvest RMZs along Type S, F, and at least 50 percent of Type Np streams; (2) Inner and Outer Zone RMZ restrictions along Type S and F streams; and (3) equipment limitation zones.

8.4.4.4 CUMULATIVE EFFECTS

Cumulative effects are those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR §402.02). Cumulative effects were addressed in the Comprehensive Cumulative Effects section of this Opinion, with respect to the aquatic and riparian environment in Washington State. It is assumed that most land surrounding and upstream of the headwater habitat used by Dunn's salamanders would be forestland since most agricultural and developed land occurs much lower in watersheds. The cumulative effects of future State or private activities in these headwater areas would likely include upland timber harvest under the FPHCP and recreation activities. These reasonably expected future State and private activities are not expected to substantially change the overall effects of the action, described above, on the Dunn's salamander.

8.4.4.5 CONCLUSION

The aggregate effects of the factors analyzed under the environmental baseline, the effects of the action, and the cumulative effects in the FPHCP Action Area, when viewed against the status of the species is not likely to jeopardize the continued existence of the Dunn's salamander.

8.4.5 VAN DYKE'S SALAMANDER (*Plethodon vandykei*)

8.4.5.1 STATUS OF THE SPECIES

Description of Species

Van Dyke's salamanders are shorter and stockier than other plethodontid salamanders. The salamander can attain a maximum size of 4.3 inches (110 millimeters) in total length (Jones et al. 2005). Females are slightly larger than males (Nussbaum et al. 1983). Nomenclature follows Crother (2001).

Historical and Current Range

Endemic to Washington, the Van Dyke's salamander is known from three separate population centers: the Olympic Mountains, the southern Cascade Range, and the Willapa Hills (Leonard et al. 1993). Most recorded locations come from the wetter, western slopes of these areas (Dvornich et al. 1997). Van Dyke's salamanders have been found at elevations ranging from sea level to 5,000 feet (1,524 meters), in areas with an average annual precipitation of at least 60 inches (1,524 millimeters) (Wilson et al. 1995; Jones 1999). Historical versus current range is unknown at this time (Marc Hayes, Personal Communication, 2005; Lannoo 2005).

Essential Habitat Components

Van Dyke's salamanders are most commonly associated with riparian habitats, or with cool, moist microsites within other habitat types (Nordstrom and Milner 1997; Petranka 1998; Jones 1999). Juveniles and adults have been found in the splash zones of streams, upland forests, moist talus, cave entrances, seeps, and along lakeshores (Blaustein et al. 1995; Jones 1999). Jones (1999) indicates that Van Dyke's salamanders may be found near streams and seeps that are perennial, or spatially or temporally intermittent (i.e., surface water may be absent during some periods or in some stretches). The Van Dyke's salamander can be found in rocks or woody debris in the coastal portion of its range, but it is found in moist talus on north-facing slopes in the interior portion of its range (Lannoo 2005). In a recent study, Van Dyke's salamanders were found in downed wood more than 75 percent of the time they were captured and preliminary analysis indicates that they seem to differentially use large-sized pieces (i.e., greater than 19 inches (50 centimeters) in diameter) than other sizes of downed wood (Marc Hayes, Personal Communication, Washington Department of Fish and Wildlife, January 26, 2006). The Van Dyke's salamander appears to be most active in the spring and fall; and most likely feeds on small invertebrates (Jones et al. 2005).

Reproductive Ecology

As of 2005, seven Van Dyke's salamander nests have been found, one nest was found under a rock and the remaining nests were found inside large decaying conifer logs near streams (Jones et al. 2005). Most of the nests were found near small headwater streams (Jones 1989; Blessing et al. 1999). Blessing et al. (1999) describes four Van Dyke's salamander nests that were found on the Olympic Peninsula; an adult salamander was found associated with all four nests. Three of the four nests described by Blessing et al. (1999) were in old-growth forest habitat, and one was in a riparian buffer of old-growth trees adjacent to a ten-year-old logged stand. Clutches of eggs, apparently laid during spring, have been found under rocks or inside large, moss-covered logs. Eggs (7 to 14 per clutch) may require more than four months to hatch, nearly twice as long as the incubation period of other similar salamander species in this area (Blessing et al. 1999; Lannoo 2005). There is probably parental protection of the eggs (Lannoo 2005). Little is known of juvenile (there is no larval stage) natural history, but one was found in rocks with little soil, approximately 11.8 inches (300 millimeters) from a stream (Lannoo 2005). The salamanders have been found to live at least 12 years (Jones et al. 2005).

Movements and Habitat Use

There is no evidence of breeding migrations in Van Dyke's salamander, but vertical movement from forest floor habitat to underground sites in response to seasonal conditions probably occurs (Lannoo 2005).

Threats to Survival and Conservation Needs of the Species

The Van Dyke's salamander is a Federal species of concern and a Washington State candidate species. Limited distribution and isolation of Van Dyke's salamander populations have prompted concern for this species' persistence (Holthausen et al. 1994; Nordstrom and Milner 1997). Lehmkuhl and Ruggiero (1991) assigned this species a high risk of local extinction based on its habitat associations, frequency of occurrence, abundance, and dispersal ability. Similarly, Thomas et al. (1993) identified the Van Dyke's salamander as a high-risk species, closely associated with old-growth forest conditions. Some studies have suggested that the distribution of Van Dyke's salamander has been limited by clearcutting (Corn and Bury 1989; Wilson et al. 1995). On the other hand, the presence of this species in 30- to 60-year-old forests indicates that individuals may persist within or recolonize disturbed habitats (Nordstrom and Milner 1997). Currently, maintenance of riparian buffers on headwater streams may protect existing populations if the suitable habitat conditions of cool and moist microclimate and woody debris of the appropriate site and decay classes are maintained (Nordstrom and Milner 1997; Petranka 1998).

Based on the above information, the conservation needs of the Van Dyke's salamander are: (1) to maintain or expand their current distribution; and (2) to avoid and minimize adverse changes to riparian and stream margin habitats.

8.4.5.2 ENVIRONMENTAL BASELINE

Populations appear to be patchily distributed and of low density, and much potential habitat appears to be unoccupied (Blaustein et al. 1995; Jones 1999). Two out of three regions where this species occurs are dominated by Federal ownership (Olympic National Park and Wilderness Area, Mount St. Helens National Monument in Gifford Pinchot National Forest), and the third is dominated by private industrial forestlands (southwest Washington). Some of the Mount St. Helens National Monument populations have survived and persisted for the past 25 years, following the 1980 eruption, in some severely disturbed locations (Jones et al. 2005).

The Van Dyke's salamander is known to occur in parts or all of the following Water Resource Inventory Areas (WRIAs): 10, 11, 16, 19, 20, 21, 22, 23, 24, 25, 26, and 27 (USFWS and NMFS 2006; Appendix A Regional Summaries).

Conservation Needs of the Species in the FPHCP Action Area

Van Dyke's salamanders are restricted to four disjunct populations in Washington: (1) the Olympic mountains; (2) the Willapa Hills; (3) the west-central Cascade mountains; and (4) in the southern and west-central parts of the State in Skamania and Thurston counties. They inhabit riparian areas and other moist areas such as seeps, waterfall splash zones, and moist talus areas. They seem to be dependent on moist riparian areas and are often associated with large woody debris. Because the Van Dyke's salamander has a limited range and occurs only in Washington and because the FPHCP Action Area overlaps a large portion of their range, maintaining the physical and ecological integrity of riparian and stream margin habitats in the FPHCP Action Area is essential to the long-term conservation of the Van Dyke's torrent salamander.

8.4.5.3 EFFECTS OF THE ACTION

The effects from the proposed action are described in detail in the Effects to Guilds – Headwater Guild section in this Opinion. The Van Dyke's salamander would be adversely affected by changes in overstory riparian canopy, through timber harvest, that are expected to increase solar radiation that reaches the riparian ground surface, especially along non-buffered portions of Type Np and Ns streams. Direct damage to riparian ground conditions through yarding timber and yarding corridors within RMZs along Type S, F, and Np streams and also along non-buffered Type Np and Ns streams would also adversely affect the Van Dyke's salamander. These effects are expected to reduce the quality of habitat, reduce the numbers, and reduce the reproductive potential of the Van Dyke's salamander at times throughout the proposed 50-year term of the Permit. However, the distribution of the Van Dyke's salamander is not expected to be altered because the above effects will be localized and temporally and spatially staggered across its range within the FPHCP Action Area during the proposed 50-year term of the Permit.

Riparian timber harvest along Type S, F, Np, and Ns streams, especially non-buffered portions of Type Np and Ns streams, is expected to reduce the amount of wood recruited to the Riparian Zone of influence. This would reduce the amount of habitat available for Van Dyke's salamanders. These adverse effects are expected to reduce the quality of habitat, reduce the numbers, and reduce the reproductive potential of the Van Dyke's salamander at times throughout the proposed 50-year term of the Permit. However, the distribution of the Van Dyke's salamander is not expected to be altered because the above effects will be localized and temporally and spatially staggered across its range within the FPHCP Action Area during the proposed 50-year term of the Permit.

Culvert and bridge maintenance and installation, and road construction and maintenance, could adversely affect the Van Dyke's salamander through direct mortality from equipment or degradation to riparian habitat adjacent to work areas. These adverse effects are expected to reduce the quality of habitat, reduce the numbers, and reduce the reproductive potential of the Van Dyke's salamander at times throughout the proposed 50-year term of the Permit. However, the distribution of the Van Dyke's salamander is not expected to be altered because the above effects will be localized and temporally and spatially staggered across its range within the FPHCP Action Area during the proposed 50-year term of the Permit.

The probability of adverse effects to Van Dyke's salamanders (especially those effects that would directly injure or kill salamanders) is low for any particular forest practice activity in a single location. However, the probability that habitat quality, numbers of individuals, and reproductive potential would be reduced across the FPHCP covered lands during the proposed 50-year Permit term is reasonably certain to occur many times in many locations.

The Van Dyke's salamander is known to occur in parts of all of the following Water Resource Inventory Areas (WRIAs): 10, 11, 16, 19, 20, 21, 22, 23, 24, 25, 26, and 27 (USFWS and NMFS 2006; Appendix A Regional Summaries). Because survey information for Van Dyke's salamanders does not exist for most WRIAs, it is impossible to determine how many individual Van Dyke's salamanders would be injured, killed, or affected by habitat degradation that disrupts breeding, feeding, and sheltering behaviors. Therefore, the amount of riparian harvest, the number of road crossing structures, and the miles of stream-adjacent roads are used as surrogates for quantifying the adverse affects on Van Dyke's salamanders. Thus, it is estimated that harvest of riparian timber for up to 88,519 acres along Type S streams, 193,530 acres along Type F streams, 81,394 acres along Type Np streams, and 532,021 acres along Type Ns streams could adversely affect Dunn's salamanders over the life of the proposed 50-year Permit term. These numbers represent the maximum amount of habitat that is expected to be affected during the proposed 50-year Permit term and likely overestimate the actual habitat would be affected as habitat surrogates lack precision. These numbers are derived from a GIS analysis described in Appendix G.

It is estimated that culvert and bridge maintenance and installation could result in adverse effects to Dunn's salamanders from up to 962 Type S stream crossings, 9,283 Type F stream crossings, 4,794 Type Np stream crossings, and 62,693 Type Ns stream crossings. Further, it is estimated that road construction and maintenance could result in adverse effects to Dunn's salamanders from up to 793 miles of road along Type S streams, 1,507 miles of road along Type F streams, and 468 miles of road along Type Np streams. These effects would occur over the life of the proposed 50-year Permit term within WRIAs 10, 11, 16, 19, 20, 21, 22, 23, 24, 25, 26, and 27 that intersect FPHCP covered lands. These numbers are derived from a GIS analysis described in Appendix G.

The conservation measures in the FPHCP minimize and mitigate adverse effects to Van Dyke's salamanders described above. These measures include: (1) no-harvest RMZs along Type S, F, and at least 50 percent of Type Np streams; (2) Inner and Outer Zone RMZ restrictions along Type S and F streams; and (3) equipment limitation zones.

8.4.5.4 CUMULATIVE EFFECTS

Cumulative effects are those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR §402.02). Cumulative effects were addressed in the Comprehensive Cumulative Effects section of this Opinion, with respect to the aquatic and riparian environment in Washington State. It is assumed that most land surrounding and upstream of the headwater habitat used by Van Dyke's salamanders would be forestland since most agricultural and developed land occurs much lower in watersheds. The cumulative effects of future State or private activities in these headwater areas would likely include upland timber harvest under the FPHCP and recreation activities. These reasonably expected future State and private activities are not expected to substantially change the overall effects of the action, described above, on the Van Dyke's salamander.

8.4.5.5 CONCLUSION

The aggregate effects of the factors analyzed under the environmental baseline, the effects of the action, and the cumulative effects in the FPHCP Action Area, when viewed against the status of the species is not likely to jeopardize the continued existence of the Van Dyke's salamander.

8.4.6 COASTAL TAILED FROG (*Ascaphus truei*) and ROCKY MOUNTAIN TAILED FROG (*Ascaphus montanus*)

8.4.6.1 STATUS OF THE SPECIES

Description of Species

Endemic to the Pacific Northwest, tailed frogs are the only species of the family Ascaphidae, and are among the most primitive living frogs. Males are distinguished by a tail-like appendage that is used for internal fertilization, an adaptation to their life in cold, swift streams (Nussbaum et al. 1983). Female frogs have no tail (Werner et al. 2004). Based on an examination of genetic differences, Nielson et al. (2001) recommended that coastal and inland populations of tailed frogs be recognized as distinct species, *Ascaphus truei* (coastal) and *A. montanus* (inland or Rocky Mountain). In general, there are not significant differences in the life histories and habitat associations of these two species, so they will be treated collectively in this discussion. Any major differences between the two species will be noted. Nomenclature follows Crother et al. (2003).

Adult tailed frogs are small, relatively flat, slender frogs that are usually brown to gray in color above, but can also be reddish or black (Blaustien et al. 1995). They can have a yellow to green triangle on the top of their head, as well as a dark stripe between the eyes. The frogs also have a dark stripe from tip of snout to shoulder, that passes through the eye (Smith 1978). The frogs have no external tympanum, smooth to warty skin, and large eyes with vertical pupils (Blaustein et al. 1995; Werner et al. 2004). Tailed frogs are unable to call (Leonard et al. 1993). The body length of adult Coastal tailed frogs range in size from 1.3 to 2.0 inches (34 to 51 millimeters) (Jones et al. 2005; Lannoo 2005). The body length of adult Rocky Mountain tailed frogs range in size from 1.2 - 2.2 inches (31 to 56 millimeters) (Werner et al. 2004). Female tailed frogs are usually larger than the male frogs (Werner et al. 2004). The tadpoles have a very distinctive large sucker-like mouth and the eggs are unpigmented (Werner et al. 2004).

Historical and Current Range

Coastal tailed frogs occur throughout the Pacific Northwest, with a range that extends from southwestern British Columbia south to northwestern California (Leonard et al. 1993). In Washington, Coastal tailed frogs have been found in the Willapa Hills and the Cascade and Olympic Mountains. The frogs have been found as high as 5,250 feet (1,600 meters) in Washington (Leonard et al. 1993).

Rocky Mountain tailed frogs occur in the Rocky Mountains of Idaho, Montana, and extreme southeastern British Columbia, mainly west of the Continental Divide (Werner et al. 2004). There are also small disjunct populations occurring in southeast Washington and northeast Oregon. The frogs have been found as high as 8,390 feet (2,557 meters) in Montana (Werner et al. 2004).

Historical versus current range of the tailed frogs does not appear to have changed much in the past 100 years (Lannoo 2005). There also appears to be no documented change in historical versus current abundance (Lannoo 2005), but this could simply be due to a lack of large scale surveys (Marc Hayes, Personal Communication, 2005). There is no evidence of a population decline (Lannoo 2005).

Essential Habitat Components

Adult tailed frogs are highly associated with aquatic habitats. They are found almost exclusively in cold, rocky streams from sea level to near timberline. The tadpole's sucker-like mouth, used for clinging to rocks and scraping away food, is a sign of this species' adaptation to life in fast-flowing water (Nussbaum et al. 1983; Leonard et al. 1993). An additional adaptation to stream life is that the adult frogs breathe through their skin due to reduced lung size; which helps in reducing the buoyancy of adult frogs (Jones et al. 2005). Breeding and rearing habitat for the tailed frog generally consists of permanent, cool (usually less than 59° F (15° C)) streams with cobble/boulder substrate and woody debris (de Vlaming and Bury 1970; Welsh et al. 1993). These conditions are typically associated with cold, clear, headwaters to mid-order streams in older forest ecosystems (Welsh et al. 1993). Adults forage mainly on land along stream banks, but also underwater, seeking cover under rocks and woody debris in streams. At night, adult tailed frogs emerge and may forage up to 1,300 feet (396 meters) into adjacent forested areas (McComb et al. 1993). The adult frogs are opportunistic predators feeding on a variety of invertebrates (Lannoo 2005). Older (greater than 200 years), multi-layer forests, downed woody material, ground-level vegetation, ground cover, and canopy closure have been shown to be important in the occurrence of tailed frogs in northwestern California and southern Washington (Aubry and Hall 1991; Welsh et. al. 1993). The presence of tailed frogs in younger-age stands indicates that suitable microhabitat conditions can be found in forests less than 200 years old (Corn and Bury 1989; Aubry and Hall 1991).

In a study of 40 perennial, non-fish-bearing streams in southwestern Washington, Wilkins and Peterson (2000) found Coastal tailed frogs only in streams with basaltic (i.e., bedrock) lithology, but this pattern may result from marine sedimentary streams being more vulnerable to harvest effects (Adams and Bury 2002). Similarly, Jackson et al. (2003) found tailed frogs only at steep basalt sites, and concluded that local geologic and topographic conditions play a large role in determining the presence and abundance of this species. In both studies, all surveyed streams occurred in second-growth forest stands. In contrast, Adams and Bury (2002) studied streams within unmanaged forests in Olympic National Park and found that stream amphibians (including tailed frogs) were common in waters with unconsolidated surface geology. Welsh and Lind (2002) also found Coastal tailed frogs to be common in streams with unconsolidated geologies in the Klamath-Siskiyou region, noting instead that stream temperature and forest age were the strongest predictors of tailed frog presence and abundance. Collectively, these findings tend to support Dupuis and Steventon's (1999) report that the competency of the parent geology had significant effects on tailed frogs, but that these effects were greatly exacerbated by timber harvest.

Reproductive Ecology

Reproduction occurs in aquatic habitats. Tailed frogs typically mate (internal fertilization) during late August and September, females lay eggs during the summer of the year after mating (Leonard et al. 1993). The eggs (28 to 96 per clutch) are laid as strings under large rocks in the stream (Lannoo 2005). The tadpoles feed on diatoms, some filamentous algae and when in season, conifer pollen (Lannoo 2005). The larvae (tadpoles) remain in the water for one to five years (two to four years has been documented in Washington) after hatching (Smith 1978; Nussbaum et al. 1983; Leonard et al. 1993; Welsh et al. 1993). The tailed frog's exceptionally long period of larval and pre-reproductive adult development (estimated seven to nine years) increases the vulnerability of local populations to habitat disturbance (Brown 1975; Daugherty and Sheldon 1982b; Jennings and Hayes 1994). These factors may also increase the amount of time required for recovery following disturbance (Blaustein et al. 1995). Tailed frog larvae are likely to be particularly sensitive to sedimentation following clearcutting along headwater streams. They cannot adhere to rocks that are coated with fine sediment, and may have difficulty moving to find suitable substrate (Jackson et al. 2003). Tadpole populations can also be wiped out by severe floods that scour the stream bed (Lannoo 2005). Tailed frogs reach sexual maturity at 7 to 9 years and may live 15 to 20 years (Jones et al. 2005; Lannoo 2005).

Movements and Habitat Use

Tailed frogs may migrate seasonally by moving to cooler, more-shaded streams during the summer (Lannoo 2005). There is no evidence of breeding migrations of tailed frogs, but there may be post-metamorphic dispersal of juvenile in the fall (Lannoo 2005). There is no evidence of territories, but the frogs appear to be very philopatric (Jones et al. 2005; Lannoo 2005).

Threats to Survival and Conservation Needs of the Species

The Coastal tailed frog is a Federal species of concern and is on the Washington State monitor list. The Rocky Mountain tailed frog is a Federal species of concern and a Washington State candidate species. Compared to other stream-breeding amphibians, tailed frogs appear to be the most-narrowly distributed and the most sensitive to short- and intermediate-term effects from timber harvest (Jackson et al. 2003). Tailed frogs have demonstrated sensitivity to increased levels of fine sediment, which may reduce the availability of algae and other foods important to tadpoles (Welsh and Ollivier 1998). Local populations are susceptible to extirpation for several reasons, including narrow niche requirements combined with isolated population distribution, long generation time, and loss of mature forest along headwater stream habitats (Welsh 1990). Of seven Pacific Northwest frogs and toads associated with old-growth forests, the tailed frog is probably the species most likely to be affected by old-growth habitat loss and degradation (Blaustein et al. 1995).

Nussbaum et al. (1983) reported that tailed frogs disappeared from streams when areas were logged, speculating that increased water temperature and siltation were the cause. Jackson et al. (2003) compared pre- and post-logging populations of Coastal tailed frogs at five streams in southwestern Washington. In the three streams that were clearcut harvested, no Coastal tailed frogs were detected immediately following harvest. Two years later, Coastal tailed frogs were still absent from two of the three streams. Corn and Bury (1989) and Dupuis and Steventon (1999) also found that logging had significant negative effects on densities of tailed frogs. In the redwood forests of northern California, Ashton et al. (2005) documented significantly greater numbers of Coastal tailed frogs in late-seral forests compared to second growth forests 37 to 60 years old. Findings from recent studies have suggested that increased sediment input may be the most-important factor behind tailed frog population declines following logging (Dupuis and Steventon 1999; Ashton et al. 2005). Dupuis and Steventon (1999) also found that buffered creeks had, on average, higher densities of tailed frogs than logged creeks. Several studies have also suggested that riparian buffer strips may be able to protect the streamside microhabitat variables required by tailed frogs, even if the surrounding habitat is not maintained as old-growth forest (Corn and Bury 1989; Bull and Carter 1996). In contrast to the above information, tailed frog tadpoles and adults were found in abundance in several high-gradient streams surrounded by young (less than 20 years old) riparian and upland stands southeast of Mount St. Helens in the Gifford-Pinchot National Forest (Sally Butts, Personal Observation, 2006). In general, potential conservation measures for tailed frogs include: protection of headwater stream habitat, leaving sediment reducing structures in the stream, reducing wind-throw near the stream, and providing a long-term source of downed wood (Jones et al. 2005).

Based on the above information, the conservation needs of the Coastal and Rocky Mountain tailed frog are: (1) to maintain or expand their current distribution; and (2) to avoid and minimize adverse changes to riparian areas and headwater streams.

8.4.6.2 ENVIRONMENTAL BASELINE

Tailed frogs are the most widely distributed of the FPHCP covered amphibian species. Their occurrence spans all types of land ownerships and is likely driven primarily by stream gradient and substrate conditions.

The Coastal tailed frog is known to occur in parts or all of the following Water Resource Inventory Areas (WRIAs): 1, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 38, 39, 45, 46, 47, and 48 (USFWS and NMFS 2006; Appendix A Regional Summaries).

The Rocky Mountain tailed frog is known to occur in parts or all of the following Water Resource Inventory Areas (WRIAs): 32 and 35. Other WRIAs near or adjacent to known sites in British Columbia and Idaho, WRIAs 51 through 62, may also support Rocky Mountain tailed frogs, however, no systematic surveys have been conducted to date to determine occurrence (USFWS and NMFS 2006; Appendix A Regional Summaries).

Conservation Needs of the Species in the FPHCP Action Area

Coastal tailed frogs occur across the Cascade and coastal mountains in British Columbia, Washington, and Oregon, and the coastal range in northern California. They also occur on the Olympic Peninsula of Washington. Rocky Mountain tailed frogs occur in the Blue Mountains in southeast Washington and northeast Oregon, and also much of Idaho, western Montana, and southeastern British Columbia. Because of their occurrence in British Columbia and Idaho, it is suspected that Rocky Mountain tailed frogs also occur in much of northeastern Washington. Both Coastal and Rocky Mountain tailed frogs inhabit riparian areas and headwater streams. They seem to be dependent on cold, clear, fast-moving headwater streams with cobble substrates and associated riparian areas. Because Coastal and Rocky Mountain tailed frogs are endemic to the Pacific Northwest and because the FPHCP Action Area overlaps a large portion of their range in Washington, maintaining the physical and ecological integrity of riparian and headwater stream habitats in the FPHCP Action Area is essential to the long-term conservation of the Coastal and Rocky Mountain tailed frog.

8.4.6.3 EFFECTS OF THE ACTION

The effects from the proposed action are described in detail in the Effects to Guilds – Headwater Guild section in this Opinion. Coastal and Rocky Mountain tailed frogs would be adversely affected by changes in overstory riparian canopy, through timber harvest, that are expected to increase solar radiation along non-buffered portions of Type Np and Ns streams, thus warming the water in shallow stream margins. Direct damage to streambank conditions through yarding timber within riparian yarding corridors is expected on occasion and would also adversely affect tailed frogs. These effects are expected to reduce the quality of habitat, reduce the numbers, and reduce the reproductive potential of tailed frogs at times throughout the proposed 50-year term of the Permit. However, the distribution of tailed frogs is not expected to be altered because the above effects will be localized and temporally and spatially staggered across its range within the FPHCP Action Area during the proposed 50-year term of the Permit.

Riparian timber harvest along Type Np and Ns streams, especially non-buffered portions, is expected to reduce the amount of wood recruited to streams. This would reduce the capacity for sediment storage, reduce substrate for aquatic invertebrate production, and possibly alter stream channel morphology. Increased sedimentation is expected to reduce the habitat quality for tailed frogs by filling interstitial spaces in stream substrate that impairs movement, egg deposition, and larval development. A reduction in aquatic invertebrate production would reduce food for tailed frogs. Possible changes in stream channel morphology could degrade stream margins and thus tailed frog habitat. Increased sedimentation, decreased invertebrate production, and possibly changes in channel morphology are expected to reduce the quality of habitat, reduce the numbers, and reduce the reproductive potential of tailed frogs at times throughout the proposed 50-year term of the Permit. However, the distribution of tailed frogs is not expected to be altered because the above effects will be localized and temporally and spatially staggered across its range within the FPHCP Action Area during the proposed 50-year term of the Permit.

Increased sediment inputs from hydrologically connected forest roads or from road construction across Type Np and Ns streams would adversely affect tailed frogs by filling interstitial spaces in stream substrate that impairs movement, egg deposition, and larval development. Electrofishing (related to adaptive management research and instream fish salvage for culvert and bridge maintenance and installation) would adversely affect tailed frogs in the form of stress, wounding, or mortality. Also, culvert and bridge maintenance and installation could adversely affect tailed frogs through short-term (i.e., days to weeks) sediment inputs and riparian and instream heavy equipment use. Increased sediment inputs from forest roads, road crossings, and culvert and bridge maintenance and installation is expected to reduce the quality of habitat, reduce the numbers, and reduce the reproductive potential of tailed frogs at times throughout the proposed 50-year term of the Permit. However, the distribution of tailed frogs is not expected to be altered because the above effects will be localized and temporally and spatially staggered across its range within the FPHCP Action Area during the proposed 50-year term of the Permit. Electrofishing is expected to affect few individual tailed frogs through stress, wounding, and direct mortality over the proposed 50-year Permit term for the FPHCP.

The probability of adverse effects to tailed frogs (especially those effects that would directly injure or kill frogs) is low for any particular forest practice activity in a single location. However, the probability that habitat quality, numbers of individuals, and reproductive potential would be reduced across the FPHCP covered lands during the proposed 50-year Permit term is reasonably certain to occur many times in many locations.

The Coastal tailed frog is known to occur in parts or all of the following Water Resource Inventory Areas (WRIAs): 1, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 38, 39, 45, 46, 47, and 48 (USFWS and NMFS 2006; Appendix A Regional Summaries). The Rocky Mountain tailed frog is known to occur in parts or all of the following WRIAs: 32 and 35 (USFWS and NMFS 2006; Appendix A Regional Summaries). However, because of their distribution in British Columbia and Idaho and the lack of surveys in northeast Washington, it is assumed that Rocky Mountain tailed frogs also occur in WRIAs 51 through 62. Because survey information for Coastal and Rocky Mountain tailed frogs is limited in most WRIAs, it is impossible to determine how many individual tailed frogs would be injured, killed, or affected by habitat degradation that disrupts breeding, feeding, and sheltering behaviors. Therefore, the amount of riparian harvest, the number of road crossing structures, and the miles of stream-adjacent roads are used as surrogates for quantifying the adverse affects on tailed frogs.

Coastal Tailed Frogs

It is estimated that harvest of riparian timber for up to 132,907 acres along Type Np streams and 717,686 acres along Type Ns streams could adversely affect Coastal tailed frogs over the life of the proposed 50-year Permit term. These numbers represent the maximum amount of habitat that is expected to be affected during the proposed 50-year Permit term and likely overestimate the actual habitat would be affected as habitat surrogates lack precision. These numbers are derived from a GIS analysis described in Appendix G.

Further, it is estimated that culvert and bridge maintenance and installation, and sediment from hydrologically-connected roads, could result in adverse effects to Coastal tailed frogs from up to 7,575 Type Np stream crossings and 89,837 Type Ns stream crossings, and 872 miles of Type Np stream-adjacent roads, over the life of the proposed 50-year Permit term within WRIAs 1, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 38, 39, 45, 46, 47, and 48 that intersect FPHCP covered lands. These numbers are derived from a GIS analysis described in Appendix G.

Rocky Mountain Tailed Frogs

It is estimated that harvest of riparian timber for up to 27,111 acres along Type Np streams and 101,768 acres along Type Ns streams could adversely affect Rocky Mountain tailed frogs over the life of the proposed 50-year Permit term. These numbers represent the maximum amount of habitat that is expected to be affected during the proposed 50-year Permit term and likely overestimate the actual habitat would be affected as habitat surrogates lack precision. These numbers are derived from a GIS analysis described in Appendix G.

Further, it is estimated that culvert and bridge maintenance and installation, and sediment from hydrologically-connected roads, could result in adverse effects to Rocky Mountain tailed frogs from up to 1,341 Type Np stream crossings and 15,473 Type Ns stream crossings, and 255 miles of Type Np stream-adjacent roads, over the life of the proposed 50-year Permit term within WRIAs 32, 35, and 51 through 62 that intersect FPHCP covered lands. These numbers are derived from a GIS analysis described in Appendix G.

The conservation measures in the FPHCP minimize and mitigate adverse effects to Coastal and Rocky Mountain tailed frogs described above. These measures include: (1) no-harvest RMZs on at least 50 percent of Type Np streams; (2) sensitive site protections (e.g., seeps, springs, Type Np intersections, perennial initiation points; and (3) unstable slope protections.

8.4.6.4 CUMULATIVE EFFECTS

Cumulative effects are those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR §402.02). Cumulative effects were addressed in the Comprehensive Cumulative Effects section of this Opinion, with respect to the aquatic and riparian environment in Washington State. It is assumed that most land surrounding and upstream of the headwater habitat of Coastal and Rocky Mountain tailed frogs would be forestland since most agricultural and developed land occurs much lower in watersheds. The cumulative effects of future State or private activities in these headwater areas would likely include upland timber harvest under the FPHCP and recreation activities. These reasonably expected future State and private activities are not expected to substantially change the overall effects of the action, described above, on Coastal and Rocky Mountain tailed frogs.

8.4.6.5 CONCLUSION

The aggregate effects of the factors analyzed under the environmental baseline, the effects of the action, and the cumulative effects in the FPHCP Action Area, when viewed against the status of tailed frog species is not likely to jeopardize the continued existence of the Coastal or Rocky Mountain tailed frog.

8.5 NATIVE FISH

(Note: Due to the large number of native fish described under section 8.5, their distribution in Water Resource Inventory Areas of Washington (WRIAs) is listed in Appendix H, Table 1. The quantification of effects, by native fish species, is also listed in Appendix H, Table 2.)

8.5.1 Dolly Varden (*Salvelinus malma*)

8.5.1.1 Status of Species

Description of Species

Within Washington State there are two types of native char, the bull trout (*Salvelinus confluentus*) and the Dolly Varden (*Salvelinus malma*). Both are similar in appearance and habitat requirements, and for some time were considered to be the same species until morphological analyses, meristic variation, and genetic analysis (Cavender 1978; Robins et al. 1980, Bond 1992; Crane et al. 1994; Leary and Allendorf 1997) confirmed that they were in fact two distinct species.

Biologists had previously identified bull trout as Dolly Varden (*Salvelinus malma*), largely because of the external similarity of appearance and the previous unavailability of adequate specimens of both species to any one taxonomist. Both species occur together in western Washington, for example, with little or no interbreeding (Leary and Allendorf 1997, as cited in USFWS 2004). Dolly Varden do not occur in eastern Washington. Lastly, bull trout and Dolly Varden each appear to be more-closely related genetically to other species of *Salvelinus* than they are to each other (Phillips *et al.* 1989; Greene *et al.* 1990; Pleyte *et al.* 1992, as cited in USFWS 2004). For example, bull trout are most-closely related to Japanese char (*S. leucomaenis*) and Dolly Varden are most-closely related to Arctic char (*S. alpinus*).

The coloration on Dolly Varden can depend on life history and vary from region to region. Generally the overall, non-spawning body color is olive green from their dorsal surface down along their sides to the belly portion, becoming a dirty to bright white on their ventral side. The pectoral and pelvic fins and anal fin remain an olive green with white leading edges on the pelvic and pectoral fins. Dolly Varden also exhibit white or cream colored spots along their sides starting at about their lateral line area to their dorsal surface. The relative sizes of these spots are small, about the size of their pupils (Wydoski and Whitney 2003). These spots, depending on region, can also range from yellow to a light orange. During spawning, char can take on a red coloration along their sides with a darker brown or olive green color on their dorsal surface. The leading edges of their pectoral and pelvic fins will also become a bright white color. Dolly Varden have smaller, shorter heads than bull trout and with eyes smaller and not-so-dorsally placed (Goetz 1989).

Historical and Current Distribution

Char in Washington State were more widely distributed historically than at present. The historic accounts of Dolly Varden in eastern Washington are now known to actually be that of bull trout. In western

Washington, bull trout and Dolly Varden can occur in the same watershed. Historical distribution of Dolly Varden has been difficult to surmise due to the confusion in identifying bull trout and Dolly Varden (USFWS 2004). Current evidence suggests that the Dolly Varden in Washington tend to be located in isolated populations in headwater tributaries above anadromous barriers (USFWS 2004).

Bull trout and Dolly Varden are known to occur together only within the area of the Coastal Puget Sound Bull Trout Distinct Population Segment and in British Columbia, Canada. Currently, genetic analyses can distinguish between the two species (Crane *et al*. 1994; Baxter *et al*. 1997; Leary and Allendorf 1997). Although morphometrics (measurements) and meristic variation (variation in characters that can be counted) can also be used successfully to distinguish the two species (Haas and McPhail 1991), there can be significant error associated with the application of this methodology by improperly trained users (Haas and McPhail 2001). Haas and McPhail (2001) determined that bull trout were much more likely to be misidentified as Dolly Varden (48 percent of the time), than Dolly Varden were to be misidentified as bull trout (2.5 percent of the time) when this methodology was applied.

McPhail and Taylor (1995) noted that upper Skagit River Dolly Varden, which are generally a stream resident, small in size, and drift feeders, predominate in tributary streams. In contrast, bull trout are migrants, much larger in size and piscivorous, and appear to predominate the main river. Other than one exception discussed below, all native char observed in accessible anadromous reaches are believed to be bull trout.

On the Olympic Peninsula, Dolly Varden have been confirmed in the Dungeness and Quinault core areas (Leary and Allendorf 1997; Young, *in litt.* 2001; Spruell and Maxwell 2002, as cited in USFWS 2004)). Dolly Varden have also been confirmed in the Soleduck River above an anadromous barrier and no bull trout have been identified in the Soleduck River. In the Coastal-Puget Sound Distinct Population Segment, Dolly Varden tend to be distributed as isolated tributary populations above natural anadromous barriers (as in the Dungeness core area), while bull trout are distributed below these barriers (WDFW 1998; Spruell and Maxwell 2002, as cited in USFWS 2004). An exception to this is found in the Quinault core area where Dolly Varden and bull trout occur within the same area in the upper Quinault River and are not isolated above a barrier (Leary and Allendorf 1997, as cited in USFWS 2004). Based on this information, we have assumed that all native char observed in accessible anadromous reaches, other than in the Quinault River, are bull trout (USFWS 2004).

Essential Habitat Components

Generally char require four types of habitat during their life cycle; spawning habitat, rearing habitat, adult habitat and overwintering habitat (Behnke 1992). Deficiencies in any one of the four can limit populations (Behnke 1992).

There are four life history forms of char:

Fluvial, in which spawning and early rearing occurs in smaller tributaries with major growth and maturation occurring in mainstem rivers.

Adfluvial, in which spawning and early rearing occurs in streams, but most growth and maturation occurs in lakes or reservoirs.

Anadromous, in which early rearing occurs in streams with major growth and maturation occurring in salt water.

Resident, in which all life stages (spawning, rearing, growth, maturation) occurs in small headwater streams, often upstream of impassable barriers.

In Washington only the bull trout is known to contain anadromous populations and has all four life history forms, whereas the Dolly Varden seem to only occur in fluvial, resident and possibly adfluvial forms.

Depending on location, char generally spawn from late August to late December, with the peak in September (Wydoski and Whitney 2003). In Alaska, Dolly Varden are known to spawn from September to early November, with the peak spawning period in October (Scott and Crossman 1973). Generally all life history forms of char prefer spawning in small, lower order rivers and streams (McPhail and Baxter 1996). Within the Columbia River system, these spawning sites are characterized by low gradients, small gravel (<20 millimeters), low water velocity (0.03-0.8 meters/second), and proximity to cover, such as cutbanks, log jams, pools, and overhanging vegetation (McPhail and Baxter 1996). Char redds are also constructed at the ends of large pools, channel margins and meander bends (Goetz 1989). Char also require specific water temperatures to spawn and are often associated with cold water springs, ground water seeps and the coldest streams in the watershed (Rieman and McIntyre 1993; McPhail and Baxter 1996). Spawning, for bull trout, is associated with falling water temperatures between 5 and 9°C, with optimum incubation temperatures between 2 and 4°C (Goetz 1989; Moyle 2002). Dolly Varden in Alaska tend to prefer spawning temperatures around 7°C (Scott and Crossman 1973).

Dolly Varden appear to have slightly colder water temperature requirements than bull trout, which may partially explain their Washington residency in upper watersheds upstream from anadromous barriers rather than in marine waters (Haas 2001, as cited in USFWS 2004).

Suitable habitat for rearing of fry is also important in all life histories of native char. The period of incubation and time to fry emergence can vary due to temperature and egg size (McPhail and Baxter 1996). Higher incubation temperatures can decrease the amount of time to hatching, whereas lower temperatures will increase the overall time to hatching (McPhail and Baxter 1996). It has been suggested that the optimal temperatures for development of bull trout occurs between 2 and 4°C (McPhail and Baxter 1996). After emerging, in either late winter or spring, char fry will remain close to the bottom and are relatively secretive and hard to find (McPhail and Baxter 1996). Young char are closely associated with substrates, often using substrates for cover (Rieman and McIntyre 1993).

Adult habitat for char varies depending on life history form. Resident populations of char are usually, but not always, separated from other populations by natural barriers (McPhail and Baxter 1996). These resident populations are usually found in the headwaters of streams or rivers where water temperatures are cool year round. The main habitat used by char in these small headwaters are pool habitats. They also utilize large wood, undercut banks, and overhanging vegetation. These resident populations generally tend to be smaller in size and mature earlier than migratory populations (McPhail and Baxter 1996).

Fluvial populations of char spend their entire adult lives, except when spawning, in large rivers (McPhail and Baxter 1996). Within these large rivers char still seek out large deep pools and instream cover (McPhail and Baxter 1996). These deep pools not only provide cover for char, they also provide cover for other types of fish in which char can feed on, such as whitefish (Goetz 1989).

Currently there are no known populations of adfluvial Dolly Varden in Washington State (S. Spalding, Personal Communication, 2004). There is documentation of a Dolly Varden being sampled from Diablo

Lake on the Skagit River (J. Chan, Personal Communication, 2004). This is thought to be an individual that either managed to pass through the dam system on Ross lake or possibly a fluvial individual of one of the small tributaries of Diablo lake. Adfluvial individuals use the lake environment as adult and overwintering habitat. They spawn in tributary streams or in the lake's inlet or outlet (Goetz 1989). Goetz (1989) summarized that bull trout forage in the littoral zone in fall and spring and move to deeper water in the summer, possibly due to temperature preferences. Bull trout have been known to utilize all parts of the lake environment (McPhail and Baxter 1996).

In Washington State, Dolly Varden seem to be restricted to the resident and fluvial life history form, while bull trout populations on the Olympic Peninsula and in the Puget Sound drainage utilize the marine environment. Dolly Varden do not seem to be anadromous in Washington whereas in British Columbia and Alaska they are anadromous and bull trout populations are fluvial, adfluvial or resident.

Reproductive Ecology

Native char spawn (depending on location) from late August to late December, when water temperatures start to drop (Wydoski and Whitney 2003). Spawning habitats for bull trout are generally characterized by temperatures that drop below 9° C (USFWS 2004). Dolly Varden in Alaska spawn when temperatures are around 7°C (Scott and Crossman 1973). Dolly Varden appear to have slightly colder water temperature requirements than bull trout, which may partially explain their Washington residency in upper watersheds upstream from anadromous barriers rather than in marine waters (Haas 2001, as cited in USFWS 2004). Preferred spawning habitats consist of low-gradient stream reaches with loose, clean gravel. Redds are often constructed in stream reaches fed by springs or near other sources of cold ground water. Fry normally emerge from early April through May, depending on water temperatures and increasing stream flows (Goetz 1989).

The choice of spawning sites is influenced by a number of physical habitat factors such as stream beds with a low percent of boulders and increased amounts of gravel and rubble, low channel gradients, overhanging vegetation, cool ground water seeps, and maximum stream temperatures of 18°C (Goetz 1989). Habitats that contain many of these factors are tailouts of pools, glide sections of streams, channel margins, and meander bends (Goetz 1989). Char can spawn as soon as four years of age (Moyle 2002). Egg production varies as to location and life history and is correlated with the size of female, with larger fish producing more eggs (Wydoski and Whitney 2003).

Movements and Habitat Use

The temperature requirements of char are very specific and represent a critical habitat characteristic (Rieman and McIntyre 1993). Summer temperatures greater than 15°C are thought to limit char distribution (Rieman and McIntyre 1993). However thermal requirements for char can change depending on life stage (USFWS 2004). Although char can tolerate warmer waters for a short period of time, an overall increase in temperatures can greatly limit their distribution and possibly add to the fragmentation of char populations (Rieman and McIntyre 1993).

The foraging behavior of char also varies as to life history and location. Char are opportunistic and adaptive in their feeding habits (Goetz 1989). As char grow they shift their diets from aquatic and terrestrial insects, and at about 110 millimeters, start feeding on small fish (McPhail and Baxter 1996). Stream dwelling resident char are usually more restricted in their movements, and are often isolated by natural barriers and cut off from migrating to larger rivers, lakes or marine environment. Their diet consists of aquatic and terrestrial insects, and small fish.

After emergence, char fry will concentrate in shallow, low velocity areas, such as side channels and small pools associated with cover to avoid predators (McPhail and Baxter 1996). Depending on life history, most fry will move into larger waters to feed and overwinter. High flow events can sometimes push juvenile char into the mainstems of rivers where predation rates are much higher (Goetz 1989). Although young char are very vulnerable to predation, predation still occurs at all stages of life histories. Adult char are preyed on by bears, otters, ospreys, eagles and man. Complex, connected habitats are vital to char in avoiding all types of predators during all life histories.

Threats to Survival

Char distribution (more notably bull trout), abundance, and habitat quality have declined rangewide (USFWS 2004). Current and past land-use practices have altered their environments in unpredictable ways (Rieman and McIntyre 1993). Within Washington State, these declines have resulted from the combined effects of habitat degradation and fragmentation, the blockage of migratory pathways, degraded water quality, poaching, entrainment into diversion channels and dams, fisheries management, and competition with non-native species (USFWS 2004). Not only have these effects had direct impacts on char populations, but they have also indirectly impacted their prey species (USFWS 2004).

Timber harvest, road building, agriculture, mining, dams, and general urbanization have all altered char habitats. Historical forest management actions that removed riparian vegetation from along streams and rivers, removed in-stream large wood, and constructed roads in sensitive locations, contributed to char habitat degradation. Dams created for generating hydroelectric power, or storing drinking water and irrigation water have cut off migratory routes of char and created unnatural hydrological regimes. Dams with improper or no fish passage ways have isolated populations of char from and have restricted genetic interchange with other populations. Dams also restrict movement of returning salmon that provide char with prey items such as salmon eggs and eventually salmon fry. Impassable culverts have also restricted movements of char.

Water quality is extremely important to native char. Char require cold and clean headwaters for spawning and fry development. Char are particularly sensitive to environmental change (Rieman and McIntyre 1993), and changes in water quality can negatively influence char populations. Agriculture, mining, and general urbanization runoff can all add harmful pollutants to water ways. Pollutants can lead to immunosuppression and increased disease susceptibility in juvenile salmon (Arkoosh et al.1998). Petrochemicals and other pollutants can be washed off of city streets and into road drains that empty into waterways. Roads from mining, timber harvesting, agriculture and urbanization can transport fine sediment into water ways causing increased siltation of spawning sites.

Hatchery stocking of non-native fish species in areas occupied by char have impacted populations through competition and hybridization. The stocking of predatory species, such as walleye (*Sander viterus*), small mouth bass (*Micropterus dolomieu*) and large mouth bass (*Micropterus salmoides*), can affect the survival rates of native salmonids, including char (USFWS 2002). Increased fishing pressure is also a major contributor to char mortality and a factor in the declines of some populations (USFWS 2004). In the early 1900's, char were caught commercially in central and southern Puget Sound, but within 10 years catch rates dropped off (USFWS 2004). Poaching and misidentification of char also impacts local populations (USFWS 2004). Char have also been documented as incidental catch by commercial, recreational and Tribal fisherman. The level of incidental catch of char within commercial fishing areas in Washington State is as yet unknown.

8.5.1.2 Environmental Baseline

The state of knowledge for identifying char as either Dolly Varden or bull trout has improved in recent years. With our current ability to separate the two species, we now have a better understanding of where Dolly Varden currently reside. The following streams are currently known to be inhabited by Dolly Varden: upper Dungeness River (upstream of the barrier at mile 24), upper Soleduck River (upstream of the falls) and the upper Quinault River on the Olympic Peninsula. The known Dolly Varden populations on the Olympic Peninsula all occur within the Olympic National Park or within Olympic National Forest. Abundance data for these streams is currently unknown.

In the North Cascades, Dolly Varden occur in the upper Skagit River; Tributaries of the North Fork Nooksack (upper Canyon and Kidney creeks); and tributaries of the South Fork Nooksack River (Bell and Pine Creeks). Dolly Varden may also be present in the Lower Skagit core area, but this has not been confirmed. Areas of known occupancy are either on National Park or National Forest lands.

With our current ability to separate bull trout from Dolly Varden, and our current occupancy data for the Dolly Varden, our conclusion is that the species is not present in the FPHCP Action Area. They are upstream of lands that could be affected by the proposed action. Abundance data for these streams is currently unknown.

<u>Role of FPHCP Action Area for Conservation of species:</u>

The role of the FPHCP Action Area for conservation of Dolly Varden is minor. Currently, documented occupancy of Dolly Varden is outside of the FPHCP Action Area. There may be some unknown areas in the FPHCP Action Area that are occupied by Dolly Varden, but generally the FPHCP Action Area will provide only a minor role in the long-term survival of Dolly Varden. Federal lands appear to provide the majority of the important habitats for Dolly Varden in Washington.

8.5.1.3 EFFECTS OF THE ACTION

General habitat effects to Dolly Varden resulting from the proposed action have been summarized above for the Steep tributary and Low-gradient Tributary Habitat Associations. Currently there is no documentation of Dolly Varden residing in the FPHCP Action Area. New populations of Dolly Varden may eventually be found and it is possible that new populations could be located in the FPHCP Action Area. However, if the current pattern of their occupancy holds, new populations would likely be found on Federal lands. Effects to Dolly Varden streams are possible where distribution of fish is underestimated and the FPHCP covered activities in presumed Type Np streams affect riparian functions in Type F streams, including large wood recruitment, stream temperature, and sediment delivery. A total of 62,414 riparian acres are potentially available to be managed that could contribute to harm of Dolly Varden.

<u>Riparian prescription effects to Dolly Varden</u>

Full riparian and in-stream function likely would not be provided to all habitats occupied by Dolly Varden. In some stream reaches, the highest quality and most structurally complex habitats may fail to develop due to the potential reduction of large wood recruitment to streams at different time scales and following different riparian management prescriptions. For example, although the FPHCP would provide the majority of available large wood adjacent to fish-bearing streams, the FPHCP allows some trees within these large wood recruitment zones to be harvested. In addition, stream-adjacent parallel roads, unbuffered areas in Type Np streams, yarding corridors, and road crossings would likely reduce potential large wood recruitment. Excessive windthrow could affect some riparian processes. The reduction of large wood over long time frames may not allow recruitment processes to form some habitats (pools, riffles, hiding cover) that Dolly Varden use. Large wood influences pool formation which is important during certain life-history stages for Dolly Varden. Large wood also provides hiding cover, sorts and releasing spawning gravels, and provides numerous other important biological and physical processes. Less structurally complex habitat may reduce densities of Dolly Varden. Less complex habitat may also affect survival of individual fish through increased competition or predation. Degradation of Type Np riparian areas and stream habitat could also alter the availability of terrestrial and aquatic invertebrates, which are an important food source for Dolly Varden at all life stages.

Dolly Varden require cool water for survival, potentially even cooler than bull trout. When RMZs achieve their Desired Future Condition, streams within the areas covered by the FPHCP, that are occupied by Dolly Varden, will receive most of the potentially available shade. There are physical situations (yarding corridors, stream-adjacent parallel roads, stream crossings, 20-acre exemptions, and windthrow) where stream shading potential will be reduced.

Along unbuffered Type Np streams, reductions in shade are likely to occur and water temperature may increase over limited distances as a result of these unbuffered Type Np streams. In some cases, increases in temperature may be delivered to downstream Type F waters and temperatures could be warmed near the confluence of Type Np and F streams. In these circumstances, there could be negative effects to Dolly Varden due to potentially elevated stream temperatures and loss of thermal refugia resulting in impairment of foraging, rearing, and spawning behaviors. Increased temperatures may result in a competitive advantage for certain species, which could affect individual fish.

Sediment effects to Dolly Varden

Sediment would be delivered to Dolly Varden habitat from road surface erosion. When FPHCP activities affect certain watershed features, such as steep unstable slopes, there may be additional sediment delivered to fish-bearing streams that are above natural background rates. Increased sediment could result in changes to channel morphology, Dolly Varden habitat could be reduced due to shallowing and filling of pools. Feeding behavior may be affected under some circumstances affecting individual fish fitness and survival. Siltation of spawning reaches could reduce egg survival. However, the FPHCP is not expected to significantly contribute to instream sediment loading to the point that Dolly Varden would be impaired at more than a streams reach scale. Often, effects might be limited to a habitat unit (pool, riffle) or several units.

Culvert and bridge replacement or installation projects are expected to provide a chronic source of sediment, at least until vegetation has been re-established. When vegetation on culvert streambanks has been restored, the amounts of sediment from road crossings are expected to decline. Short segments of stream are routinely dewatered for culvert installation or replacement and the chance for localized fish mortality increases with these projects.

Effects from the 20-acre Exemption Rule

Although it is there is uncertainty on how often this rule would be implemented, when it is implemented the 20-acre Exemption Rule would affect Dolly Varden. In watersheds with a high proportion of 20-acre exempt landowners, this rule would increase the likelihood that large wood recruitment would be inadequate to maintain properly functioning habitat (USFWS & NMFS 2006). There is also the potential for increased sedimentation, reduced shade, increased stream temperatures, and an increase in windthrow.

Where these adverse effects occur, essential behaviors associated with foraging, reproduction and growth may be impeded and Dolly Varden may occupy the stream at reduced levels and have reduced survival.

Summary of adverse effects to Dolly Varden

The proposed action will have short- to long-term adverse effects on sediment, large wood, and temperature. These effects would be most severe from unbuffered Type Np streams and their downstream effects that result in disruption of natural riparian and aquatic processes and functions in Type F streams. These effects to the aquatic environment may result in impairment of essential foraging, rearing, and spawning behavior of Dolly Varden. It is difficult to predict the severity of these effects because effects to these fish will vary from activity to activity depending on the specific riparian prescription applied, the location, historical management practices, geological characteristics of the watershed, and the biotic community present.

Activities covered under the FPHCP are expected to have direct and indirect adverse effects to adult and juvenile Dolly Varden ranging from mortality to sublethal effects. Direct injury and death to Dolly Varden would likely occur during some stream crossing construction activities (stream dewatering and fish rescue and relocation, and blockage of upstream migration during construction). Alterations of the riparian and aquatic environment will reduce the ability of streams to support prey species, thus reducing the fish's ability and success at finding forage in these streams. In a degraded environment increased competition with and predation by other species is anticipated. This could affect the growth and survival of juvenile and adult Dolly Varden.

The role of the FPHCP Action Area for conservation of Dolly Varden is minor. Currently, documented occupancy of Dolly Varden is outside of the FPHCP Action Area. There may be some unknown areas in the FPHCP Action Area that are occupied by Dolly Varden, but generally the FPHCP Action Area will provide only a minor role in the long-term survival of Dolly Varden. Federal lands appear to provide the majority of the important habitats for Dolly Varden in Washington.

Summary of beneficial effects

The long-term benefits of the FPHCP for Dolly Varden would occur as riparian areas mature, roads are managed with watershed processes in mind, adaptive management is implemented, and fish passage is maintained and restored. The FPHCP's incorporation of BMPs and RMAPs will substantially reduce road surface erosion to Dolly Varden habitat. Most adverse effects are associated with the downstream effects from RMZs on Type Np streams and the 20-acre exemption rule and not from RMZs directly adjacent to Type F streams. Effects are not expected to significantly decrease the distribution of Dolly Varden in the FPHCP Action Area, because the FPHCP is not expected to significantly contribute to habitat degradation to the point that Dolly Varden would be harmed at more than a stream reach scale. Often, effects might be limited to a habitat unit (pool, riffle) or several units.

8.5.1.4 CUMULATIVE EFFECTS

Cumulative effects were addressed in the **Comprehensive Cumulative Effects**, with respect to the aquatic and riparian environment in Washington State. Additional information regarding cumulative effects for Dolly Varden was presented in the section steep **Tributary and Low-gradient Tributary Guilds: Cumulative Effects.**

8.5.2 Coastal Cutthroat Trout (*Oncorhyncus clarki clarki*) and Westslope Cutthroat Trout (*Onchorhynchus clarki lewisi)*

8.5.2.1 Status of the Species

Description of Species

In Washington State there are two subspecies of native cutthroat trout, the coastal cutthroat trout (*Oncorhynchus clarki clarki)*, and the westslope cutthroat trout (*Onchorhynchus clarki lewisi)* (Wydoski and Whitney 2003). A primary distinguishing physical feature for these species is that the maxillary generally extends beyond the posterior margin of the eye, especially in fish larger than 4 inches. Cutthroat trout also have hyoid teeth behind the tongue between the first and second gill clefts (Wydoski and Whitney 2003). Cutthroat trout usually have the trademark orange "slash" under the lower jaw, but it can be absent in silvery sea-run or anadromous forms. The small spots are similar on both coastal and westslope cutthroat trout, being small and irregular in outline (nonrounded) (Behnke 1992).

Coastal cutthroat trout are distinguished by numerous irregular dark spots over the entire body, including the anterior area below the lateral line (Wydoski and Whitney 2003). There can sometimes be red coloration on the operculum of non-anadromous and on anadromous fish that have been in freshwater for some time (Wydoski and Whitney 2003). Sea-run individuals can be light to dark silver in color, sometimes masking their spots. Resident freshwater fish tend to be darker with a coppery or brassy sheen (Behnke 1992). Pale yellowish colors may appear on the body, and the lower fins may be yellow to orange-red (Behnke 1992).

Westslope cutthroat trout also have small irregular dark spots; however, they are found primarily above the lateral line and are most numerous on the caudal peduncle. The spots are absent from the anal fin (Wydoski and Whitney 2003). The area within an arc extending from the origin of the pectoral fin to a point just above the lateral line and downward to the origin of the anal fin usually has very few or no spots (Behnke 1992). The coloration of the westslope cutthroat trout can be variable, generally silver with yellowish tints, but bright yellow, orange, and especially red colors can be expressed to a much greater extent than on coastal cutthroat trout (Behnke 1992). Behnke (1992) also states that the coloration of westslope cutthroat trout under some circumstances is influenced by the food consumed by the fish due to certain pigments deposited in the skin.

Historic and Current Range

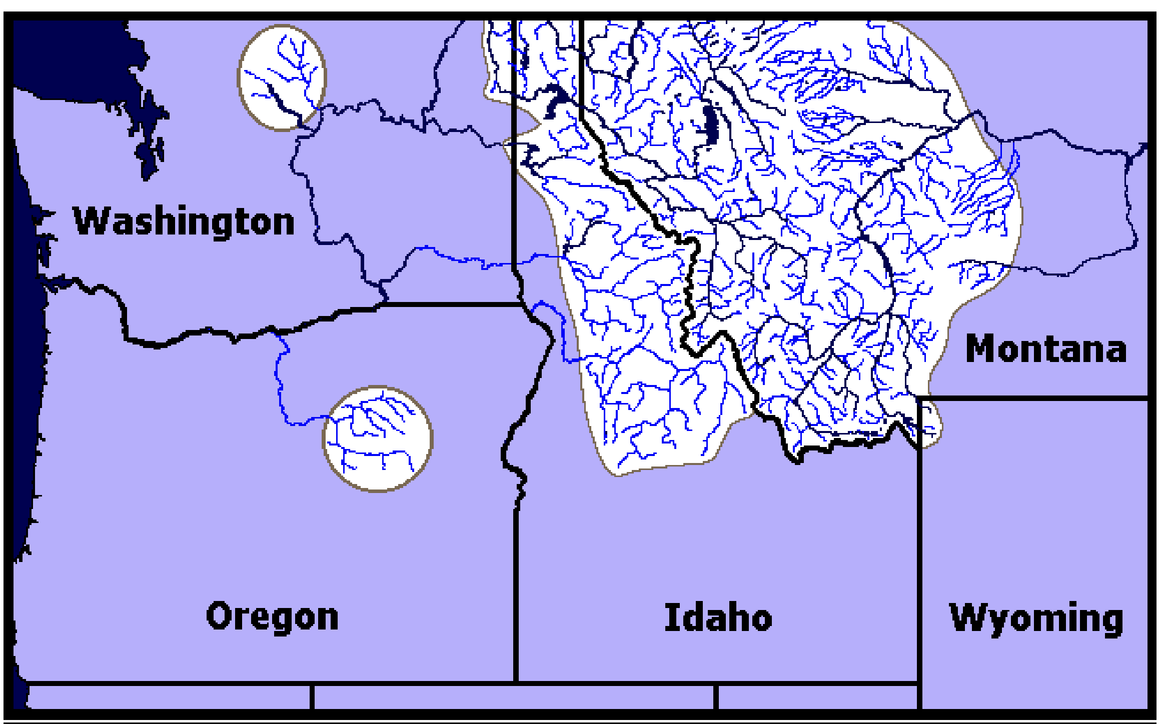
The coastal cutthroat trout occurs from Prince William Sound in Alaska to Humboldt Bay in California (Trotter 1989). In Washington, the historic and current distribution of coastal cutthroat trout includes the coastal watersheds, Puget Sound watersheds, and areas along the Strait of Juan De Fuca. It also occurs in tributaries to the lower Columbia River upstream to approximately the Klickitat River (Wydoski and Whitney 2003).

The historic distribution of westslope cutthroat trout is relatively unknown. West of the Continental Divide, and within Washington State, westslope cutthroat trout are native to the Spokane River above Spokane Falls (Behnke 1992), Methow, and Chelan watersheds (USFWS 1999c) (Figure 8-2). The Methow and Chelan are disjunct populations in the middle Columbia basin (Behnke 1992). Behnke (1992) states that surveys conducted in 1948-1950 contained references to cutthroat trout in the North Fork of the Ahtanum Creek, a tributary of the Yakima River, and in the Wenatchee River watershed. Behnke (1992) also states that cutthroat trout were reported from the Chewack River, which flows to the

Methow River north of Lake Chelan. Behnke (1992) believes that although the Methow drainage has been stocked with both rainbow and cutthroat trout for many years, the widespread occurrence of cutthroat trout indicates that the westslope subspecies is native to the Methow River drainage, and probably also the Wenatchee and Entiat River drainages. Westslope cutthroat trout west of the Cascade crest are believed to be introduced populations (USFWS 1999c).

The range of westslope cutthroat trout increased through years of hatchery stocking. In eastern Washington, westslope cutthroat trout now occur in 1,509 miles of 493 streams and 311 lakes in the Yakima, Wenatchee, Entiat, and Methow Rivers, Lake Chelan drainage, and Pend Oreille River drainages (Wydoski and Whitney 2003). The furthest southern extent of westslope cutthroat trout in eastern Washington occurs in Toppinish Creek, a tributary of the Yakima River (Wydoski and Whitney 2003). This subspecies also occurs on the west slope of the Cascade Mountains, but has not been extensively inventoried (Wydoski and Whitney 2003). The drainages include the Skagit, North Fork Skykomish, South Fork Tolt, Cowlitz, and Cispus Rivers (Wydoski and Whitney 2003). Since the westslope cutthroat trout is native to eastern Washington, there is a high likelihood that the populations west of the Cascade Mountains were introduced.

Figure 8-2. The historic distribution of westslope cutthroat trout in the United States (modified from Behnke 1992). The large region consists primarily of the upper Columbia River and upper Missouri River basins; some waters in the eastern part of this region may not have been occupied historically (MTFWP, *in litt*. 1998). Also shown are the Lake Chelan and Methow River drainages in Washington and the John Day River drainage in Oregon. (USFWS 1999c)



Essential Habitat Components

Generally, trout require four kinds of habitat during their life cycle: spawning habitat, rearing habitat, adult habitat, and overwintering habitat (Behnke 1992). Quantity or quality of these habitat types can influence populations (Behnke 1992). There are four life history forms of cutthroat trout: fluvial, adfluvial, resident, and anadromous. Only the coastal cutthroat trout contains anadromous stocks and has all four life history forms; the westslope cutthroat trout only occurs in three forms (Wydoski and Whitney 2003).

Coastal cutthroat trout generally spawn in small headwater streams and tributaries of small streams and coastal rivers (Trotter 1989). Coastal and westslope cutthroat trout prefer spawning habitat that contains pools, moderate-sized gravel for spawning, overhanging vegetation, submerged rocks and logs, large woody debris (LWD), and undercut banks to use as cover. Both the coastal and westslope cutthroat trout require clean, cool, well oxygenated waters. Cutthroat trout usually prefer the tail-outs of pools in small streams for spawning. In Northern California, spawning of coastal cutthroat trout occurs in water velocities of 0.3-0.9 meters/second, but cutthroat trout have also been observed to spawn in small streams in Oregon with flows as low as 0.01-0.03 meters/second where velocities over the redds were very low (Moyle 2002). Spawning temperatures can range from 9-17°C (Moyle 2002).

Cutthroat trout select spawning areas close to instream cover which provides emerging fry cover. After hatching, cutthroat trout alevins remain in the gravel for several weeks until their yolk sac is absorbed (Moyle 2002). After emerging from the gravel, fry will move into shallow habitats on the edges of streams, where currents are slow, temperatures are warm, and small invertebrates are abundant; the best of these habitats are adjacent to areas with deciduous riparian vegetation, which provides cover, shade, and food (Moyle 2002). Fry typically prefer shallower and slower water velocities (<0.30 meters/second, optimum being 0.08 meters/second) than older life stages (Moyle 2002). Fry can then use the cover to escape from predators and feed on benthic and drift insects, crustaceans and salmon eggs (Moyle 2002).

Adult habitat for coastal cutthroat trout can vary according to life history. Anadromous forms occupy salt water habitats for short periods of time. Some may never move beyond an estuary. Other fish may remain close to the coast, often in low salinity plumes of big rivers (Moyle 2002). Coastal cutthroat trout in Puget Sound move and feed along beaches in water less than 10 feet deep (Wydoski and Whitney 2003). Often, coastal cutthroat trout will move between coastal river systems (Wydoski and Whitney 2003). The time actually spent in the salt water environment varies, but most remain for an average of about 90 days (Wydoski and Whitney 2003). The coastal and westslope cutthroat trout with an adfluvial life history spend from 1 to 4 years as juveniles in tributaries before moving into lakes (Wydoski and Whitney 2003). In lakes where only they occur, cutthroat trout will occupy all habitats, including shallow littoral areas, open limnetic areas, and benthic areas (Wydoski and Whitney 2003). In lakes where rainbow trout and char occur, cutthroat trout will generally use the nearshore littoral areas while the other species occupy the offshore, open-water habitats (Wydoski and Whitney 2003).

The fluvial life history form of the westslope cutthroat trout is similar to that of the coastal cutthroat trout (Wydoski and Whitney 2003). They both occur in pristine headwater streams or alpine lakes, and for the most part exhibit little movement, generally inhabiting lateral shoreline areas of the streams during the summer and moving into pools during the winter (Wydoski and Whitney 2003).

Overwintering habitat is also very crucial to the survival of the coastal and westslope cutthroat trout. Though coastal cutthroat trout have the ability to occupy the marine environment, there are no reports that they overwinter there (Wydoski and Whitney 2003). Coastal cutthroat trout will occupy non natal streams and rivers during winter and then move to their natal systems to spawn. Adfluvial stocks of coastal cutthroat and westslope cutthroat trout will move into the lake environment to overwinter. Fluvial and resident cutthroat trout, inhabiting a small stream, will both overwinter in deep pools, often with fallen logs or undercut banks. Boulders and scour holes provide alternative forms of cover (Moyle 2002).

Reproductive Ecology

As stated above, the coastal cutthroat trout occurs in four life history forms (anadromous, adfluvial, fluvial, and resident) while the westslope occurs in only three (adfluvial, fluvial and resident) (Wydoski and Whitney 2003). The anadromous form of the coastal cutthroat trout will first spawn at two to four years old, and may return two to five times to overwinter and spawn (Moyle 2002). Coastal cutthroat trout spawn in low gradient reaches of small tributaries, or in the lower regions of streams. The spawning period for coastal cutthroat trout ranges from December to June. The females will use their tails to build redds in clean gravel, from 1.2 to 10 centimeters in diameter (Moyle 2002). Substrates containing finer particles can reduce the survival of embryos. The redds can measure approximately 350 millimeters in diameter by 100 to 120 millimeters in depth (Moyle 2002). After spawning, the female will then cover the redd with about 150 to 200 millimeters of gravel (Moyle 2002). Cutthroat trout prefer the tailouts of pools in small tributaries or headwaters to construct their redds. The fecundity of female cutthroat trout will increase with the size and age (Moyle 2002). After spawning, the embryos will hatch after 6-7 weeks of incubation, depending on temperature (Moyle 2002).

Adfluvial westslope cutthroat trout spawn between March and July in Montana at temperatures of approximately 50°F (Wydoski and Whitney 2003). They also prefer the tailouts of pools to construct their redds. They then move downstream into the lake shortly after spawning (Wydoski and Whitney 2003). Fluvial and resident cutthroat trout spawn in small tributaries or headwaters and migrate very little downstream after spawning is complete. Westslope cutthroat trout in spawning migrations remained within a 219-yard reach in tributaries of the Blackfoot River in Montana (Wydoski and Whitney 2003).

Movements and Habitat Use

Movements and migration, and habitat use of coastal and westslope cutthroat trout, can vary according to region. Some factors that influence the movements of cutthroat trout are: temperatures, oxygen levels, food, spawning habitat, and avoiding predators.

Coastal cutthroat and westslope cutthroat trout both have various life history forms. It is not unusual to have migratory and non-migratory individuals within the same population. Movements of cutthroat trout for locating food or spawning can cover large or relatively small distances. Some headwater stream forms of coastal cutthroat trout may spend their entire lives within a 200-meter stream reach (Wyatt, as cited in Trotter 1989). Anadromous forms of coastal cutthroat trout may migrate long distances to estuaries or large rivers to feed heavily on fish and crustaceans (Moyle 2002). Most sea run populations of coastal cutthroat trout leave their streams only for the summer months and return to overwinter in freshwater streams and rivers, even as nonspawning fish (Moyle 2002). Riverine forms of coastal and westslope cutthroat trout must also move about as river flows and prey availability change, and will often move into rivers and streams to prey on outmigrating salmon (Moyle 2002). The apparent preference of juvenile cutthroat trout for small streams and shallow riffles within larger streams is probably due to interactions with more aggressive coho salmon and steelhead juveniles, which keep small cutthroat trout from occupying pools or larger waters (Moyle 2002).

Cutthroat trout are exposed to a wide range of water temperatures. When changes occur in water temperature or other physical factors, the fish usually respond by seeking refugia. Adult and subadult cutthroat trout will seek cover provided by the shade of large trees, submerged rocks and logs, and undercut banks (Wydoski and Whitney 2003). Cutthroat trout generally prefer stream habitats that are cool (<18°C) and well shaded with an abundance of instream cover (Moyle 2002). Preferred temperatures by adults is 15.5°C (range: 10°C to 21°C) (Wydoski and Whitney 2003). Optimum temperatures for spawning of coastal cutthroat trout ranged from 6.1°C to 17.2°C and for egg incubation from 4.4°C to 12.7°C (Johnson et al. 1999). It has been reported that the lower and upper lethal temperatures of coastal cutthroat trout are 0.5°C and 23°C (Johnson et al. 1999).

Threats to Survival

Both species of cutthroat trout have been petitioned for listing under the ESA. After analyzing the available scientific information for the westslope cutthroat trout, on April 14, 2000, (65 FR 20120) we announced that it was not likely to become threatened or endangered for the foreseeable future. This prompted litigation that stated that hybridization issues were not appropriately analyzed in the listing decision. A new status update was done incorporating new genetic analysis information and we concluded that the initial determination for not listing was warranted (68 FR 46989).

The southwestern Washington/Columbia River Distinct Population Segment of coastal cutthroat trout was proposed as threatened in 1999. After reviewing the available scientific information, we determined that the listing was not warranted (67 FR 44934). Improvements in forest management practices, relatively healthy sized populations of coastal cutthroat trout within much of the DPS, and improved understanding of the ability of freshwater forms to produce anadromous progeny, lead to the conclusion that the species in this area was not threatened.

Limiting factors for both the coastal and westslope cutthroat trout include excessive siltation due to historic and current logging practices, reduced qualities and quantities of large woody debris, urbanization, cattle grazing, water diversions (for agriculture and drinking water) and water pollution. Degraded riparian habitats can increase stream temperatures, and small streams that may have cutthroat trout, are particularly sensitive to incoming radiation, which can increase temperatures and reduce dissolved oxygen levels. Lowered dissolved oxygen levels and increased temperatures can give a competitive edge to pikeminnows and several non-native species that will either prey on juvenile cutthroat trout or out-compete them for resources (Rieman and Apperson 1989). Brook trout tend to replace westslope cutthroat trout where westslope cutthroat trout have declined, whereas rainbow trout (once established and naturally reproducing) can displace westslope cutthroat trout where the two overlap.

Threats to survival of cutthroat trout include: urbanization, agriculture, grazing, passage obstructions, logging, mining, over fishing, hatcheries, poaching, water-withdrawls, loss and degradation of wetlands, loss and degradation of estuaries, and competition with other species (Johnson et al. 1999; USFWS 1999c; SaSI 2000).

Westslope cutthroat trout were considered abundant in the Spokane River drainage, however, the effects of logging activities, road construction, and mineral extraction have degraded habitat, and increased access, over fishing, and the introduction of non-native fish species have combined to reduce the distribution, number of larger fish, and overall abundance of westslope cutthroat trout within the drainage (Hunt and Bjornn 1995, Dunnigan and Bennett 1995; Mauser *et al.* 1988; Lider, *in litt*. 1985). Declines have occurred to all life history forms from tributary streams, mainstem rivers, and lakes (Mauser *et al.* 1988; Behnke 1992).

Many threats, such as road building, timber harvesting, mining, urban development and grazing animals within the Riparian Zone, can increase the amount of sediment transported into a stream or river and increase instream temperatures, which can be fatal to developing fry. Migratory barriers such as diversion dams and poorly constructed or old failing culverts can be impassable to juvenile and adult fish. This can fragment distribution and cut off spawning and rearing habitat need to maintain the population.

The introductions of non-native fish have also had negative affects on the populations of native cutthroat trout. Coastal rainbow trout have been widely stocked throughout the range of both the coastal and westslope cutthroat trout for sport fishing. Rainbow and cutthroat trout have been known to hybridize which complicates the preservation of pure strains of cutthroat trout. In the past, hatchery-reared rainbow trout were also stocked into lakes and streams which changed native fish assemblages living there. Cutthroat trout often were out-competed for resources.

Pollution can also impact the populations of native cutthroat trout. The urbanization of many coastal regions and estuaries located near urban centers receive chemical contaminants via direct pipeline discharges from coastal communities and from ships, rivers, atmospheric deposition, and non-point source runoff (Kennish 1992). Pollution in urban estuaries has the potential to adversely influence the health, and ultimately the survival, of juvenile salmonids in the estuary (Casillas et al. 1998). Over-fishing can result in declines of cutthroat trout. Behnke (1992) states that of cutthroat trout in general, the westslope subspecies is vulnerable to exploitation by anglers, but it can also respond favorably from implementing protective angling regulations.

Threats to the survival of westslope cutthroat were identified and analyzed in the 1999 USFWS status review. This review included threats throughout its entire range by watershed and included Washington State. The threats analyzed were:1) the present or threatened destruction, modification, or curtailment of the species' habitat or range; 2) overutilization for commercial, recreational, scientific, or educational purposes; 3) disease or predation; 4) the inadequacy of existing regulatory mechanisms; and 5) other natural or manmade factors affecting the species' continued existence. We concluded that these threats were not severe enough to warrant listing under the ESA. Further, we determined that the existing regulations pertinent to westslope cutthroat trout and aquatic habitat, large distribution of the species (frequently on Federal lands), numerous and genetically pure westslope cutthroat trout, and that the declines appear to have occurred earlier in the 20th century, did not necessitate the listing of the species as threatened (USFWS 1999c and 2003). Additionally, the 2003 status update determined that the westslope cutthroat trout was not threatened by hybridization (68 FR 46989).

Many of the remaining westslope cutthroat trout stocks are restricted to small, headwater streams in mountainous areas, where the adverse effects of human activities on them and its habitat have often been negligible. This is especially true for many of the remaining, genetically pure westslope cutthroat trout stocks (e.g., Shepard *et al.* 1997, as cited in USFWS 1999c). Such spatial separation precludes natural movement and interbreeding among stocks, however, thereby increasing the likelihood that some stocks will become extinct due to limited genetic variability. In addition, the probable small sizes of these individual westslope cutthroat trout stocks and the short stream reaches that they might inhabit, make individual stocks more vulnerable to extirpation due to natural catastrophes such as floods, landslides, wildfires and other stochastic environmental effects. Remaining westslope cutthroat trout stocks in the Upper Columbia River (Washington) drainage, for example, occupy stream reaches that average 3.4 miles long (USFWS 1999c).

In the anadromous watersheds, coastal cutthroat trout spend more time in freshwater than most of the other salmonids in the Pacific Northwest, and hence are more dependant upon properly functioning watersheds. Degraded habitat has been associated with more than 90 percent of extinctions or declines of Pacific salmonid stocks (Gregory and Bisson 1997, as cited in Johnson et al. 1999). Reeves et al. (1997a) and Behnke (1992) suggest that the cutthroat trout's dependence and sensitivity to their freshwater environment may earn them the metaphor "canary in the coal mine."

Salmonid studies on the relationships of timber harvest and fish response have been ongoing in the Alsea watershed in Oregon for a number of years. Research has investigated the impact of different timber harvest patterns on coastal cutthroat trout and coho salmon response (Reeves et al. 1997a). In a specific study, one basin was clearcut including the riparian zone, another basin received 25 percent patch cuts with intact riparian zones, and the third basin was not harvested and acted as the control. Following logging, the biomass of coastal cutthroat trout declined substantially in the clearcut basin. The patch cut and no harvest basins did not change in cutthroat trout biomass. The population of cutthroat trout remained depressed in the clearcut basin for over 20 years, but has recently shown signs of recovery (Reeves et al. 1997a).

Similar forest harvest studies in Carnation Creek, British Columbia, documents that the effects of forest harvest occurred differently to different species and at different time frames (Hartman et al. 1987). Population changes among young salmonids were positive to some components of forest harvest and negative to others. Streamside clearing along with climatic change reportedly increased cutthroat trout length in upper Carnation Creek (Hartment et al. 1987). A western Washington study (Bisson and Seddell 1984, as cited in Reeves et al. 1997a) found higher percentages of age 0 cutthroat trout, but lower percentages of age 1 and older cutthroat trout in a logged watershed compared to an old growth forest. Reeves et al. (1997a) suggests that pool quality (depth and cover) may decline in watersheds impacted by logging, with cutthroat trout declining in their ability to persist. Shallow pools without large wood may favor juvenile coho salmon over coastal cutthroat trout due to the competitive edge that juvenile coho have over cutthroat trout (Reeves et. al. 1997a). Streams that only had cutthroat trout, and no juvenile coho, did not show the declines associated with the shallowing of pools. Cutthroat trout densities have been shown to increase in winter pool habitats in response to large wood placement (Roni and Quin 2001).

8.5.2.2 ENVIRONMENTAL BASELINE (within the FPHCP Action Area)

Coastal Cutthroat Trout

In 2000, the Washington Department of Fish and Wildlife released its Salmonid Stock Inventory Coastal Cutthroat Trout (SaSI 2000) for Washington State. This inventory identified 40 "stock complexes" within Washington State. A stock complex is a group of stocks typically located within a single watershed, or other relatively limited geographic area, and believed to be closely related to one another (SaSI 2000). Of these 40 stock complexes, one was considered to be healthy, 7 were considered to be depressed and the status of the other 32 complexes was unknown (Table 8-35). The 7 depressed stocks are located in the lower Columbia River area (SaSI 2000). As described above, we determined that the southwest Washington/Columbia River coastal cutthroat trout population was not warranted for listing under the ESA in 2002.

Table 8-35. WDFW SaSI coastal cutthroat trout status.

	Healthy	Depressed	Critical	Unknown	Extinct
Puget Sound					
North Puget Sound	1	0	0	7	0
South Puget Sound	0	0	0	4	0
Hood Canal	0	0	0	2	0
Strait of Juan de Fuca	0	0	0	3	0
Total	1	0	0	16	0
Coastal					
North Coast	0	0	0	6	0
Grays Harbor/Willapa Bay	0	0	0	6	0
Total	0	0	0	12	0
Columbia River					
Lowe Columbia	0	7	0	4	0
Washington State					
40 Total Stock Complexes	1	7	0	32	0
Percent of Total	2%	18%	0%	80%	0%

For coastal cutthroat trout, quantitative estimates of historical abundance generally are lacking (Johnson et al. 1999). Currently, anadromous, fluvial, adfluvial and resident populations of coastal cutthroat trout are present throughout Western Washington, but quantifiable estimates on their population status is relatively unknown.

Westslope cutthroat trout

In eastern Washington, westslope cutthroat trout occur in 1,509 miles of 493 miles of streams and in 311 lakes (Williams 1999 as cited in Wydoski and Whitney 2003). Westslope cutthroat trout are actively reared and stocked in and throughout eastern Washington (Anderson, Personal Communication, 2004). There has been some stocking of westslope cutthroat trout in western Washington (Upper Skagit) but the population is considered small and isolated in the North Cascades. This population was not placed there by WDFW hatchery personal and is not currently supplemented by hatchery stocking. WDFW currently lists the westslope cutthroat trout as a species of concern (2004). Their population status in Washington is for the most part unknown at this time. However, as described above, we determined in 2000 and 2003 that listing of the westslope cutthroat trout under the ESA was not warranted, with the reasons provided in the Federal Register Notices, cited above.

The Spokane, Chelan, and Methow watersheds were analyzed as part of the FWS westslope cutthroat trout status review and are reported below.

Spokane River Drainage

The Spokane River drainage is located in northern Idaho with a very small portion in Washington. The majority of the Spokane watershed is outside of the FPHCP Action Area. The Pend Oreille drainage, Washington (EPA drainage 17010216), is in the northeast corner of Washington State and for these analyses includes the Pend Oreille River and all tributaries below Albeni Falls Dam downstream to the Canada-USA border. The drainage encompasses 1080 square miles of which approximately 60 percent is public land managed by the U.S. Forest Service (Streamnet web site). The Salmo-Priest wilderness area encompasses approximately 30,600 acres (4 percent) within this drainage.

Historically, westslope cutthroat trout were considered abundant in the Spokane River drainage, however, the effects of logging activities, road construction, and mineral extraction have degraded habitat, and increased access, over fishing, and the introduction of non-native fish species have combined to reduce the distribution, number of larger fish, and overall abundance of westslope cutthroat trout within the drainage (Hunt and Bjornn 1995; Dunnigan and Bennett 1995; Mauser *et al.* 1988; Lider, *in litt.* 1985 as cited in USFWS 1999c). The Pend Oreille River was found to lack quality habitat for salmonids and is likely better suited for spiny-rayed predators. In 1986, it was determined that over half of the Pend Oreille River shoreline had been developed or consisted of grass banks (Horner *et al.* 1987).

The percentage of HUCs known or predicted to be inhabited by westslope cutthroat trout stocks that were known or predicted to be depressed was largest in Oregon's John Day River drainage (100 percent), and Idaho and Washington's Pend Oreille River drainage (93.4 percent). The Pend Oreille River stock was considered depressed or predicted depressed (USFWS 1999c).

Methow River Watershed:

The majority of the Methow drainage occurs on Federal lands outside of the FPHCP Action Area. Some portions are within the FPHCP lands, however. Westslope cutthroat trout are native to this drainage, with resident and adfluvial life forms present historically and today.

In portions of the mainstem Methow River, habitat has been and continues to be adversely modified. Channelization or stream alteration has occurred along 35 miles (22 percent) of the Methow River (Mullan *et al.* 1992, as cited in USFWS 1999c). Sediment delivery is estimated to be about 10 percent greater than natural background loading (Mullan *et al.* 1992, as cited in USFWS 1999c). Past fires in the headwaters involving riparian habitat have exposed the stream to isolation and increased water temperatures (WDFW, *in litt.* 1995, as cited in USFWS 1999c). Westslope cutthroat trout of the Methow River watershed are isolated in fragmented habitats created by natural barrier and/or habitat modifications (Molesworth, USFS, Personal Communication, 1999). This presents an elevated risk to their survival in these tributaries in the instance of catastrophic events (USFWS 1999c).

Overutilization of resident westslope cutthroat trout is not considered a notable threat in this drainage. Most westslope cutthroat trout throughout the historic and introduced range occupy habitat that is not easily accessible to anglers and in general, the westslope cutthroat trout are very small and not selected for by anglers (WDFW, *in litt.* 1998b). Predation of westslope cutthroat trout is known to occur by numerous native and introduced species, is an important source of mortality to westslope cutthroat trout, and can act as a destabilizing force when habitat loss and overexploitation are experienced (Rieman and Apperson 1989). Available information does not identify any disease problems in this drainage. Since the early 1900s, stocking programs have introduced non-native trout into the Methow River watershed (WDFW, *in litt.* 1998a). The introduction of rainbow and brook trout has greatly increased the risk of competition, predation, and hybridization. In addition, the wide distribution and abundance of non-native species increases fishing pressure, which may aggravate the exploitation of westslope cutthroat trout in the same waters (Rieman and Apperson 1989).

Lake Chelan Watershed

Approximately 90 percent of the drainage is public land managed primarily by the U.S. Forest Service and National Park Service. However, there are some lands within the FPHCP. The construction of Lake Chelan Dam in 1928 raised the water level of the lake by 24 feet and inundated potentially important spawning habitat of adfluvial westslope cutthroat trout at the mouths of tributary streams. The westslope cutthroat trout of Lake Chelan (33,104 surface acres) are reproductively isolated and in long-term decline (Brown 1984 in USFS*, in litt.* 1999b, as cited in USFWS 1999c).

Stream surveys of eight north shore tributaries from 1990-1993 indicated that none of the streams conformed to expected pool frequencies or the Forest Plan Standard for pools. Fine-sediment deposition in pools and embeddedness > 35 percent was identified as a problem in many (6 of 8) of these tributaries. The amount of large woody debris (4 of 8 tributaries) and water temperature (3 of 8 tributaries) was also determined to not meet Forest Plan Standards in numerous tributaries (USFS*, in litt.* 1998d, as cited in USFWS 1999c).

Lake trout, first stocked in Lake Chelan in 1980, have established a naturally reproducing population and are known to be a significant predator to westslope cutthroat trout (Mauser *et al.* 1988, as cited in USFWS 1999c). Non-native hatchery stocking programs still continue in Lake Chelan.

Other watersheds occupied by westslope cutthroat trout in FPHCP Action Area

In eastern Washington, westslope cutthroat trout now occur in 1,509 miles of 493 streams and 311 lakes in the Yakima, Wenatchee, Entiat, and Methow Rivers, Lake Chelan drainage, and Pend Oreille River drainages (Wydoski and Whitney 2003). The furthest southern extent of westslope cutthroat trout in eastern Washington occurs in Toppinish Creek, a tributary of the Yakima River (Wydoski and Whitney 2003). This subspecies also occurs on the west slope of the Cascade Mountains, but has not been extensively inventoried (Wydoski and Whitney 2003). The drainages include the Skagit, North Fork Skykomish, South Fork Tolt, Cowlitz and the Cispus Rivers (Wydoski and Whitney 2003). Since the westslope cutthroat trout is native to eastern Washington, there is a high likelihood that the populations west of the Cascade Mountains are introduced. The population status of westslope cutthroat trout in these watersheds is unknown.

Role of the FPHCP Action Area for Conservation of the Species:

The FPHCP Action Area encompasses a significant segment of the cutthroat trout distribution in Washington, especially for coastal cutthroat trout. The majority of the distribution of westslope cutthroat trout (both historic and transplanted) is on Federal land and will not be subject to the proposed action. The exception to this is the Pend Orielle River, which has westslope cutthroat trout. The coastal cutthroat trout distribution, on-the-other hand, is substantially located in the FPHCP Action Area and will be influenced by the FPHCP. Coastal cutthroat trout are normally represented in species assemblages in western Washington, and in small headwater streams, are often the only salmonid present. The FPHCP Action Area provides an important conservation role for cutthroat trout. High quality aquatic habitats within the FPHCP Action Area are necessary for the long-term survival of cutthroat trout in Washington.

8.5.2.3 EFFECTS OF THE ACTION

General habitat effects to cutthroat trout from the proposed action have been summarized above for the Steep Tributary Guild. Coastal and westslope cutthroat trout will occupy habitats found in Mainstem and Low-gradient Guilds.

There are an estimated 23,558 road crossing and 51,061 miles miles of stream-adjacent parallel roads that will deliver sediment to coastal cutthroat trout and 2,809 of road crossing and 664 miles of stream-adjacent parallel roads that will deliver sediment to westslope cutthroat trout habitat for Type S, F, and Np streams.

Riparian prescription effects to cutthroat trout

Full riparian and in-stream function likely would not be provided to all habitats occupied by cutthroat trout. In some stream reaches, the highest quality and most structurally complex habitats may fail to develop due to the potential reduction of large wood recruitment at different time scales and following different riparian management prescriptions. For example, although the FPHCP would provide the majority of available large wood adjacent to fish-bearing streams, the FPHCP allows some trees within these large wood recruitment zones to be harvested. In addition, stream-adjacent parallel roads, unbuffered areas in Type Np streams, yarding corridors, and road crossings would likely reduce potential large wood recruitment. Windthrow could affect some riparian processes. The reduction of large wood over long time frames may not allow processes to form some habitats (pools, riffles, hiding cover) that cutthroat trout use. Large wood influences pool formation which is important during certain life history stages for cutthroat trout. Large wood also provides hiding cover, sorts and releasing spawning gravels, and provides numerous other important biological and physical processes. Less structurally complex habitat may reduce densities of cutthroat trout. Less complex habitat may also affect survival of individual fish through increased competition or predation. For example, coho may displace cutthroat trout when pools are filled or habitat complexity is reduced. Degradation of Type Np stream associated RMZs and stream habitat could also alter the availability of terrestrial and aquatic invertebrates, which are an important food source for cutthroat trout at all life stages.

When RMZs achieve their Desired Future Condition, streams within the areas covered by the FPHCP that are occupied by cutthroat trout will receive most of the potentially available shade. There are physical situations (yarding corridors, stream-adjacent parallel roads, stream crossings, 20-acre exemptions, and windthrow) where stream shading potential will be reduced. Along Type Np streams, reductions in shade are likely to occur and water temperature may increase over limited distances as a result of these unbuffered Type Np streams. In some cases, increases in temperature may be delivered downstream to Type F waters and temperatures could be warmed near the confluence of Type Np and F streams. In these circumstances, there could be negative effects to cutthroat trout due to potentially elevated stream temperatures and loss of thermal refugia resulting in impairment of foraging, rearing, and spawning behaviors. Increased temperatures may result in a competitive advantage for certain other species, which could affect individual fish.

Sediment effects to cutthroat trout

Sediment would be delivered to cutthroat trout habitat from road surface erosion. When FPHCP activities affect certain watershed features, such as steep unstable slopes, there may be additional sediment delivered to fish-bearing streams that are above natural background rates. Increased sediment could result in changes to channel morphology, and cutthroat trout habitat could be reduced due to filling of pools.

When pool depth is reduced this can result in a competitive advantage for other species (Reeves et al. 1997a). Feeding behavior may be affected under some circumstances affecting individual fish fitness and survival. Siltation of spawning reaches could reduce egg survival. However, the FPHCP is not expected to significantly contribute to instream sediment loading to the point that cutthroat trout would be impaired at more than a stream reach scale. Often, effects might be limited to a habitat unit (pool, riffle) or several units.

Culvert and bridge replacement or installation projects are expected to provide a chronic source of sediment, at least until vegetation has been re-established. When vegetation on culvert or bridge streambanks has been restored, the amount of sediment from road crossings is expected to decline. Short segments of stream are routinely dewatered for culvert installation or replacement and the chance for localized fish mortality increases with these projects.

Summary of effects from the 20-acre Exemption Rule

Although it is there is uncertainty about how often this rule would be implemented, when it is implemented the 20-acre Exemption Rule would adversely affect cutthroat trout. In watersheds with a high proportion of small landowners, this rule would increase the likelihood that large wood recruitment would be inadequate to maintain properly functioning habitat (USFWS & NMFS 2006). There is also the potential for increased sedimentation, reduced shade, increased stream temperatures, and increased windthrow. Where these adverse effects occur, essential behaviors associated with foraging, reproduction and growth may be impeded and cutthroat trout may occupy the stream at reduced levels and have reduced survival.

Summary of negative effects to Cutthroat trout

The proposed action will have short- to long-term adverse effects on sediment, large wood, and temperature. These effects would be most severe from unbuffered Type Np streams and their associated downstream effects that result in disruption of natural riparian and aquatic processes and functions. These effects to the aquatic environment may result in impairment of essential foraging, rearing, and spawning behavior of cutthroat trout. It is difficult to predict the severity of these effects because effects to these fish will vary from activity to activity depending on the specific riparian prescriptions applied, the location, historical management practices, geological characteristics of the watershed, and the biotic community present.

Activities covered under the FPHCP are expected to have direct and indirect adverse effects to adult and juvenile cutthroat trout ranging from mortality to sublethal effects. Direct injury and death to cutthroat trout would likely occur during some stream crossing construction activities (stream dewatering and fish rescue and relocation, and blockage of upstream migration during construction). Alterations of the riparian and aquatic environment will reduce the ability of streams to support prey species, thus reducing the fish's ability and success at finding forage in these streams. In a degraded environment, increased competition with and predation by other species is anticipated. This could affect the growth and survival of juvenile and adult cutthroat trout.

Summary of beneficial effects

The long-term benefits of the FPHCP for cutthroat trout will occur as riparian areas mature, roads are managed with watershed processes in mind, adaptive management is implemented, and fish passage is maintained and restored. The FPHCP's incorporation of BMPs and RMAPs would substantially reduce road surface erosion to cutthroat trout habitat. Most adverse effects are associated with the downstream effects from RMZs on Type Np streams and the 20-acre exemption rule. Effects are not expected to significantly decrease the distribution of the redband or cutthroat trout in the FPHCP Action Area, because the FPHCP is not expected to contribute to habitat degradation to the point that cutthroat trout would be harmed at more than a stream reach scale. Often, effects might be limited to a habitat unit (pool, riffle) or several units.

8.5.2.4 CUMULATIVE EFFECTS

Cumulative effects were addressed in the **Comprehensive Cumulative Effects**, with respect to the aquatic and riparian environment in Washington State. Additional information regarding cumulative effects for the westslope and coastal cutthroat trout was presented in the section **Steep Tributary Guild: Cumulative Effects.**

8.5.3 Coastal Rainbow Trout (*Oncorhynchus mykiss irideus*) and Columbia Redband Trout (*Oncorhynchus mykiss gairdneri)*

8.5.3.1 Status of the Species

<u>Description of Species</u>

In Washington State there are two distinct types of resident native rainbow trout recognized by Behnke (1992): the coastal rainbow trout (*Oncorhynchus mykiss irideus* - including the Beardsley trout *Oncorhynchus mykiss beardslei* of Lake Crescent), and the Columbia redband rainbow trout (*Oncorhynchus mykiss gairdneri*).

Generally rainbow trout of both types can be highly variable in color, body shape, and meristic characters (Moyle 2002). No set of character values distinguishes all coastal rainbow trout from all trout of redband evolutionary lines (Behnke 1992). Considerable genetic interchange between coastal rainbow and interior redband trout in the Columbia River basin has probably occurred during and since the last glacial period (Behnke 1992). In general, adult coastal rainbow trout are recognized by the broad red to pink band (rainbow) that runs laterally from their opercle, on their head, to the end of their caudal peduncle where it meets the tail. Above this red band the coloring of the dorsal surface can be a dark olive to bright green or dark blue to steel blue color. Also covering their dorsal surface and both the dorsal fin and adipose fin are numerous black spots. These spots also cover the tail fin, usually in radiating lines. Below the red lateral band the color of the body can be green or bluish silver turning to white at the belly. This area can sometimes have a few black spots or be completely void of spotting. Typical characters of Columbia redband trout are variable, but generally differentiated from coastal rainbow by larger spots, more-elliptical parr marks that often include dorsal and ventral supplementary rows (as in cutthroat trout), a tendency for yellow and orange tints on the body, a trace of a cutthroat mark, and light-colored tips on dorsal, anal, and pelvic fins (Behnke 1992).

Juvenile rainbow trout exhibit similar colorations to that of adults. Juvenile rainbows, however, have 5-13 widely spaced parr marks centered along their lateral line (Moyle 2002). Juveniles can also posses 5-10 dark marks on their backs between the head and dorsal fin (Moyle 2002). They can also have white to orange tips on their dorsal and anal fins, and few or no black spots on the tail (Moyle 2002).

Historic and Current Range

The coastal rainbow trout's historic range is from the Columbia River, along the coast of Washington including Willapa Bay and Grays Harbor, the Olympic Peninsula and Straight of Juan De Fuca, Hood Canal, Puget Sound, and the San Juan Islands. The redband rainbow trout's range is the Columbia River basin east of the Cascade Coastals to barrier falls including the Okanogan, Pend Oreille, Spokane, and Snake Rivers (Behnke 1992). The coastal rainbow trout's range also extends up the Columbia River and coastal and redband trout overlap in the mid-Columbia River basin (Wydoski and Whitney 2003). The non-migratory coastal strain of rainbow trout is now widely distributed beyond it historical range due to extensive stocking of this popular sportfish into lakes and streams throughout the state (Wydoski and Whitney 2003).

Essential Habitat Components

Generally trout require four kinds of habitat during their life cycle: spawning habitat, rearing habitat, adult habitat, and overwintering habitat (Behnke 1992). Deficiencies in any one of the four will limit populations (Behnke 1992). In general, coastal and redband trout prefer cool water, less than 70°F, containing high amounts of dissolved oxygen, although they can inhabit water with temps ranging from 32°F up to 80°F (Wydoski and Whitney 2003).

Spawning habitat is usually dependent on five criteria: substrate size, stream/river depth, water velocity, upwelling of ground water, and cover. In high gradient systems spawning success can be limited due to higher water velocities which can carry off smaller more suitable substrate and leave behind larger boulders and rubble (Behnke 1992). In lower areas of watersheds, high sediment loads can blanket redds with silt and restrict spawning success. In the Yakima River, rainbow trout redds occurred in substrate that was mostly 0.25 to 6.35 centimeters in diameter at a mean depth of 0.3 to 0.4 meters where water velocity was 0.6 to 0.7 meters/second (Wydoski and Whitney 2003). Areas of upwelling of ground water are also selected for egg incubation due to its constant cool temperature (or warm temperature in the fall and winter months) and flow throughout the year. Cover, such as a log jams or undercut banks, also provides adult spawners and emerging fry a refuge to hide from predators.

Rearing habitat requirements for juvenile rainbow trout can be diverse depending on life history and season. Rearing habitats for rainbow trout incorporate cover to hide from predators, cool temperatures, and a readily accessible food supply. For example, Behnke states that after hatching and during the first months of life, trout need habitat with protective cover and low water velocity. Examples of habitats that contain these factors are found along the margin of the stream or river, in small spring seeps or tributaries, and in side channels, sloughs and braided channels. Whereas after trout start to increase in size, and for the first year or two of life rainbow trout are found in cool, fast-flowing permanent streams and rivers where riffles predominate over pools, where there is ample cover from riparian vegetation or undercut banks, and where invertebrate life is diverse and abundant (Moyle 2002).

Optimal adult habitat provides larger adult fish adequate amounts of cover such as undercut banks, jog jams and ample overhanging vegetation and riparian cover. In a study by Binns and Eiserman (1979) concerning trout biomass in Wyoming streams, the authors found that it is also important that base stream flows don't drop below 25 percent of the average daily flow. A drop below 25 percent would expose and therefore remove much of the desirable cover that trout depend on, such as the undercut banks and preferred shoreline areas.

Overwinter habitat is also very important to the survival of trout. Overwinter survival is related to the amount of deep water with low current velocity and protective cover like deep pools with large boulders and rootwads or areas of beaver ponds (Bjornn 1971; Bustard and Narver 1975). Adult trout in headwater streams with poor overwintering habitat and severe winter conditions have been shown to migrate during the fall to larger streams and rivers in lower elevations to overwinter.

Redband trout appear to have evolved to a variety of environmental conditions, more so than other salmonids, as represented by their diversity of landscapes they are found in. Their persistence in some heavily disturbed basins suggests that they may be less sensitive to habitat degradation than other salmonids (Lee et al. 1997).

Reproductive Ecology

Rainbow trout normally spawn in the spring between February and June, depending on the temperature and location (Wydoski and Whitney 2003). Some wild populations of rainbow trout do spawn in the fall in rivers with unusual thermal characteristics (Behnke 1992). For trout to be able to spawn in the fall they must posses developed gonads and be able to locate warmer spring-fed areas of the river or stream. The disadvantage of fall spawning is that eggs of rainbow trout cannot tolerate several months of near freezing winter conditions and unless they were laid near or in a warmer spring seep they would most likely all die. All native western trout evolved to spawn in flowing waters that circulate dissolved oxygen throughout the redd (Behnke 1992). Embryos need the most oxygen when their development is most rapid, which occurs just before hatching at a time of rising water temperatures (Behnke 1992).

In streams, most western trout first spawn 2-4 years after their parents spawned (Behnke 1992). As with most other salmonids, the female digs a redd in the gravel (gravel size 1 to 13 centimeters in diameter) of a tail out of a pool or in a riffle (Moyle 2002). Water velocities over redds can be 20 to 155 centimeters/second, and at depths of 10 to 150 centimeters (Moyle 2002). During redd construction, male trout will move close to a female in an attempt to establish a territory and spawn with the female. The male will aggressively fend off other males intent on spawning with the female. Spawning takes place when the male trout induces the female to lay her eggs, and as she expels them from her body he fertilizes them. The number of eggs per female in rainbow trout varies from 200 to 9,000 and is dependent on the size of the female and the strain or stock or the fish (Wydoski and Whitney 2003). The fertilized eggs are deposited in the constructed redd and fall into crevices between the larger rocks unable to be moved by the female. Resident rainbow trout can spawn more than once in their life time, and it is not unusual for fish to skip a year between spawns (Moyle 2002). Typically, more females than males are repeat spawners (Behnke 1992).

Time of egg hatching varies greatly with region, and can be anywhere from 3 to 7 weeks, with several more weeks of in-gravel development before they are completely free swimming fry. The fry initially live in quiet waters close to shore and exhibit little aggressive behavior for several weeks (Moyle 2002).

Movements and Habitat Use

Movements, migration, and habitat use of resident rainbow trout may vary according to region. Some factors that can influence the movements of rainbow trout are: locating optimal temperatures, oxygen levels, food, spawning habitat, and avoiding predators. Rainbow trout will move to habitats that contain cool (<20°C, with lethal temps >23°C) well oxygenated waters or areas that contain ample food supply. Predators have a strong effect on microhabitats selected by rainbow trout (Moyle 2002). Small trout select places to live based largely on proximity to cover in order to hide from both avian predators (kingfishers, herons, mergansers) and predatory fish (Moyle 2002).

In streams, different sizes of rainbow trout show distinct preferences for different microhabitats as defined by depth, velocity, substrate, and cover (Moyle 2002). Fry (<50 millimeters SL) typically concentrate in shallow (<50 centimeters) water along stream edges, where water column velocities are low (1 to 25 centimeters/second) (Moyle 2002). Juveniles (50 to 120 millimeters SL) occur in deeper (50 to100 centimeters) and faster (10 to 30 centimeters/second) water, usually among rocks or other cover (Moyle 2002). Larger fish seek out a wide variety of deeper habitats (often including "pockets" behind rocks, runs, or pools) but typically stay close to fast water capable of delivering drifting invertebrates to them, such as inflowing water at the head of pools (Moyle 2002). Adult trout increase their foraging efficiency by moving into high-velocity water only to feed and then quickly returning to low-velocity areas for holding (Moyle 2002). Habitat used by young of the year rainbow trout in the upper Yakima River basin was water that was 0.1 meter deep with a current of 0.2 meters/second on the bottom (Wydoski and Whitney 2003). Age 1 fish occupied water with similar depth and velocity of 0.12 meters deep with a current of 0.2 meters/second on the bottom (Wydoski and Whitney 2003).

Threats to Survival

Hatchery plantings of coastal rainbow trout have been so widely stocked throughout the state that their present range has now expanded beyond their historic. It can be said that due to the widespread stocking of this popular sport fish, the coastal rainbow trout's population has increased.

Agriculture, dams, over harvest, logging, mining, hybridization, and competition with other trout contributed to the decline of redband trout abundance, distribution, and genetic diversity in the Columbia River Basin (Williams et al. 1989; Behnke 1992). Frequently, redband trout are restricted to isolated headwater streams. The long-term persistence of these populations may be threatened by the loss of migratory life history forms and connectivity with other populations. The redband trout's population status has more recently become a question for Federal, state, and local authorities. The U.S. Forest Service considers the redband trout a sensitive species (Ken MacDonald, Forest Service Fishery Biologist, Wenatchee Office, Personal Communication, 2004). In 2000, the FWS determined that listing the Great Basin redband trout as threatened under the ESA was not warranted (65 FR 14932). The Great Basin redband trout does not occur in Washington.

There is continued concern that the continued widespread stocking of coastal rainbow trout and other non native species within the redband trout's range will result in hybridized populations and displacement of native redband trout. There is a high likelihood that the most substantial threats to the redband trout's population is from introductions of non native species and general habitat loss within its' range. Questions remain on the population status of redband trout.

Threats to rainbow trout survival can be variable depending on species and location. Like most salmonids, rainbow trout need clear, clean, and cold water for proper egg development and fry emergence. As they mature and grow, their habitat requirements change and can vary according to their region. Any change in either part of their ecosystem can have deleterious affects on their survival. Threats to the quality of habitat include increasing water temperatures during egg and fry development, or decreasing dissolved oxygen levels. Providing functional riparian vegetation contributes streamside shade which facilitates keeping fish-bearing waters cool. Riparian vegetation also provides: instream hiding cover for fish; attenuates stream flow; create pools and riffles; and traps sediment. Impoundment by levees or bank armoring with rip rap can constrict the channel and cause it to downcut removing spawning gravel and redds. Also high flows can be the cause of heavy precipitation which can transport large amounts of sediment from runoff of roads and degraded streambanks which can cover redds and incubating eggs or larval fish.

Competition with non native species has always been a major threat to native rainbow trout. The introduction of non native fish species intro a stream or lake for sport can permanently change the ecosystem for native rainbow trout by removing food from the system, limiting cover to native trout, predation on native trout fry and juveniles, and occupying preferred spawning areas. Hybridization with like species can also disrupt the genetic diversity of native species of rainbow trout. Pollution is also an important factor affecting the populations of native rainbow trout. It has been shown that pollution increases the probability of disease-related impacts on fish populations (Arkoosh 1998).

8.5.3.2 ENVIRONMENTAL BASELINE (within the FPHCP Action Area)

Non-anadromous rainbow trout are distributed across most of the FPHCP Action Area. Both species of rainbow trout occur in the mid-Columbia River basin, and in western Washington, the coastal subspecies occurs. The population of the coastal rainbow trout population appears to be stable. They have a broad distribution across many watersheds in the FPHCP Action Area. Some populations of the anadromous steelhead are listed under the ESA.

The redband rainbow trout, once the most widely distributed salmonid in the Columbia basin (Lee et al. 1997), still appears to be broadly distributed in eastern Washington but their current status is often unknown (Table 8-36). Lee (1997) estimates that redband trout occur in 64 percent of their combined historical range. One reported difficulty was to differentiate juvenile steelhead from sympatric redband trout. Another difficulty for making accurate status determinations is that potential hybridization has occurred for some time due to extensive fish stocking programs which can make classifications difficult.

Table 8-36. Summary of the current status and distribution classifications (number of subwatersheds) for redband trout (sympatric and allopathic) throughout the Columbia Basin. (Lee et al. 1997).

Ecological Unit	Total	Historical	Total Current	Strong*	Depressed*	Status Unknown
Northern Cascades	340	340	253	5	4	244
Columbia Plateau	1089	1050	465	24	156	282
Blue Coastals	695	695	574	48	95	428
Northern Glaciated Mountains	955	456	281	25	13	243

The only Ecological Unit that is specific to Washington is the Northern Cascades, the other units include WA and other states. The * refers to spawning and rearing. Models were used to predict the status of redband trout based on biophysical characteristics of the watershed and patterns of distribution reported for redband trout.

The status estimates from Table 8-36 show that generally, the status of redband trout in these areas is unknown. The Columbia Plateau, Blue Coastals, and Northern Glaciated Coastals Ecological Units are predominately outside of the FPHCP Action Area, but do have some areas that include eastern Washington. The Northern Cascades Unit is primarily on Federal lands.

Role of FPHCP Action Area for Conservation of species:

The FPHCP Action Area encompasses a significant segment of the rainbow trout distribution in Washington. Federal and HCP lands also provide substantial areas that these species occupy. Rainbow trout need high quality streams for their survival. The FPHCP Action Area provides the streams, lakes, and wetlands that the species requires. Rainbow trout are part of the aquatic community and will respond favorably to watersheds managed with natural process in mind. The role of FPHCP covered lands are important to the long-term survival of rainbow trout in Washington.

8.5.3.3 EFFECTS OF THE ACTION

General habitat effects to rainbow and redband trout resulting from the proposed action have been summarized above for the Low-Gradient Tributary Guild. Rainbow trout will also occur in other habitats, particularly in the Mainstem and Steep Tributary Guilds.

Riparian prescription effects to rainbow and redband trout

Full riparian and in-stream function likely would not be provided to all habitats occupied by rainbow trout. In some stream reaches, the highest quality and most structurally complex trout habitats may fail to develop due to the potential reduction of large wood at different time scales and following different riparian management prescriptions. For example, although the FPHCP would provide the majority of available large wood adjacent to fish-bearing streams, the FPHCP allows some trees within these large wood recruitment zones to be harvested. In addition, stream-adjacent parallel roads, unbuffered areas in Type Np streams, yarding corridors, and road crossings would likely reduce potential large wood recruitment. Excessive windthrow could affect some riparian processes. The reduction of large wood over long time frames may not allow recruitment processes to form some habitats (pools, riffles, or hiding cover) that rainbow trout use. Large wood influences pool formation which is important during certain life history stages for trout. Large wood also provides hiding cover, sorts and releases spawning gravels, and provides numerous other important biological and physical processes Less structurally complex habitat may reduce densities of rainbow trout. Less complex habitat may also affect the survival of individual fish through increased competition or predation. Degradation of Type Np riparian areas and stream habitat could also alter the availability of terrestrial and aquatic invertebrates, which are an important food source for rainbow trout at all life stages.

When RMZs achieve their Desired Future Condition, streams within the areas covered by the FPHCP, that are occupied by rainbow and redband trout, will receive most of the potentially available shade. There are physical situations (yarding corridors, stream-adjacent parallel roads, stream crossings, 20 acre exemptions, and windthrow) where stream shading potential will be reduced. Along Type Np streams, reductions in shade are likely to occur and water temperature may increase over limited distances as a result of these unbuffered Type Np streams. In some cases, increases in temperature may be delivered downstream to Type F waters and temperatures could be warmed near the confluence of Type Np and F streams. In these circumstances, there could be negative effects to redband and rainbow trout due to potentially elevated stream temperatures and loss of thermal refugia resulting in impairment of foraging, rearing, and spawning behaviors. Increased temperatures may result in a competitive advantage for certain fish species, which could affect individual fish. For example, redside shiners were found to be competitively superior to steelhead trout when temperatures were above 64° F (Wydoski and Whitney 2003) and in laboratory experiments Sacramento pikeminnow out-competed steelhead in warm water (Reese and Harvey 2002).

Sediment effects to rainbow and redband trout

Sediment would be delivered to rainbow trout habitat from road surface erosion. When FPHCP activities affect certain watershed features, such as steep unstable slopes, there may be additional sediment delivered to fish-bearing streams that are above natural background rates. Increased sediment could result in changes to channel morphology, and rainbow and redband trout habitat could be reduced due to shallowing and filling of pools. Feeding behavior may be affected under some circumstances affecting individual fish fitness and survival. Siltation of spawning reaches could reduce egg survival. However, the FPHCP is not expected to significantly contribute to instream sediment loading to the point that rainbow and redband trout would be impaired at more than a stream reach scale. Often, effects might be limited to a habitat unit (pool, riffle) or several units. There are 22,172 and 4, 921 road crossings in Type S, F, and Np of coastal and redband rainbow trout, respectively.

Culvert and bridge replacement or installation projects are expected to provide a chronic source of sediment, at least until vegetation has been re-established. When vegetation on culvert and bridge streambanks has been restored, the amount of sediment from road crossings are expected to decline. Short segments of stream are routinely dewatered for culvert installation or replacement and the chance for localized fish mortality increases with these projects.

Summary of effects from the 20-acre Exemption Rule

Although it is there is uncertainty regarding how often this rule would be implemented, when it is implemented the 20-acre Exemption Rule would adversely affect rainbow and redband trout. In watersheds with a high proportion of 20-acre exempt landowners, this rule would increase the likelihood that large wood recruitment would be inadequate to maintain properly functioning habitat (USFWS & NMFS 2006). There is also the potential for increased sedimentation, reduced shade, increased stream temperatures, and increased windthrow. Where these adverse effects occur, essential behaviors associated with foraging, reproduction and growth may be impeded and rainbow and redband trout may occupy the stream at reduced levels and have reduced survival.

Summary of negative effects to rainbow and redband trout

The proposed action will have short- to long-term adverse effects on sediment, large wood, and temperature. These effects would be most severe from unbuffered Type Np streams and their associated downstream effects that result in disruption of natural riparian and aquatic processes and functions. These effects to the aquatic environment may result in impairment of essential foraging, rearing, and spawning behavior of rainbow and redband trout. It is difficult to predict the severity of these effects because effects to these trout will vary from activity to activity depending on the specific riparian prescriptions applied, the location, historical management practices, geological characteristics of the watershed, and the biotic community present.

Activities covered under the FPHCP are expected to have direct and indirect adverse effects to adult and juvenile rainbow and redband trout ranging from mortality to sublethal effects. Direct injury and death to these trout would likely occur during some stream crossing construction activities (stream dewatering and fish rescue and relocation, and blockage of upstream migration during construction). Alterations of the riparian and aquatic environment will reduce the ability of streams to support prey species, thus reducing the trout’s ability and success at finding forage in these streams. In a degraded environment increased competition with and predation by other species is anticipated. This could affect the growth and survival of juvenile and adult trout.

Summary of beneficial effects to rainbow and redband trout

The long-term benefits of the FPHCP for rainbow and redband trout will occur as riparian areas mature, roads are managed with watershed processes in mind, adaptive management is implemented, and rainbowand redband trout passage is maintained and restored. The FPHCP's incorporation of BMPs and RMAPs would substantially reduce road surface erosion to rainbow trout habitat. Because most adverse effects are associated with the downstream effects from RMZs on Type Np streams and the 20-acre exemption rule the FPHCP is not expected to significantly contribute to habitat degradation to the point that rainbow trout would be harmed at more than a stream reach scale. Often, effects might be limited to a habitat unit (pool, riffle) or several units. Effects are not expected to significantly decrease the distribution of the redband or rainbow trout in the FPHCP Action Area.

8.5.3.4 CUMULATIVE EFFECTS

Cumulative effects were addressed in the **Comprehensive Cumulative Effects**, with respect to the aquatic and riparian environment in Washington State. Additional information regarding cumulative effects for the covered fish species was presented in the section **Mainstem Guild: Cumulative Effects.**

In addition to those cumulative effects discussed earlier in this document, increases in stream temperature from global warming may give a competitive advantage to some species (redside shiner, for instance) that occupy the same streams as rainbow trout.

8.5.4 Kokanee (*Oncorhyncus nerka*)

8.5.4.1 Status of the Species

Description of Species

Kokanee are a non-anadromous, landlocked form of sockeye salmon. Their body is fusiform, streamlined, and laterally compressed (Moyle 2002). Adults lack distinct spots on their backs and caudal fins (Wydoski and Whitney 2003). The dorsal surface of their head and body is usually a steel-blue to green-blue color, and their sides are bright silver. The dorsal fin may sometimes have a few dark spots with the other fins clear or opaque. Kokanee are distinguished from other salmon by having 28-40 long, slender and closely spaced gill rakers on their 1st gill arch (Wydoski and Whitney 2003).

Male kokanee will develop a bright red or a dirty red-gray color over their backs and sides, (including the dorsal, adipose and anal fins) during breeding. Their caudal fin will sometimes be a dark red, black, or dark green color, as can their pelvic and pectoral fins. Their head to lower jaw becomes a bright green to olive-green color, with their lower jaw a dirty white to gray color. Males will also develop a hooked or kyped snout and a small hump anterior to the dorsal fin. Size during breeding can range from 200 to 510 millimeters in length. The largest kokanee recorded in Washington was taken from Lake Roosevelt and weighed 2.6 kilograms and measured 590.5 millimeters (Wydoski and Whitney 2003). Breeding female kokanee also take on a red to red-gray color like that of the male; however, females do not develop a hooked nose or green coloration on the head.

Historical and Current Range

Kokanee are native to British Columbia, Canada, Alaska, Idaho, Washington, Siberia, and Japan (Scott and Crossman 1973; Moyle 2002). The historical range of native kokanee in Washington State is largely unknown or incomplete. Three native stocks of kokanee were found in the Upper Columbia River and its tributaries prior to the installation of hydroelectric dams: Arrow Lakes, Kootenay Lake, and the Chain Lakes in B.C. (Wydoski and Whitney 2003). In a petition to list the Issaquah Creek native summer run of kokanee (a Lake Sammamish tributary), the petitioners listed 12 lakes in Washington State as having, (or historically having), a native population of kokanee. These lakes included: Baker Lake, Banks Lake, Billy Clapp Lake, Bumping Lake, Cle Elum Lake, Cooper Lake, Crescent Lake, Kachees Lake, Keechelus Lake, Ozette Lake, Whatcom Lake, and Wenatchee Lake.

The range of kokanee in Washington State has been vastly increased due to stocking practices by the Washington Department of Fish and Wildlife. Lakes in eastern and western Washington are continuously stocked with kokanee for sport fishing. According to a Whatcom County Water Resources (WCWR) (2003) fact sheet about kokanee, two-thirds of Washington State's kokanee fisheries are dependent on the stocking of kokanee fry from the Lake Whatcom hatchery on Brannian Creek. Thirty-six lakes in Washington are stocked annually with 14.4 million Lake Whatcom kokanee (WCWR 2003).

Essential Habitat Components

Generally, there are four basic habitat types required by kokanee and salmon during their life cycle: spawning, rearing, adult and overwintering habitat (Behnke 1992). However, for kokanee, rearing, adult and overwintering habitats are all located within the lake environment. While in this environment, kokanee will move seasonally within the water column to locate optimal temperatures, food sources and adequate oxygen levels.

Spawning usually takes place in a small tributary of the lake they inhabit. Spawning may also take place along the lake shore where upwellings of groundwater occur (Garrett et al. 1998). These upwelling sites may enhance embryo survival by providing a more-stable thermal environment and providing a constant flow of water throughout the incubation period (Garrett et al. 1998). Lake spawning also occurs where wave action and storm events have resulted in shoreline areas with clean, well-washed gravel, free of fine sediment (Federicks et al. 1995). For stream spawning, kokanee require cool (6 to 13°C), clean water (Moyle 2002) with adequate substrate to construct a redd. Kokanee generally construct redds in areas of gravel or small cobble with limited amounts of silt or fine substrate material. It has been found that high levels of fine sediment reduce embryo survival (Garrett et al.1998). Generally, riffles or the tail-outs of pools contain clean, uniform-sized gravel to spawn. After hatching and rearing in the gravel for up to six weeks, the kokanee fry will immediately migrate downstream, usually at night, into the lake environment. Studies in Montana have shown that migrating fry have made a 60 mile migration to Low gradient Lake in less than 72 hours (MDFWP 1985).

After entering the lake environment as fry, young kokanee will seek out the well-oxygenated open waters of the lake to rear (Moyle 2002). The growth of kokanee in this open-water zone is directly related to the overall abundance of zooplankton (Clarke and Bennett 2002). Kokanee will inhabit the surface waters (1 to 3 meters in depth), as long as the preferred temperatures (10 C-15 °C) and prey items remain (Moyle 2002). During the summer months when temperatures at the surface increase, kokanee will move to deeper, cooler waters. Kokanee will spend from 2 to 7 years in the lake environment before they return to their natal streams to spawn (Moyle 2002).

Reproductive Ecology

Kokanee remain in fresh water their entire lives. The size and age of spawning kokanee depend in part on growing conditions (food, light, and temperature) and on the origin of the stock. Kokanee usually reach maturity when they are around 200 to 380 millimeters in length (Wydoski and Whitney 2003).

Kokanee spawn in streams and along the shores of lakes. In streams, females construct a redd in which to lay their eggs and in lakes spawning occurs along a shoreline which is characterized by well washed clean gravel free of silt (Federicks et al. 1995), or upwellings of groundwater (Garrett et al. 1998). Female kokanee (254 to 380 millimeters long) can produce from 300 to 1,700 eggs and may spawn up to 3 times or until her eggs have been depleted. Males and females will die a short time (2 to 4 days) after spawning. Like all salmon, their decaying bodies become a source of nutrients for other organisms in the lake or stream.

The fertilized eggs develop in the gravel, which can take from 4 to 9 weeks (WCWR 2003). The emerged alevins will remain in the gravel until they have consumed their yolk sac. They emerge from the gravel during the spring as fry and migrate downstream to the lake at night with the help of high spring runoff (Moyle 2002; Wydoski and Whitney 2003). The fry then begin to feed on plankton upon reaching the lake (Moyle 2002).

Movements (migration) and Habitat Use

Movements of kokanee within the lake environment are influenced by: optimal temperatures and oxygen levels, food sources, and avoiding predators. In lakes, kokanee prefer water temperatures close to 10°C and inhabit surface waters as long as temperatures are around 10°C, or colder (Wydoski and Whitney 2003). As surface waters warm up in the summer, kokanee move to deeper and colder waters. For example, in Lake Tahoe in Northern California, kokanee are found most of the year at depths of less than 4 meters, but in July through September they concentrate at depths of 17 to 40 meters (Moyle 2002). In some lakes, kokanee display daily vertical movements in the water column, moving into warmer waters to feed at night and then down into colder waters during the day to digest their meals (Moyle 2002). Kokanee in the lake environment are also preyed upon by a variety of predators, such as bull trout and other piscivorous fish. Kokanee generally inhabit the pelagic areas of the lake and avoid the shorelines and benthic zones which are occupied by kokanee and bull trout.

When kokanee are ready to spawn they begin to move to the mouths of their natal streams, or specific lake shore areas, and stage for a short time to develop their spawning colors and shape. Optimal habitat for spawning contains cool temperatures, between 6 C and 13°C (Moyle 2002) and suitable gravel absent of fine sediment. Instream cover such as logjams, boulders, and debris piles provide good cover from predators for adults. Redds are placed in suitable gravel usually found at the tail-outs of pools or in shallow riffles. When fry emerge they migrate downstream at night and immediately into the lake. A kokanee study in Idaho documented significantly higher survival of eggs in areas of upwelling versus non-upwelling, although the upwelling sites had a higher percentage of fine sediment (Garret et al. 1998).

Threats to Survival

Historical information on abundance and distribution of kokanee is largely unknown. Past and current stocking of hatchery kokanee has increased their distribution in Washington. Though hatchery stocking of kokanee might have increased their abundance in some watersheds, it is possible this action may have replaced native populations as well. This compounds determinations on the stability of the species in Washington.

Like many native salmon and trout species in Washington State, losses in key habitat areas (e.g., spawning, rearing, and adult habitat) will negatively affect the ability of a native population to persist. In Lake Whatcom, habitat issues include the loss of suitable spawning habitats in major tributaries from timber harvest and overall residential development (WCWR 2003). Threats to survival include habitat degradation and fragmentation caused by timber harvesting, road building, urbanization, agricultural practices, and general pollution of waterways.

In the Lake Washington basin a number of factors are likely responsible for the historical decline of native kokanee. These factors include: (1) hatchery outplanting programs and resulting genetic introgression; (2) widespread habitat loss and degradation; (3) trapping programs conducted by WDF; (4) blocked upstream passage by artificial barriers and low flows; (5) shifts in zooplankton densities and composition in Lake Washington and Lake Sammamish; (6) disease; (7) predation and competition from non-native fish species, including *O. nerka* from other basins; and (8) sport-fishing pressures (King County 2000).

Kokanee hatchery practices, loss of migration corridors, loss of riparian zones, water withdrawl, urbanization and agriculture can all affect kokanee. The stocking of one strain of kokanee into systems that historically had several can homogenize the overall population. This can reduce the genetic variability and make them more susceptible to diseases. The stocking of non-native piscivorous fish species, such as bass, can reduce native populations and affect the survival rates of kokanee. Also, increased fishing pressure can contribute to mortality of kokanee.

The NMFS listed the Lake Ozette sockeye as threatened under the ESA in 1999 (64 FR 14529). Kokanee and sockeye occur in Lake Ozette but are substantially different genetically. The kokanee are generally a tributary spawner and the sockeye are predominately a beach spawner in the lake. One of the threats identified for the Lake Ozette sockeye was forest practice activities contributing to widespread sedimentation of lake tributaries, lakeshore spawning beaches, and outwash fans. Although past logging practices may not have been directly linked to sockeye declines, those past practices contributed to the failure of sockeye to rebuild after commercial harvest ended (64 FR 14529). Kokanee may also have been affected by past logging practices in this watershed.

8.5.4.2 Environmental Baseline (within the FPHCP Action Area)

Currently, Washington State maintains numerous populations of kokanee by hatchery rearing and stocking throughout the state. Lake Whatcom kokanee are used as an egg source for stocking programs throughout the state (Wydoski and Whitney 2003). There is also concern, however, that some native populations, such as populations within the Lake Washington/ Lake Sammamish Basin, are in need of protection (Berge and Higgins 2003). This watershed, however, is not going to be substantially influenced by the proposed action. We are currently unaware of population trend or abundance figures for the populations of kokanee in Washington.

Role of the FPHCP Action Area for Conservation of the Species:

Kokanee occur throughout much of the FPHCP Action Area and have a high likelihood of being influenced by the FPHCP. The FPHCP Action Area provides an important conservation role for kokanee. High quality aquatic habitats within the FPHCP Action Area will contribute to the long-term survival of kokanee.

8.5.4.3 EFFECTS OF THE ACTION

General habitat effects to kokanee resulting from the proposed action have been summarized above for the Lentic and Low-gradient Guilds.

Riparian prescription effects to Kokanee

Full riparian and in-stream function likely would not be provided to all habitats occupied by kokanee. In some stream reaches, the highest quality and most structurally complex habitats may fail to develop due to the potential reduction of large wood recruitment to streams at different time scales and following different riparian management prescriptions. For example, although the FPHCP would provide the majority of available large wood adjacent to fish-bearing streams, the FPHCP allows some trees within these large wood recruitment zones to be harvested. In addition, stream-adjacent parallel roads, unbuffered areas in Type Np streams, yarding corridors, and road crossings could reduce potential large wood recruitment. Excessive windthrow could affect some riparian processes. The reduction of large wood over long time frames may not allow processes to form some habitats (pools, riffles, and hiding cover) that kokanee use. Large wood influences pool formation which is important during certain life history stages for kokanee. Large wood also provides hiding cover, sorts and releases spawning gravels, and provides numerous other important biological and physical processes. Less structurally complex habitat may reduce densities of kokanee. Less complex habitat may also affect survival of individual fish through increased competition or predation. Degradation of Type Np stream riparian areas and stream habitat could also alter the availability of terrestrial and aquatic invertebrates, which are an important food source for Kokanee at all life stages.

When RMZs achieve their Desired Future Condition, streams on FPHCP covered lands that are occupied by kokanee would receive most of the potentially available shade. There are physical situations (yarding corridors, stream-adjacent parallel roads, stream crossings, 20-acre exemptions, and windthrow) where stream shading potential would reduced. Along Type Np streams, reductions in shade are likely to occur and water temperature may increase over limited distances as a result of these unbuffered Type Np streams. In some cases, increases in temperature may be delivered downstream to Type F waters and temperatures could be warmed near the confluence of Type Np and F streams. In these circumstances, there could be negative effects to Kokanee due to potentially elevated stream temperatures and loss of thermal refugia resulting in impairment of foraging, rearing, and spawning behaviors. Increased temperatures may result in a competitive advantage for certain species, which could affect individual fish.

Sediment effects to kokanee

Sediment would be delivered to kokanee habitat from road surface erosion. When FPHCP activities affect certain watershed features, such as steep unstable slopes, there may be additional sediment delivered to fish- bearing streams that are above natural background rates. Increased sediment could result in changes to channel morphology, and kokanee habitat could be reduced due to shallowing and filling of pools. Feeding behavior may be affected under some circumstances affecting individual fish fitness and survival. Siltation of spawning reaches could reduce egg survival. However, the FPHCP is not expected to significantly contribute to instream sediment loading to the point that Kokanee would be impaired at more than a stream reach scale. Often, effects might be limited to a habitat unit (pool, riffle) or several units.

Culvert and bridge replacement or installation projects are expected to provide a chronic source of sediment, at least until vegetation has been re-established. When vegetation on culvert and bridge streambanks has been restored, the amount of sediment from road crossings are expected to decline. Short segments of stream are routinely dewatered for culvert installation or replacement and the chance for localized fish mortality increases with these projects.

Effects from the 20-acre Exemption Rule

Although there is uncertainty regarding how often this rule would be implemented, when it is implemented the 20-acre Exemption Rule would adversely affect kokanee. In watersheds with a high proportion of 20-acre exempt landowners, this rule would increase the likelihood that large wood recruitment would be inadequate to maintain properly functioning habitat (USFWS & NMFS 2006). There is also the potential for increased sedimentation, reduced shade, increased stream temperatures, and increased windthrow. Where adverse effects occur, essential behaviors associated with foraging, reproduction and growth may be impeded, Kokanee may occupy the stream at reduced levels, and may have reduced survival.

Summary of adverse effects to kokanee

The proposed action could have short- to long-term adverse effects on sediment, large wood, and temperature. These effects would be most severe from unbuffered Type Np streams and their associated downstream effects that result in disruption of natural riparian and aquatic processes and functions. These effects to the aquatic environment may result in impairment of essential foraging, rearing, and spawning behavior of kokanee. It is difficult to predict the severity of these effects because effects to these fish will vary from activity to activity depending on the specific riparian prescriptions applied, the location, historical management practices, geological characteristics of the watershed, and the biotic community present.

Activities covered under the FPHCP are expected to have direct and indirect adverse effects to adult and juvenile kokanee ranging from mortality to sublethal effects. Direct injury and death to kokanee could likely occur during some crossing construction (stream dewatering and fish rescue and relocation, and blockage of upstream migration during construction). Alterations of the riparian and aquatic environment could reduce the ability of streams to support prey species, thus reducing the fish's ability and success at finding forage in these streams. In a degraded environment increased competition with and predation by other species is anticipated. This could affect the growth and survival of juvenile and adult kokanee.

Summary of beneficial effects

The long-term benefits of the FPHCP for kokanee would occur as riparian areas mature, roads are managed with watershed processes in mind, adaptive management is implemented, and kokanee passage is maintained and restored. The FPHCP's incorporation of BMPs and RMAPs would substantially reduce road surface erosion to kokanee habitat. Most adverse effects are associated with the downstream effects from RMZs on Type Np streams and the where the 20-acre exemption rule is implemented. Effects are not expected to significantly decrease the distribution of kokanee in the FPHCP Action Area. The FPHCP is not expected to significantly contribute to habitat degradation to the point that kokanee would be harmed at more than a stream reach scale. Often, effects might be limited to a habitat unit (pool, riffle) or several units.

8.5.4.4 CUMULATIVE EFFECTS

Cumulative effects were addressed in the **Comprehensive Cumulative Effects**, with respect to the aquatic and riparian environment in Washington State. Additional information regarding cumulative effects for the covered fish species was presented in the section **Lentic and Low gradient Tributary Guilds: Cumulative Effects.**

8.5.5 Mountain Whitefish (*Prosopium williamsoni*) and Pygmy Whitefish (*Prosopium coulteri*)

8.5.5.1 Status of the Species

Description of the Species

The mountain whitefish is a slender, silvery (olive green to dusky on back), fish with a forked tail and a short, pointed head (approximately 20 percent of the total length) (Moyle 2002). They have large scales which may have pigmented borders with 74 to 90 scales along the lateral line (Scott and Crossman 1973). It has a small subterminal toothless mouth (Moyle 2002), and has a single nose flap between nostrils (Scott and Crossman 1973). Mountain whitefish can live up to 15 years (McPhail and Troffe 1998). The largest mountain whitefish recorded in Washington was 530 millimeters and weighed 2.3 kilograms (Wydoski and Whitney 2003). Spawning adults will develop nuptial turbercles along their heads, backs, and sides (Moyle 2002). Juvenile mountain whitefish are silver with two or more rows of black spots on their sides (Scott and Crossman 1973). One row is along the lateral line consisting of seven to eleven large parr marks (Moyle 2002), while another row of spots is along their back.

The pygmy whitefish is a small (average size 12 to 15 centimeters, with a maximum size around 280 centimeters), cigar-shaped fish with silvery sides and brown back. Individuals less than 10 to 12 centimeters have 7 to 14 distinct dark parr marks along the lateral line (Mackay 2000). They have relatively large scales, (50 to 70 along the lateral line), and large eyes (Mackay 2000). Their head is longer than the body depth with a mouth posterior to the tip of the snout. Spawning individuals will develop nuptial tubercles on their head, backs, sides and pectoral fins, with the ventral fins becoming orange (Mackay 2000).

Historic and Current Distribution

The mountain whitefish has a broad distribution across the western United States and British Columbia and Alberta, Canada. In Washington, it is currently distributed throughout the Puget Sound Basin, the lower, mid and upper Columbia Basin, Snake River Basin, and the Chehalis and Coastal River Basins (Wydoski and Whitney 2003).

The pygmy whitefish has a distribution across northern North America including Canada and Alaska (Wydoski and Whitney 2003). The pygmy whitefish was historically located in 15 lakes in Washington, but current distribution is now limited to 9 lakes (Table 8-37) (Hallock and Mongillo 1998). Washington is at the southern end of its range. The pygmy whitefish has no sport or commercial value (Hollock and Mongillo 1998).

Table 8-37. Historic and current distribution of pygmy whitefish.

Lake	County	Past	Presence Current
Bead	Pend Oreille	Yes	Yes
Buffalo	Okanogan	Yes	No
Chelan	Chelan	Yes	Yes
Chester Morse	King	Yes	Yes
Cle Elum	Kittitas	Yes	Yes
Crescent	Clallam	Yes	Yes

Table 8-37. Historic and current distribution of pygmy whitefish. (continued)

Diamond	Pend Oreille	Yes	No
Horsehose	Pend Oreille	Yes	No
Kachess	Kittitas	Yes	Yes
Keechelus	Kittitas	Yes	Yes
Little Pend Oreille Lakes	Stevens	Yes	No
Marshall	Pend Oreille	Yes	No
North Twin	Ferry	Yes	No
Osoyoos*	Okanogan	Yes	Yes
Sullivan	Pend Oreille	Yes	Yes

*Partially located in Canada.

Essential Habitat Components

Mountain whitefish

Although mountain whitefish can be quite numerous and range throughout much of the state and occupy lakes, rivers, and streams, very little is known about their essential habitat components. Generally, mountain whitefish require different habitat types during the different stages of their lives, such as spawning, rearing, foraging and over-wintering habitats.

For spawning, mountain whitefish require gravel, cobble, or rocky reaches of streams or lake shoals to lay their eggs (Wydoski and Whitney 2003). Spawning habitats between 4.4 and 7.2°C are chosen (Wydoski and Whitney 2003). As the eggs hatch, mountain whitefish fry will move into shallow, low velocity habitats such as depositional areas to spend their first summer (McPhail and Troffe 1998). Zero age mountain whitefish in the Yakima Basin have been found at depths of 0.37 meters and a current of 0.27 meters/second (Wydoski and Whitney 2003). As they increase in size, juvenile mountain whitefish will move into deeper, faster water (McPhail and Troffe 1998). Adults will occupy riffle habitats in summer feeding on benthic invertebrates (Wydoski and Whitney 2003). They also occupy clear and cool (9 to 11°C) (Wydoski and Whitney 2003) streams with pools deeper than 1 meter and live close to the bottom (Moyle 2002). They are also found in large schools over gravel bars at the mouths of tributary streams.

Pygmy whitefish

Pygmy whitefish occupy deep, unproductive (oligotrophic) lakes where water temperatures are 10°C and below (Wydoski and Whitney 2003). They are considered a glacial relict (Mackay 2000). Adults do not make extensive migrations to spawn, forage, and over-winter (Wydoski and Whitney 2003). They are found at depths of 0.7 to 92 meters in Washington (Hallock and Mongillo 1998), and 50 to 170 meters in Canada (Mackay 2000). Spawning habitats are usually in moderate to swift stream velocities in silty or clear streams (Wydoski and Whitney 2003). Zero-age fish have been found in both open water and nearshore habitats (Hallock and Mongillo 1998).

Reproductive Ecology

Mountain whitefish mature at 3 to 4 years of age (Wydoski and Whitney 2003). Spawning in Washington is usually in the fall from September to December (Wydoski and Whitney 2003). Adults exhibit pre-spawn movements into pools 2 meters deep or deeper (Wydoski and Whitney 2003) as temperatures begin to drop (Moyle 2002). Adults do not prepare gravel like salmon and trout do. Instead they select course gravel, cobble, or rocks less than 500 millimeters in diameter to scatter their eggs, which are not adhesive (Moyle 2002). Eggs will then fall into the interstitial spaces between the rocks to develop. Preferred spawning temperatures are between 4 and 7°C (Wydoski and Whitney 2003), with high embryo mortality occurring above 9°C (Moyle 2002), and peak spawning occurring at 6°C (McPhail and Troffe 1998). Spawning usually takes place in shallow (less than 3 meters in depth) stream riffles or runs, or possibly along stretches of rocky shoals that have high wave action (Wydoski and Whitney 2003). Spawning often takes place at dusk or at night (Moyle 2002). After spawning, adults migrate to over-wintering areas. Fry emerge after approximately 150 days, usually in late April to early May, often in conjunction with high spring flows (McPhail and Troffe 1998).

Male pygmy whitefish mature at one to two years of age and are between 60 to 80 millimeters in length, and females mature from one to three years and are between 70 to 230 millimeters in length (Mackay 2000). Adults spawn in the riffles of rivers and streams, or the shorelines of lakes (Wydoski and Whitney 2003). Spawning occurs from late summer to early winter depending on location (Wydoski and Whitney 2003). Adults scatter their eggs over coarse gravel (Hallock and Mongillo 1998) in temperatures between 0 and 4°C (Wydoski and Whitney 2003). Lake dwelling populations can usually complete spawning within a three week period (Hallock and Mongillo 1998). Adult female pygmy whitefish have been found to spawn in consecutive years (Hallock and Mongillo 1998). After spawning, adults will move downstream back into the lake to over-winter.

Movements and Habitat Use

Adult mountain whitefish in Alberta, Canada, exhibit extensive and complex movements that are associated with spring and summer feeding, pre-spawning, spawning, and post-spawning activities (Wydoski and Whitney 2003). Adults will migrate from summer foraging habitats to pre-spawning areas (McPhail and Troffe 1998). These pre-spawning migrations can either be upstream or downstream movements into mainstem rivers or into lower reaches of large tributaries (McPhail and Troffe 1998). From large rivers, mountain whitefish may also move upstream into smaller tributaries to spawn (Moyle 2002). The pre-spawning movements are generally made into pools that are approximately 2.0m or greater in depth (Wydoski and Whitney 2003). From there, the adults move into riffles or runs to spawn (Wydoski and Whitney 2003). After spawning, adults will migrate to over-wintering habitats, which can be 4.5 to 10.5 miles from the spawning grounds (Wydoski and Whitney 2003). Within the upper Columbia River Basin in Canada, mountain whitefish have been documented with fidelity to specific foraging sites (McPhail and Troffe 1998). This has also been shown from the McGregor River, Canada, where mountain whitefish were tagged at a summer foraging site and then recaptured the next year at the same site (McPhail and Troffe 1998). This implies a year-to-year site fidelity in adult mountain whitefish with occasional short-term shifts to different environments, for example spawning and over-wintering habitats (McPhail and Troffe 1998).

Mountain whitefish fry must also move to preferred habitat types. After drifting downstream, young-of-year mountain whitefish will select low velocity, shallow depositional areas along the margins of streams (McPhail and Troffe 1998). In the Columbia River in Canada, fry have actually been documented moving upstream to preferred habitats (McPhail and Troffe 1998). As juvenile mountain whitefish increase in size they gradually begin to move into deeper and faster habitats (McPhail and Troffe 1998).

Pygmy whitefish do not make extended migrations to spawning or over-wintering/foraging habitats (Wydoski and Whitney 2003). They primarily make short local movements from the lake into a selected tributary to spawn (Wydoski and Whitney 2003). They require cold water in mountainous regions that has moderate to swift velocity (Hallock and Mongillo 1998). They are categorized as a cold water stenotherm (narrow temperature range). Within the lake environment, they are generally separated from other whitefish (Mackay 2000), and occupy depths of 30 meters or greater (Wydoski and Whitney 2003).

Threats to Survival

Mountain whitefish

Due to the activities of man in the last 150 years, most native fish populations throughout the state have been substantially reduced. Land use practices, urbanization, pollution, overfishing, and the introduction of exotic species have all had detrimental effects on native fish assemblages throughout the state. Mountain whitefish occur in the same habitats as other native fish, such as salmon, trout, and char, and it is likely they too have been affected by the actions of man. Due to their migration patterns they can have populations fragmented by dams and other man made barriers. Increased sediment into spawning areas can increase embryo mortality. Removing riparian habitat, which influences water temperatures, can create thermal barriers and decrease egg to emergent survival. Many of the native fish populations face similar problems and whitefish are no exception. However, is it unclear to the extent these actions have had on populations of mountain whitefish. We are unaware of historic mountain whitefish population size, and information on current populations is also lacking.

Pygmy whitefish

Pygmy whitefish previously occupied 15 lakes, but are now known to occur only in 9 lakes in Washington State (Hallock and Mongillo 1998). The main reason for their decline has been the use of fish killing piscicides in the 1950's, used to eradicate non-favorable species (Hallock and Mongillo 1998). The introduction of exotic species which prey on the small pygmy whitefish, such as largemouth and smallmouth bass, were also responsible for their decline (Hallock and Mongillo 1998).

Water temperatures greater than 10°C and dissolved oxygen levels less than 5 mg/l may limit pygmy whitefish habitat (Hallock and Mongillo 1998). Poor water quality combined with introduced exotic species may also be responsible for the elimination of pygmy whitefish (Hallock and Mongillo 1998). Two populations of pygmy whitefish in Alberta, Canada, may be potentially affected by warming that has occurred since the last ice age. Warmer water temperatures in these two lakes may eventually force pygmy whitefish to compete with other species (Mackay 2000). Siltation of spawning sites from forest management practices, and increased development, could cause abandonment of spawning areas or disrupt spawning migrations (Hallock and Mongillo 1998).

8.5.5.2 ENVIRONMENTAL BASELINE (within the FPHCP Action Area)

Currently, 9 lakes are known to contain pygmy whitefish and it is currently suspected that there are no other lakes in the state with the species (Hollock and Mongillo 1998). Of the 9 lakes, 4 are predominately surrounded by Federal Lands and are only minimally affected by proposed action: Lake Crescent, Lake Chelan, Lake Sullivan, and Bead Lake. The following 3 lakes are influenced through Federal and private land management activities, some of which will likely be the FPHCP: Cle Elum Lake, Kachess Lake, and Keechelus Lake. Lake Chester Morse is managed under the City of Seattle HCP (2000) and is not subject to the proposed action. Lake Osoyoos is primarily surrounded by lands not managed under the proposed action, although it is within a watershed that has lands that will be managed under the proposed action. Pygmy whitefish population status within these 9 lakes is currently unknown. Lake Osoyoos and its watershed may be the most prone to development and management activities that are not favorable to the species.

The mountain whitefish has a broad distribution in Washington and is abundant in some areas (Wydoski and Whitney 2003). The WDFW classifies whitefish as a "game fish" and currently allows 15 whitefish to be caught daily of no minimum size. The majority of angling apparently targets mountain whitefish, although there is no discernment between the two species in WDFW fishing regulations (WDFW 2005). The mountain whitefish population appears to be stable in the FPHCP Action Area.

Role of the FPHCP Action Area for the Conservation of the Species:

The FPHCP Action Area encompasses a significant portion of both species distribution in Washington. As described above, a considerable portion of the pygmy whitefish distribution is associated with Federal lands, and as such, is outside of the FPHCP Action Area. The FPHCP Action Area will provide a moderate role in the conservation of the pygmy whitefish. The mountain whitefish, however, has a substantial overlap of its distribution with the FPHCP Action Area. The FPHCP Action Area will provide a substantial role in the conservation of the mountain whitefish.

8.5.5.3 EFFECTS OF THE ACTION

General habitat effects resulting from the proposed action have been summarized above for the mountain whitefish in the Low Gradient and Mainstem Guilds. Effects to the pygmy whitefish are summarized in the Lentic Guild.

Riparian prescription effects to whitefish

Full riparian and in-stream function likely will not be provided to all habitats occupied by whitefish. In some stream reaches, the highest quality and most structurally complex habitats may fail to develop due to the potential reduction of large wood at different time scales and following different riparian management prescriptions. For example, although the FPHCP will be providing the majority of available large wood adjacent to fish-bearing streams, the FPHCP allows some trees within these large wood recruitment zones to be harvested. In addition, stream-adjacent parallel roads, unbuffered areas in Np streams, yarding corridors, and road crossings would likely reduce potential large wood recruitment. Excessive windthrow could affect some riparian processes. The reduced potential of large wood over long time frames may not allow recruitment processes to form some habitats (pools, riffles, or hiding cover) that whitefish use. Large wood influences pool formation which is important during certain life history stages for whitefish. Large wood also provides hiding cover, sorts and releases spawning gravels, and provides numerous other important biological and physical processes. Less structurally complex habitat may reduce densities of whitefish. Less complex habitat may also influence survival of individual fish through increased competition or predation. Degradation of riparian areas and stream habitat could also alter the availability of terrestrial and aquatic invertebrates, which are an important food source for whitefish at all life stages.

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Both species of whitefish require cool water for survival. Water temperatures greater than 10º C and dissolved oxygen less than 5 mg/l in deep water zones of lakes may limit pygmy whitefish habitat (Hallock and Mongillo 1998). Water temperatures $<7°$ C are used for spawning by both species in the fall, when air and water temperatures are declining. When RMZs achieve their Desired Future Condition, streams within the areas covered by the FPHCP that are occupied by whitefish will receive most of the potentially available shade. There are physical situations (yarding corridors, stream-adjacent parallel roads, stream crossings, 20-acre exemptions, and windthrow) where stream shading potential may be reduced. Along Type Np streams, reductions in shade are likely to occur and water temperature may increase over limited distances as a result of these unbuffered Type Np streams. In some cases, increases in temperature may be delivered downstream to Type F waters and temperatures could be warmed near the confluence of Type Np and F streams. In these circumstances, there could be negative effects to whitefish due to potentially elevated stream temperatures and loss of thermal refugia resulting in impairment of foraging, rearing, and spawning behaviors. Increased temperatures may result in a competitive advantage for certain species, which could affect individual whitefish.

Sediment effects to whitefish

Sediment would be delivered to whitefish habitat from road surface erosion. When FPHCP activities affect certain watershed features, such as steep unstable slopes, there may be additional sediment delivered to fish-bearing streams that are above natural background rates. Increased sediment could result in changes to channel morphology, and whitefish habitat could be reduced due to filling of pools. Feeding behavior may be affected under some circumstances affecting individual fish fitness and survival. Siltation of spawning reaches could reduce egg survival. However, the FPHCP is not expected to significantly contribute to instream sediment loading to the point that whitefish would be impaired at more than a stream reach scale. Often, effects might be limited to a habitat unit (pool, riffle) or several units.

Culvert and bridge replacement or installation projects are expected to provide a chronic source of sediment, at least until vegetation has been re-established. When vegetation on culvert or bridge streambanks has been restored, the amount of sediment from road crossings are expected to decline. Short segments of stream are routinely dewatered for culvert installation or replacement and the chance for localized fish mortality increases with these projects.

Effects from the 20-acre Exemption Rule

Although there is uncertainty regarding how often this rule would be implemented, when it is implemented the 20-acre Exemption Rule would adversely affect whitefish . In watersheds with a high proportion of 20-acre exempt landowners, this rule would increase the likelihood that large wood recruitment would be inadequate to maintain properly functioning habitat (USFWS & NMFS 2006). There is also the potential for increased sedimentation, reduced shade, increased stream temperatures, and increased windthrow. Where these adverse effects occur, essential behaviors associated with foraging, reproduction and growth may be impeded, and whitefish may occupy the stream at reduced levels and they may have reduced survival.

Summary of adverse effects to whitefish

The proposed action will have short- to long-term adverse effects on sediment, large wood, and temperature. These effects would be most severe from unbuffered Type Np streams and their downstream effects that result in disruption of natural riparian and aquatic processes and functions in Type F streams. These effects to the aquatic environment may result in impairment of essential foraging, rearing, and spawning behavior of whitefish. It is difficult to predict the severity of these effects because effects to these fish will vary from activity to activity depending on the specific riparian prescriptions applied, the location, historical management practices, geological characteristics of the watershed, and the biotic community present.

Activities covered under the FPHCP are expected to have direct and indirect adverse effects to adult and juvenile whitefish ranging from mortality to sublethal effects. Direct injury and death to whitefish would likely occur during some stream crossing construction activities (stream dewatering and fish rescue and relocation, and blockage of upstream migration during construction). Alterations of the riparian and aquatic environment could reduce the ability of streams to support prey species, thus reducing the fish's ability and success at finding forage in these streams. In a degraded environment increased competition with and predation by other species is anticipated. This could affect the growth and survival of juvenile and adult whitefish.

Summary of beneficial effects

The long-term benefits of the FPHCP for whitefish would occur as riparian areas mature, roads are managed with watershed processes in mind, adaptive management is implemented, and whitefish passage is maintained and restored. The FPHCP's incorporation of BMPs and RMAPs will substantially reduce road surface erosion to whitefish habitat. Most adverse effects are associated with the downstream effects from RMZs on Type Np streams and where the 20-acre exempt rule is implemented. Effects are not expected to significantly decrease the distribution of the redband or whitefish in the FPHCP Action Area, because the FPHCP is not expected to significantly contribute to habitat degradation to the point that whitefish would be harmed at more than a reach scale. Often, effects might be limited to a habitat unit (pool, riffle) or several units.

8.5.5.4 CUMULATIVE EFFECTS

Cumulative effects were addressed in the **Comprehensive Cumulative Effects**, with respect to the aquatic and riparian environment in Washington State. Additional information regarding cumulative effects for whitefish was presented in the section steep **Tributary and Low-gradient Tributary Guilds: Cumulative Effects.**

8.5.6 Pacific Lamprey (*Lampetra tridentata*),River Lamprey (*Lampetra ayresi*), Western Brook Lamprey (*Lampetra richardsoni*)

8.5.6.1 Status of the Species

Description of Species

Lampreys are eel-like in shape but lacking jaws and paired fins (Moyle 2002). They have cartilaginous skeletons, a single nostril and two semicircular canals in each side of the head (Moyle 2002). They generally have 7 small round gill openings on either side of their heads. In transformed or adult parasitic individuals, their tongues have sharp horny plates (Moyle 2002) which are used as identifying characteristics. Adult and metamorphed lampreys also have well developed eyes, whereas the larval form, or ammocoetes, has no eyes.

Pacific lamprey, as a spawning adult, is the largest of the three species of native lamprey, growing to over 400 millimeters in total length (Moyle 2002).

The distinguishing characteristic of an adult Pacific lamprey, besides their length, is the arrangement of the teeth in their sucker-like mouth. Their large supra-oral lamina has 3 cusps, the lateral teeth are in 4 pairs, and the posterior teeth are parallel to the margins of the mouth (Wydoski and Whitney 2003). The mid cusp is smaller than the two lateral cusps (Moyle 2002). The tongue also ends in 14-21 small points (Moyle 2002). The two dorsal fins are slightly separated in which the second dorsal fin is continuous with the caudal fin (Moyle 2002). Sexually mature females have a well developed ventral fin fold on the caudal oedema that resembles an anal fin. Male Pacific lamprey, do not develop this fin fold and have no anal fin (Wydoski and Whitney 2003). Adults also have 62-71 body segments (myomeres) (Moyle 2002). The dorsal fin in the male is higher than that of the female (Moyle 2002). The body and the lower half of the oral hood are usually dark in coloration and typically there is a pale area associated with a ridge in the caudal region (Moyle 2002). Spawning adults have dark coloration, sometimes a greenish black, with a pale or gold colored belly (Moyle 2002).

The river lamprey is relatively small as an adult, around 170mm, compared to the Pacific lamprey (Moyle 2002). As an adult, the river lamprey's supra-oral lamina has only two cusps, the lateral teeth are in three pairs, and there are no posterior teeth (Wydoski and Whitney 2003). Their body color is usually darker on their backs and sides with a silver to yellowish color on the belly (Moyle 2002). In spawning adults the two dorsal fins grow closer together and eventually join (Moyle 2002). They have an average of 68 myomeres in adults and 67 in ammocoetes (Moyle 2002). Ammocoetes heads are pale in coloration with a prominent line behind the eye spot (Moyle 2002).

The brook lamprey are also small (180 millimeters in total length) as adults (Moyle 2002). Their tooth plates are poorly developed and are the only native species of lamprey that is not parasitic. Their supra-oral plate has cusps at each end but not in the middle (Moyle 2002). There are 7-10 tooth-like cusps on the infraoral plate and 3 circumolar plates on each side of the mouth, the mid one with 2-3 cusps (Moyle 2002). They have 52-67 myomeres in adults as well as in ammocoetes (Moyle 2002). Their coloration is dark on the back with a yellow to white on the belly (Moyle 2002). Ammocoetes have dark pigmentation on their tail and on the head above the gill openings (Moyle 2002).

Cultural significance:

Pacific lampreys are an important religious food of indigenous people in the mid-Columbia River basin. Pacific lamprey also has medicinal value to tribal peoples. Lampreys continue to be a part of the tribal culture in the Pacific Northwest (Close et al. 2002).

Historic and Current Distribution

The historic distribution of Pacific lamprey encompassed the entire Puget Sound, Strait of Juan de Fuca, coastal areas, as well as the Columbia River Basin upstream to Kettle Falls and the Spokane River to the Spokane Falls (Wydoski and Whitney 2003). The Pacific lamprey has been found from Mexico to Alaska and Japan. It is also found in Idaho. In Washington, it currently is found in tributaries of the Columbia River to Chief Joseph Dam and upstream on the Snake River to Hells Canyon Dam (Wydoski and Whitney 2003). Pacific lamprey are found in most large rivers and streams along the coast and the Strait of Juan De Fuca, throughout Puget Sound, and parts of Hood Canal (Wydoski and Whitney 2003).

Historical distribution of river and western brook lamprey is unknown at this time. They most likely occupied rivers and streams throughout the Puget Sound, Strait of Juan de Fuca, coastal areas, Hood Canal and the Columbia River Basin. However with the construction of dams throughout the Columbia and Snake Rivers, lamprey populations were fragmented and upstream areas of spawning and suitable habitat were cut off, limiting a majority of the populations to the lower reaches of the Columbia and Snake Rivers. The Columbia River dams may not have had as much of an effect on the river lamprey in comparison to the Pacific lamprey because of its apparent preference to use areas closer to the ocean (Lee et al. 1997).

The current distribution of the river lamprey consists of rivers and streams along the coast from the mouth of the Columbia River to the mouth of the Hoh River, and throughout the Puget Sound (Wydoski and Whitney 2003). An adult was found below Easton Lake on the Yakima River in 1959, and several possible ammocoetes of the river lamprey were discovered on the South Fork Touchet River in 1993 (M. Hallock, Personal Communication, 2004).

The western brook lamprey is the only species of native lamprey that does not have an anadromous life form. Western brook lampreys live their entire lives in fresh water. Current distribution of the western brook lamprey is considered as occupying rivers and streams from the Hoh River south along the coast to the mouth of the Columbia River, upstream on the Columbia River to the Yakima River, including the Cowlitz and the Lewis Rivers, the Walla Walla and Touchet Rivers, and throughout the Yakima River (Wydoski and Whitney 2003).

Essential Habitat Components

Essential habitat components of native lampreys vary as to species and stage of development. However, ammocoetes from each of the three species are very difficult to distinguish and therefore life history descriptions and habitat requirements tend to be generalized for all species (Kostow 2002).

Essential to all three species of lamprey is that they require fresh, clean flowing water to spawn in. The Pacific and river lampreys are anadromous and therefore move into the marine environment to feed as developing sub adults (Beamish 1980; Beamish and Levings 1991; Kostow 2002; Moyle 2002; Wydoski and Whitney 2003), whereas the brook lamprey remains in fresh water throughout its entire life cycle (Graham and Brun 2002; Kostow 2002; Moyle 2002; Pirtle et al. 2003; Wydoski and Whitney 2003). All three species of lamprey also require freshwater habitat for rearing and overwintering.

The Pacific, river, and brook lampreys, as ammocoetes, prefer small substrates in coldwater streams for rearing such as mud and fine silt deposits (Kostow 2002; Moyle 2002; Wydoski and Whitney 2003). These conditions are generally located in backwaters and in quiet eddy along the banks of streams and rivers (Wydoski and Whitney 2003). The ammocoetes burrow into the fine silt and mud to hide from predators. The mud and silt also contains detritus, algae and diatoms that the ammocoetes filter feed on (Kostow 2002).

Overwintering has been observed in adult Pacific lamprey returning from the sea. Tagged lamprey were found to hid under rocks and were sedentary in pools for several months until they moved onto the spawning grounds (Kostow 2002).

The Pacific and river lamprey spend part of their life cycle within the marine environment (Beamish 1980; Beamish and Levings 1991). However it is not fully understood what types of habitat are being used during this phase of their life cycle. The Pacific lamprey has been collected at depths of 70 to 250 meters and up to 10 to 100 kilometers off shore (BioAnalysts 2000). In the marine environment, the river lamprey has been found to utilize surface waters in which they feed from, and are not found in mid or deep water areas (Beamish 1980).

Reproductive Ecology

All three species of lamprey require fresh, clean flowing water for spawning. The western brook lamprey is the only species that remains in freshwater its entire life, while the Pacific and river lamprey move into the marine environment during part of their life cycles (Beamish 1980; Beamish and Levings 1991; Kostow 2002; Moyle 2002). All species also spawn around the same time, from April to July. In general, all species seek out spawning areas in riffles or at the tail-outs of pools (Kostow 2002; Larson and Belchik 1998). Lampreys construct a nest which can be from 10 to 30 centimeters in diameter and 2.5 to 8 centimeters deep, by attaching their oral disks onto rocks and debris and moving downstream (Wydoski and Whitney 2003). Pacific lampreys lay from 34,000 to 238,400 eggs, river lampreys lay from approximately 11,000 to 37,000 eggs, and western brook lampreys lay approximately 1,000 to 4,000 eggs (Wydoski and Whitney 2003).

Substrate chosen to construct the nest is usually a composition of gravel and sand (Kostow 2002). Adult Pacific lampreys are the largest of the three and can spawn in larger substrates and faster water velocities than other native lamprey species (Pirtle 2003; Wydoski and Whitney 2003). Spawning takes place when the nest is completed and the female attaches herself to a rock upstream of the nest with her oral disk. The male then attaches his oral disk to her head or a nearby rock and wraps himself around the female and releases milt while the female released her eggs. The sticky fertilized eggs then fall into the nest and stick to rocks and are covered by sand and small sized gravel (Kostow 2002). After spawning the adult lampreys will die a short time after. However, adult Pacific lamprey still containing eggs have been captured in downstream traps, which could suggest the possibility of spawning a second time (Wydoski and Whitney 2003). After the ammocoetes hatch they will remain within the gravel for a few days. They then move into the current and begin a downstream search for suitable rearing habitat. The ammocoetes of all species are filter feeders and burrow tail first into fine sediment areas of sand and silt. Here they remain feeding on detritus and diatoms (Beamish and Levings 1991).

Movements and Habitat Use

Lampreys can exhibit various ranges of movement occupying many types of habitats throughout their lives. However for all species early life history (freshwater phase) descriptions tend to be generalized due to the difficulty in distinguishing each species ammocoetes from one another (Kostow 2002).

Ammocoetes movements can occur throughout the year and can be associated with both discharge patterns and transformation (Pirtle et al. 2003). High discharge events that can cause scouring will often displace ammocoetes from their sand and silt burrows. When lampreys have transformed into adults they actively swim upstream to their spawning grounds. This can often be many kilometers away from their adult feeding habitats, as with the Pacific and river lampreys.

Pacific and River Lamprey

The Pacific and river lampreys have very similar life cycles. Both are anadromous and often occupy the same types of habitat. Pacific and river lamprey ammocoetes both occupy habitats that contain soft substrates within rivers or streams to burrow in. It is unknown how long the river lamprey spends as an ammocoete (Wydoski and Whitney 2003; Moyle 2002). Pacific lamprey will spend between 4 and 7 years in fresh water (Wydoski and Whitney 2003). Both species as newly formed young adults then migrate downstream to the sea. Beamish and Levings (1991) found that migratory activity was closely associated with increases in discharge. Migration was also closely associated with time of day. Young adult Pacific lamprey migrate mainly at night (Wydoski and Whitney 2003; Beamish and Levings 1991). The river lamprey has been documented in moving both day and night with a possible preference for night (Moyle 2002).

In the marine environment Pacific and river lamprey have been documented in occupying different habitats. The Pacific lamprey have been collected from 10 to 100 kilometers offshore along the Oregon coast at depths of 800 meters, but are typically found between 70-250 meters (Wydoski and Whitney 2003). They remain in the ocean from 3-4 years (Beamish 1980). During their time in the ocean the young lamprey will begin their parasitic life phase. As opportunistic feeders, they will feed on many types of rockfish, cod, salmon, low-gradientfish and herring (BioAnalysts 2000). The river lamprey is rarely found at depths >50 meters (Beamish 1980), and only spend 4-5 months in the sea (Wydoski and Whitney 2003). River lamprey are also associated with low salinity, between 26-30 ppt (sea water is 39 ppt) (Wydoski and Whitney 2003). Beamish also found in British Columbia that river lamprey are found in the vicinity of major rivers and their distribution throughout the surface waters may indicate a preference for reduced salinities.

Western Brook Lamprey

The western brook lamprey remains in freshwater its entire life, only moving within the confines of its natal watershed. They tend to occupy smaller streams with lower gradients (Wydoski and Whitney 2003). During their lives western brook lampreys move very little, with most movement occurring during passive downstream movements after they leave their burrows (Kostow 2002). Western brook lamprey ammocoetes live for 3-4 years in Washington State and 4-5 years in British Columbia (Moyle 2002). Brook lamprey have been found to distribute themselves within a creek system according to size (Kostow 2002). The smaller ammocoetes migrate further upstream to finer sediment and shallower water while larger ones move downstream and choose coarser sandy substrates rich in organic matter and in deeper waters (Kostow 2002). After undergoing metamorphism, about 4 months, western brook lampreys enter deep burrows and become dormant (Kostow 2002). Unlike the Pacific and river lamprey, the western brook lamprey is temperature sensitive and will remain burrowed until the correct temperatures rise above 10°C (Kostow 2002). When temperatures are right the newly metamorphosed adults will emerge from their burrows and migrate short distances to find suitable spawning gravels. Unlike their counterparts, western brook lampreys as adults never feed. After spawning both the male and female die.

Threats to Survival

Pacific lampreys appear to have declined substantially from California to Washington (69 FR 77158). At Ice Harbor Dam on the lower Snake River, almost 50,000 were recorded in 1963. In 2001 the Pacific lamprey count dropped to 203, and in 2003 it was 1700. On the North Umpqua River at the Winchester Dam in Oregon, Pacific lamprey declined from a high of over 46,000 in 1996 to 15 in 1997 (69 FR 77158). Annual counts of Pacific lampreys at the Red Bluff Diversion Dam on the upper Sacramento River have declined from 38,492 in 1972 to 107 or less since 1996.

All lamprey species require cool, clean, connected and complex habitats similar to Pacific salmon and char for survival. Availability and accessibility of suitable spawning and rearing habitat may affect the amount of recruitment that occurs within a basin (Houde 1987, Potter et al. 1986, as cited in Stone et al. 2002). Close et al. (1995) identified four main causes that may account for declines in native lamprey: (1) poor spawning and rearing habitat, (2) pollution, (3) unfavorable ocean conditions which can reduce prey items, and (4) migration barriers (dams). The Fish and Wildlife Service in the recent 90 day finding (69 FR 77158) to not list lampreys in Washington state (and CA, ID, and OR) identified the above threats and also: 1) dewatering habitats occupied by ammocoete; 2) over harvest, 3)introductions of non-native fish.

Pacific lamprey have to survive up to 11 years before they spawn. They can spend to 6 – 7 years as ammocoetes, 1 -3 years in the marine environment, and up to 1 year in freshwater before they spawn. Fecundity is high, but in comparison to most salmonids they have to survive 2 to 3 times as long before they spawn. Western brook and river lamprey probably spawn 2 to 4 years sooner than Pacific lamprey, but must still survive a number of years before spawning.

Quality habitat during any stage of a lamprey's life cycle is critical in its development and maintenance of its population. Throughout Washington State increasing urbanization has impacted vital habitats for lamprey. Agricultural developments in river valleys may have also contributed to a reduction in habitat carrying capacity (BioAnalysts 2000). Lampreys tend to favor lower basin areas, with low gradient reaches (Kostow 2002). These areas generally have high urban, industrial, and agriculture development (Kostow 2002). They are also prone to sedimentation, which may be harmful to the ammocoetes. Removal of riparian vegetation, increased sedimentation, and irrigation withdrawals reducing streamflows and elevating temperature, are all results of increased development within the lower river reaches.

Pollution is also a possible cause in the overall decline in lamprey populations. However there has been some speculation that lampreys can tolerate poor water quality (Kostow 2002). How this tolerance relates to long term survival of populations is unknown. Decreased dissolved oxygen, elevated temperatures, DDT and other man made chemicals, and increased fecal coliform have all had negative affects upon other native fish species. Temperature may be one of the more important factors limiting lamprey success. The Pacific lamprey generally prefer temperatures lower than 20°C, while the western brook lamprey uses temperature to initiate emergence from their burrows (BioAnalysts 2000; Kostow 2002).

Ocean conditions are also a factor that can influence the populations of Pacific and river lamprey. The western brook lamprey does not have an ocean phase of its life cycle and remains within freshwater its entire life. However, other types of fish that have anadromous life cycles do contribute to the overall production of a watershed in which their bodies function as a nutrient transports. When they die and release their marine-derived nutrients into the system via decay, they provide food for many types of life forms within the watershed. Western brook lamprey as ammocoetes likely feed of the marine-derived nutrients in the forms of algae and detritus. The Pacific and river lamprey spend months to years within the marine environment, feeding and growing on various prey items from salmon to whales (Beamish 1980). If these types of food items are not as available due to unfavorable ocean conditions, then a reduction in the population could occur due to starvation. Ocean fisheries may also reduce prey items (BioAnalysts 2000).

The construction and current operations of dams may more directly impact the populations of native lamprey, as does many other in-water structures such as culverts, tide gates and hatchery weirs. Lamprey are unique among other native fish due to their ability to use their sucker mouths to climb natural barriers and penetrate headwater areas that are not available to other types of fish (Kostow 2002). However, they are unable to negotiate many types of artificial barriers. Lampreys are generally weak swimmers, they lack paired fins and have no jumping ability (Kostow 2002). Although they use fish ladders associated with dams, their passage efficiency is poor. They have difficulty where lips or gratings need to be crossed, areas where water velocity is higher, and areas that are lighted at night (Kostow 2002).

Reservoirs created by dams may also impact lamprey populations. Reservoirs may delay the downstream migration of young adults (BioAnalysts 2000). Longer passage time within a reservoir can increase encounters with native and non-native predators (BioAnalysts 2000). Juvenile lamprey can also get impinged on screens at dams used to bypass anadromous fish (BioAnalysts 2000). Road culverts can also become migration barriers to lampreys. The smooth surfaces of culverts, increased water velocities, and perched downstream ends can inhibit the upstream migration of adult lampreys.

Population dynamics of Pacific lamprey are unknown. Filter-feeding ammocoetes have a long (5-6 year) freshwater residence period that may benefit from increased nutrient input from salmonid carcasses. During this long larval stage, Pacific lamprey fall prey to a wide variety of species including trout, crayfish, and birds (Pacific States Marine Fisheries Commission 2000).

The Idaho Chapter of the American Fisheries Society determined that dams on the Columbia and Snake rivers, alteration of streams, and harvest of ammocoetes for use as bait by fisherman are the most serious threats to the Pacific lamprey in Idaho (IDAFS, as cited in Lee et al. 1997).

The limited amount of ecological information currently available about Pacific lamprey is insufficient to evaluate the species' population status in Washington State. However, in Oregon, this species is considered a species of concern, due primarily to its apparent widespread decline. Although the reasons for this decline are poorly understood, it is likely due to conditions both in oceanic and freshwater habitats; passage at hydroelectric and irrigation dams may also be a contributing factor throughout its range (Oregon Department of Fish and Wildlife 1996; Renaud 1997).

Notably, a related northern species, the Arctic lamprey (*Lampetra japonica*), faces significant mortality in late spring and summer when low stream levels leave burrowed ammocoetes (larvae) stranded in dry stream edges (Scott and Crossman 1973). Degradation of habitat due to scouring of stream bottoms by splash damming, water withdrawls, logging, grazing, and pollutants from urban and agricultural runoff may have contributed to this species' decline. Losses of wetlands, side channels, back eddies, and beaver ponds resulting from agricultural, forestry, or urban development practices or channelization from flood control affect the juvenile life stages. The lamprey's food supply can be reduced by high stream temperatures and lack of stream cover (Pacific States Marine Fisheries Commission 2000).

Historical practices in Washington of splash damming logs, clearcutting to the streambank, limiting or preventing fish migration, and removing large wood from streams, simplified stream channels to the detriment of aquatic species. While commonly reported as harming salmonid species, in all likelihood these past practices also degraded lamprey habitats. Complex aquatic and riparian habitats create in-stream diversity that larval lamprey and spawning lamprey require for long-term survival.

8.5.6.2 ENVIRONMENTAL BASELINE (within the FPHCP Action Area):

Pacific Lamprey:

Pacific lamprey abundance and distribution data in Washington is extremely limited (69 FR 77158). The following text is from the December 27, 2004, Federal Register for a 90 day finding on a Petition to List Three Species of Lampreys as Threatened or Endangered:

"Substantial declines in the distribution and abundance of Pacific lampreys in Washington have apparently occurred in tributaries of the Columbia and Snake Rivers, and in the Elwha River and Salt Creek on the Olympic Peninsula. R. Fuller (WDFW, in litt. 2004) indicates the species was more common in the 1980s, then declined in the 1990s, and has increased in counts in 2003 and 2004, although not to past levels. WDFW biologists noted this pattern of change in the Stillaguamish, Snohomish, Skagit, Green, Tolt, and Quillayute Rivers, Hood Canal, and the Strait of Juan de Fuca (R. Fuller, in litt. 2004). Pacific lamprey redds (a spawning nest formed by fish in a river bed where their eggs and sperm are deposited) and individuals have been observed less frequently in the past 10 years in streams and rivers of the Strait of Juan de Fuca (B. Vadas, Personal Communication, 2004).

Tribal elders of the Elwha Klallam Tribe report that Pacific lampreys were historically abundant in the Elwha River and other north Olympic Peninsula rivers, including the Pysht, Hoko, and Dungeness Rivers, and Salt Creek (Mike McHenry, Elwha Klallam Tribe, Personal Communication, 2004). Anecdotal information suggests current numbers may represent less than 5 percent of their historical observations (M. McHenry, Personal Communication, 2004). Only one Pacific lamprey (a juvenile in 2003) has been recorded on the Elwha River, below the dam, in the last 20 years (M. McHenry, Personal Communication, 2004).

In southwest Washington, Pacific lampreys are common in Mill Creek and in the Grays, Skamokawa, Elochoman, Abernathy, Germany, Kalama, South Fork Toutle, and Green Rivers (R.Fuller, in litt. 2004). In the 1960s, Pacific lampreys were common in the Chehalis River system (Nawa et al. 2003), and appeared to be more common on the coast than in the Puget Trough (R. Fuller, in litt. 2004). From 1997 to 2000, thousands of lampreys were trapped on the North Fork Toutle River, but numbers have declined from 2000 to 2004 (R. Fuller, in litt. 2004). Pacific lampreys have been documented in Cedar Creek and its tributaries (Pirtle et al. 2003), at the Speelyai Hatchery on the Lewis River (R. Fuller, in litt. 2004), and in streams near Franz Lake National Wildlife Refuge in Skamania County (Nawa et al. 2003).

In eastern Washington, Pacific lampreys historically occurred in numerous other basins, including the Spokane River and Asotin Creek (ACCDLSC 1995; Wydoski and Whitney 2003). The purported historical occurrence of Pacific lampreys in the mainstem Columbia River above Chief Joseph Dam and Grand Coulee Dam prior to their construction (BioAnalysts, Inc. 2000) is supported by historical documentation of remnant Pacific lamprey at Kettle Falls and in the Spokane River up to Spokane Falls (Wydoski and Whitney 2003).

Where historical information does exist for river basins (Walla Walla, Wenatchee, Tucannon, Asotin), Pacific lampreys were described as ‘‘abundant,’’ ‘‘common,’’ or ‘‘likely had large runs’’ (Service 1959; ACCDLSC 1995; G. Mendel, WDFW, Personal Communication, 1994, cited in Jackson et al. 1996; Lane and Lane cited in Confederated Tribes of the Umatilla Indian Reservation (CTUIR) 2004; Swindell cited in CTUIR 2004). In 1999, surveys found Pacific lamprey ammocoetes were absent from reaches in the Walla Walla River subbasin (Bronson cited in CTUIR 2004). Adult Pacific lampreys have not been documented in the Asotin Creek watershed since at least 1980, although small lampreys of unknown species have been observed (ACCDLSC 1995). A 2002 trapping study designed to capture emigrating Chinook salmon in the Entiat River found Pacific lampreys to be the most numerous species captured during the time of the study. Most outmigration of lampreys occurred during the highest stream flows of the trapping period (Service, in litt. 2002). Although Pacific lampreys are occasionally caught incidentally at a screw trap on the Tucannon River, lamprey production in this subbasin is considered low (Close 2000) because the population has rapidly declined since 1981 (G. Mendel, Personal Communication, 1994, cited in Jackson et al. 1996).

Pacific lampreys occur throughout the mid-Columbia and Snake Rivers and many associated river basins, including the Tucannon, Walla Walla, Yakima, Wenatchee, Entiat, and Methow Rivers. The Pacific lamprey distribution currently extends up to Chief Joseph Dam on the Columbia River, and to Hells Canyon Dam on the Snake River (Nass et al. 2003; CTUIR 2004).

Passage data from numerous mainstem Columbia (McNary, Rock Island, Rocky Reach, and Wells) and Snake River dams (Ice Harbor) suggest that, although annual numbers fluctuate widely at each project, there is a decreasing trend in the number of adult Pacific lampreys counted at each project (BioAnalysts, Inc. 2000). Data indicate that large declines occurred during the late 1960s and 1970s, and that current counts continue to be well below historical levels (Close et al. 1995; BioAnalysts, Inc. 2000; Corps 2003). For example, the number of adult Pacific lampreys counted at the fish ladder at Ice Harbor Dam on the Snake River declined from 50,000 in 1963 to approximately 1,700 in 2003 (Corps 2003).

Although adult lamprey counts have increased at Snake River dams (Ice Harbor, Lower Monumental, Little Goose, and Lower Granite) and Columbia River dams (McNary, Priest Rapids, Rock Island, Rocky Reach, and Wells) in recent years, they are still considered to be well below historical levels (Close et al. 1995; Corps 2003; BioAnalysts, Inc. 2004). For example, counts at Rocky Reach Dam have shown a decline from more than 17,000 adult Pacific lampreys in 1969 to an average of 330 between 1983 and 2001. However, counts increased to 1,842 and 2,521 adult Pacific lampreys in 2002 and 2003, respectively (BioAnalysts, Inc. 2004). Increased numbers of lampreys in recent years may be an artifact of increased sampling or due to increased food abundance in the ocean (BioAnalysts, Inc. 2000).”

Western Brook Lamprey:

Detailed population and distribution data for the western brook lamprey is not available. The following text is from the December 27, 2004, Federal Register for a 90 day finding on a Petition to List Three Species of Lampreys as Threatened or Endangered:

Although western brook lampreys were considered common in Washington in 1936 (Nawa et al. 2003), Morrow (1980) stated, without documentation, that the species ‘‘is not particularly abundant anywhere as far as is known.’’ The species’ known distribution includes parts of the Olympic Peninsula, including streams on the southern and western boundaries of the Olympic Peninsula, but not streams on the northern and eastern boundaries (Mongillo and Hallock 1997). In surveys conducted during the 1930s, western brook lampreys were collected on the Olympic Peninsula from the Quillayute, Queets, Quinault, Humptulips, Wynoochee, and Satsop Rivers, but not the Hoh River, and from Chimacum Creek (Mongillo and Hallock 1997; Cooper cited in R. Fuller, in litt. 2004). Mongillo and Hallock (1997) include the Hoh River in the distribution of the western brook lamprey because the species is found in the adjacent Quillayute and Queets Rivers. Other observed localities include coastal and Puget Sound streams, including the lower reaches of the Nisqually River (Cook-Tabor 1999), North Creek near Seattle, and Dry Creek in Mason County (Froese and Pauly 2004). This species has also been recently reported from the Nooksack River (R. Fuller, in litt. 2004), the North Fork and South Fork Chelatchie Creeks, and tributaries of Cedar Creek in the Lewis River watershed (Pirtle et al. 2003).

Historically, western brook lampreys were considered abundant in the Walla Walla River subbasin (Lane and Lane cited in CTUIR 2004; Swindell cited in CTUIR 2004). Numerous unidentified lampreys were documented as ‘‘abundant’’ at the Tumwater trap on the Wenatchee River in 1955 (Service 1959).

Western brook lampreys are known to occur in the Yakima and Walla Walla River Basins. While the abundance of the western brook lamprey is unknown, the populations in the Walla Walla River subbasin appear to be self sustaining (CTUIR 2004). In 1998, assessments of the Walla Walla River subbasin indicated that lampreys were present in 8 of 12 subwatersheds inventoried (Mendel cited in CTUIR, in litt. 2004). Although not identified to species, these individuals were assumed to be western brook lampreys because Pacific lampreys have not been documented in recent sampling efforts (Bronson cited in CTUIR 2004). Western brook lampreys are thought to be in the Entiat River (Phil Archibald cited in Service, in litt. 2004b). Small river or western brook lampreys were documented in Asotin Creek by Mendel and others (ACCDLSC 1995).

River Lamprey:

Detailed population and distribution data for the river lamprey is not available. The available data for this species is even less than for the other two species of lamprey in the FPHCP Action Area. The following text is from the December 27, 2004, Federal Register for a 90 day finding on a Petition to List Three Species of Lampreys as Threatened or Endangered:

In Washington, there are no historical distribution records for river lamprey, although the species probably occurred in most major rivers (Wydoski and Whitney 1979). Morrow (1980) stated, without documentation, that the river lamprey ‘‘does not appear to be particularly abundant anywhere within its range.’’ The current distribution of river lamprey includes rivers and streams along the coast from the mouth of the Columbia River to the mouth of the Hoh River, throughout Puget Sound, and in the Lake Washington basin (Wydoski and Whitney 2003), but not on the Olympic Peninsula (Mongillo and Hallock 1997). Two records (1931 and 1959) of river lamprey in Lake Cushman (Mongillo and Hallock 1997; S. Brenkman, Personal Communication, 2004), suggest this lake may have once supported an adfluvial (lake dwelling) population (Mongillo and Hallock 1997). The petition notes specimens were collected from the Bogachiel River in 1897, Lake Pleasant (date unknown), off the coast of Washington in 1999, and 4.0 miles (6.4 kilometers) off La Push, Washington in 2002. River lamprey ammocoetes were trapped in the 1980s in the lower reach of the Nisqually River, but no river lamprey population estimates or in-stream distribution information are available (Cook-Tabor 1999).

WDFW listed the river lamprey as a ‘‘State Candidate’’ in 1998 because of its uncertain status. Surveys are ongoing to determine if the species should be listed as State endangered, threatened, or sensitive (Wydoski and Whitney 2003; WDFW 2004).

River lampreys occur in the Columbia River and have been documented in the Yakima River basin. River lampreys were identified by the Pacific Northwest National Laboratory (2004) in the Hanford Reach of the Columbia River. Numerous unidentified lamprey species were documented as ‘‘abundant’’ at the Tumwater trap on the Wenatchee River in 1955 (Service 1959), but may have been either river or western brook lampreys. Also, small lampreys documented in Asotin Creek by Mendel and others (Mendel cited in ACCDLSC 1995) were not identified to species and may have been either river or western brook lampreys.

None of the three lamprey species in the FPHCP Action Area are listed under the ESA. Although none may currently be listed, there is still considerable cause for concern for the long-term survival for these species. Lampreys are important culturally and ecologically, but lack of public interest, or in some cases outright disdain for lampreys, has been partly responsible for their current status. There currently appears to be an overall population decline for the Pacific lamprey and some of the threats to this species may not be fully understood. There is a substantial lack of knowledge on life history ecology for the river lamprey and even less is known about its population status. Perhaps the population status of the western brook lamprey is the most stable, but yet, there are fundamental questions on its historical distribution, life history, and regional trends. The long-term outlook for lampreys are currently unknown, but a future listing under the ESA is not unlikely.

Role of the FPHCP Action Area in Conservation of the Species:

The FPHCP Action Area encompasses a significant segment of the lamprey distribution in Washington. Many of the aquatic ecosystems these species depends upon are not on Federal or previously approved HCP lands, but are distributed in areas that will be subject to the proposed action. For example, the Fish and Wildlife Service is conducting a lamprey habitat use and population dynamic study in Cedar Creek, a tributary to the Lewis River in southern Washington. Cedar Creek is substantially surrounded by, and potentially influenced by, the proposed action. This stream may be representative of other streams occupied by lampreys in that they may be largely influenced by the FPHCP. The lower gradient portions of many streams, and those that are commonly anticipated to be influenced by the proposed action, appear to encompass a substantial portion of the areas these lamprey species are likely to inhabit. Numerous suitable habitats for lampreys occur in the FPHCP Action Area. The role of the FPHCP Action Area for long-term conservation for lampreys appears to be significant.

8.5.6.3 EFFECTS OF THE ACTION

General habitat effects resulting from the proposed action have been summarized above for the Low-gradient Tributary and Mainstem Guilds. In addition to the effects analyzed above, lampreys may experience effects differently from other aquatic species due to their unique life history characteristics.

Effects of riparian prescriptions to lamprey

Full riparian and in-stream function likely would not be provided to all habitats occupied by Pacific, river and western brook lampreys. In some stream reaches, the highest quality and most structurally complex habitats may fail to develop due to the potential reduction of large wood recruitment to streams at different time scales and following different riparian management prescriptions. For example, although the FPHCP would provide the majority of available large wood adjacent to fish-bearing streams, the FPHCP allows some trees within these large wood recruitment zones to be harvested. In addition, stream-adjacent parallel roads, unbuffered areas in Type Np streams, yarding corridors, and road crossings will likely reduce potential large wood recruitment. Excessive windthrow could affect some riparian processes. Large wood in freshwater habitats is important for lamprey cover and for storing and releasing the appropriate sediment used for spawning by adults and for burrowing by ammocoetes. Because lamprey ammocetes spend an extensive period of time burrowed into silt, they are vulnerable to changes in stream morphology and hydrology that results in bedload movement. Lamprey habitat use has been positively correlated with pool forming large wood (Roni 2001). Under some circumstances, the FPHCP may not allow the highest quality lamprey habitats to develop and reduced densities of lamprey may result from this.

When RMZs achieve their Desired Future Condition, streams within the areas covered by the FPHCP that are occupied by lamprey will receive most of the potentially available shade. There are situations (yarding corridors, stream-adjacent parallel roads, 20-acre exemptions, and windthrow) where stream shading would be reduced from full ecological potential. Although little is know about the temperature requirements of lamprey, in some circumstances there may be negative effects to lampreys due to elevated stream temperatures. Along Type Np streams, reductions in shade are likely to occur and water temperature may increase over limited distances as a result of these unbuffered Type Np streams. In some cases, increases in temperature may be delivered downstream to Type F waters and temperatures could be warmed near the confluence of Type Np and F streams. In some circumstances, riparian processes associated with production of microscopic plant and animals that provide a forage base for the ammocetes could be affected by effects of the FPHCP to the riparian area.

Sediment effects to lampreys

Due to the long residency time that Pacific lampreys spend in freshwater, they are vulnerable to disturbances that alter natural sediment levels in nursery streams (Lee et al. 1997). Some ammocoetes require quality habitat in freshwater for up to six or seven years before they migrate to the ocean. In contrast, juvenile coho normally reside in freshwater for less than two years. Such an extended time in freshwater increases the chance that sediment causing disturbances, including bedload movement, could adversely affect juvenile lampreys. Water quality consistent with robust diatom production may also be key factor for survival (Lee et al. 1997).

At certain life history stages lamprey are most sensitive to excessive sedimentation of their streams. Ammocoetes in their burrows are filter feeders and depend upon microscopic plant and animal matter. Excessive sedimentation that negatively alters the processes associated with the production and consumption of these food items could negatively influence those individuals. Feeding behaviors may be affected and survival of lamprey could be reduced. Lamprey could be negatively influenced by hillslope erosion and road management related sediment. Although the FPHCP incorporation of BMP's and RMAP's will substantially reduce road surface erosion to lamprey habitats, roads are still expected to deliver sediment to lamprey habitats above natural background rates. Individual lampreys and their habitat could be affected from sediment, resulting in reduced egg and amoretti survival.

Increases in stream flow that cause bed scouring would potentially dislodge ammocoetes from their burrows (Close et al. 2002). In some situations, especially when multiple anthropogenic factors are working synergistically (rip rapped banks, increased road induced runoff, overall changes in hydrology) there would be increased stream flows, with possible dislodgement of lamprey larva. Dislodged larva have an increased risk of predation.

Implementation of the FPHCP requires fish passage for all fish. Under the FPHCP, roads and their associated crossing structures must be constructed and maintained to provide for fish passage at all life stages. Using steelhead as an indicator in the Columbia River basin, it is estimated that 50 percent of the historic range of the Pacific lamprey is blocked (Lee et al. 1997). While the construction of dams has often been found to limit Pacific lamprey passage (Moser and Close 2003), impassable culverts are also barriers.

Dewatering or reducing stream flow can adversely affect larva survival. Short segments of stream are routinely dewatered for culvert installation or replacement. Dewatering short sections of streams with lamprey ammocoetes present in the substrate will likely harm those in dewatered sections. Ammocoetes that are in their burrows may not be able to survive the extended duration of lack of water during culvert replacement.

Effects from the 20-acre Exemption Rule

Although there is uncertainty regarding how often this rule would be implemented, when it is implemented the 20-acre Exemption Rule would adversely affect lamprey. In watersheds with a high proportion of small landowners, this rule would increase the likelihood that large wood recruitment would be inadequate to maintain properly functioning habitat (USFWS & NMFS 2006). The potential for increased sedimentation and reduced shade also occurs. Frequently, these 20-acre parcels are lower in watersheds and likely would occur adjacent to habitats occupied by lampreys.

Summary of adverse effects

The proposed action will have short- to long-term adverse effects on sediment, large wood, and temperature. These effects would be most severe from unbuffered Type Np streams and their associated downstream effects that result in disruption of natural riparian and aquatic processes and functions. These effects to the aquatic environment may result in impairment of essential foraging, rearing, and spawning behavior of Pacific, river, and brook lamprey. It is difficult to predict the severity of these effects because effects to these fish will vary from activity to activity depending on the specific riparian prescription applied, the location, historical management practices, geological characteristics of the watershed, and the biotic community present. Because of the inherent and expected patchiness of lamprey habitat occupancy, adverse effects to lamprey from the FPHCP will vary in response to the lamprey's location in the watershed. An activity associated with the FPHCP may be detrimental to lampreys in some locations, but the same activity conducted in another location may have less of an impact to lampreys.

Activities covered under the FPHCP are expected to have direct and indirect adverse effects to amulets and adult lamprey ranging from mortality to sublethal effects. Direct injury and death to lamprey would likely occur during some stream crossing construction (stream dewatering and lamprey rescue and relocation, and blockage of upstream migration during construction). Alterations of the riparian and aquatic environment would reduce the ability of streams to support prey species, thus reducing the amulets ability to successfully forage in these streams. In a degraded environment increased predation by other species is anticipated. This could affect the growth and survival of amulets and adult lamprey.

Summary of beneficial effects

The long-term benefits of the FPHCP are expected to outweigh the short-term, negative affects to lamprey. The severity of individual effects to the three species of lamprey will vary from activity to activity depending on the location, past management practices, geological characteristics of the watershed, and the biotic community present. Effects are not expected to significantly decrease distribution of Pacific, river, and brook lamprey in the FPHCP Action Area. Maturation of riparian areas, restoring and maintaining lamprey passage, adaptive management, and improved road management practices are all expected from implementation of the FPHCP.

8.5.6.4 CUMULATIVE EFFECTS

Cumulative effects were addressed in the **Comprehensive Cumulative Effects**, with respect to the aquatic and riparian environment in Washington State. Additional information regarding cumulative effects for the covered fish species was presented in the section **Low-gradient Tributary and Mainstem Guild: Cumulative Effects.**

No additional information is available with respect to cumulative effects for this particular species above those cumulative effects already discussed earlier in this document.

8.5.7 Olympic mudminnow (*Novumbra hubbsi*)

8.5.7.1 Status of the Species

Description of Species

The Olympic mudminnow is found only in Washington State (Wydoski and Whitney 2003), and is the only representative member of the Umbridae (Mudminnow) family. It is a small fish with an average length 52 millimeters (Mongillo and Hallock 1999). It is olive-green or brown in coloration with faint vertical bars along its sides and a light underbelly. During the breeding season, the male becomes a dark brown to almost black color with iridescent blue-green, yellow or white bars along their sides. The Olympic mudminnow's fins are characterized by soft fin rays. Their dorsal and anal fins are approximately equal in size and are both set far back on the body. Their caudal fin is truncated or indented and they lack a lateral line. The upper jaw is nonprotactile and they lack a grove between the upper lip and the snout (Mongillo and Hallock 1999).

Historical and Current Range

Information on the historical distribution of the Olympic mudminnow is sparse. Fossils of the genus *Novumbra* have been unearthed in early-middle Oligocene Era deposits in the Columbia River drainage indicating that Olympic mudminnows may have been more widespread (Mongillo and Hallock 1999).

Currently, Olympic mudminnow are restricted to the southern and western lowlands of the Olympic Peninsula, the Chehalis and lower Deschutes River drainages, and south Puget Sound lowlands west of the Nisqually River (Mongillo and Hallock 1999). This distribution was dictated by the most-recent glacial event during the Pleistocene Era. There is also a population of Olympic mudminnow in the Cherry and Issaquah Creek drainages in Snohomish and King Counties. The WDFW does not consider these populations natural and suspects that these were introduced illegally via aquariums (Mongillo and Hallock 1999).

Essential Habitat Components

Olympic mudminnow are found in slow-moving streams, wetlands, and ponds (Mongillo and Hallock 1999). They require habitats composed of soft mud or silt substrates with little or no water flow and abundant aquatic vegetation (Mongillo and Hallock 1999). Olympic mudminnow can tolerate water temperatures between 0° and 28°C, but have a narrow tolerance for flowing water and salinity (Mongillo and Hallock 1999; Wydoski and Whitney 2003). Olympic mudminnow tend to avoid bright light by hiding under undercut banks and underneath vegetation (Wydoski and Whitney 2003). Olympic mudminnow are also restricted to the lowland areas due to their preference for slow moving streams and wetlands. Overall, Olympic mudminnow must have three main habitat characteristics: fine-silt substrate, wetlands or slow moving streams, and aquatic vegetation. Without these characteristics, their presence is unlikely.

Reproductive Ecology

Starting in late November, spawning often takes place over an extended period of time, with less spawning activity during the colder winter months and picking up again in March and lasting until mid June (Mongillo and Hallock 1999). April and May are peak spawning months for the Olympic mudminnow when water temperatures reach 10-18°C (Mongillo and Hallock 1999).

During the spawning season, males become very dark in coloration and develop thin vertical iridescent blue-green, yellow, or white bars along their bodies (Wydoski and Whitney 2003). The edges of their dorsal and anal fins also turn a light blue to white color (Mongillo and Hallock 1999). Males will set up territories approximately 110 centimeters long by 40 centimeters wide consisting of several clumps of vegetation. These territories are aggressively defended against intruders including young salmon and sticklebacks. When a female enters the territory the male and female display what is called a “wigwag dance”. If the female is receptive after the dance, they will move into one of the clumps of vegetation to spawn. Females will release one or two sticky eggs at a time that are fertilized by the male. The eggs are then deposited in the vegetation near the bottom where they begin to develop. Hatching takes place about 9 days later in water temperatures of 15-17°C. No parental care is provided the developing young. Young Olympic mudminnow seldom move and remain close to, or stuck to, the vegetation. In laboratory studies, fry disperse after about seven days (Mongillo and Hallock 1999).

Movements and Habitat Use

Currently there is no documentation on the movements or migrations of the Olympic mudminnow. Olympic mudminnow occupy ponds, bogs and wetlands that have little to no water flow. Occasional floods of these areas could disperse populations to new areas, but this would only be a passive movement and not an intended migration.

8.5.7.2 ENVIRONMENTAL BASELINE (within the FPHCP Action Area)

Within the FPHCP Action Area, Olympic mudminnow are restricted to the southern and western lowlands of the Olympic Peninsula, the Chehalis and lower Deschutes River drainages, and south Puget Sound lowlands west of the Nisqually River (Mongillo and Hallock 1999). There is also a population of Olympic mudminnow in the Cherry and Issaquah Creek drainages in Snohomish and King Counties, however, it is believed that these populations were introduced illegally via aquariums (Mongillo and Hallock 1999).

Currently 90 percent of the populations of Olympic mudminnow seem to be stable, while the other 10 percent are at some risk (Mongillo and Hallock 1999). Since they depend on healthy wetlands for their survival, and their range is very restricted, they are vulnerable to become threatened or endangered if their habitats are not conserved appropriately.

Role of the FPHCP Action Area for Conservation of the Species

Olympic mudminnow habitat occurs in the FPHCP Action Area. The FPHCP Action Area will contribute to the long-term conservation of the species.

8.5.7.3 EFFECTS OF THE ACTION

General habitat effects to the Olympic mudminnow resulting from the proposed action have been summarized above for the Lentic Guild.

Riparian prescription effects to Olympic mudminnow

No adverse effects to Olympic mudminnow habitat are expected from FPHCP riparian prescriptions.

Sediment effects to Olympic mudminnow

Sediment would be delivered to Olympic mudminnow habitat from road surface erosion. When FPHCP activities affect certain watershed features, such as steep unstable slopes, there may be additional sediment delivered to fish-bearing streams that are above natural background rates. Increased sediment could result in changes to channel morphology, resulting in a reduction in the available slow moving channel habitat preferred by Olympic mudminnow. Increases in sediment levels could smother aquatic vegetation and feeding behavior may be affected resulting in reduced individual fish fitness and survival.

Effects from the 20-acre Exemption Rule

Although there is uncertainty regarding how often this rule would be implemented, when it is implemented the 20-acre Exemption Rule would adversely affect Olympic mudminnow. In watersheds with a high proportion of 20-acre exempt landowners, this rule would increase the likelihood that large wood recruitment would be inadequate to maintain properly functioning habitat (USFWS & NMFS 2006). There is also the potential for increased sedimentation, reduced shade, increased stream temperatures, and increased windthrow. Where these adverse effects occur, essential behaviors associated with foraging, reproduction and growth may be impeded, and Olympic mudminnow may occupy the stream at reduced levels and they may have reduced survival.

Summary of adverse effects to Olympic mudminnow

The proposed action will have short- to long-term adverse effects on sediment, large wood, and temperature. These effects would be most severe from unbuffered Type Np streams and their downstream effects that result in disruption of natural riparian and aquatic processes and functions in Type F streams. These effects to the aquatic environment may result in impairment of essential foraging, rearing, and spawning behavior of Olympic mudminnow. It is difficult to predict the severity of these effects because effects to these fish will vary from activity to activity depending on the specific riparian prescriptions applied, the location, historical management practices, geological characteristics of the watershed, and the biotic community present.

Activities covered under the FPHCP are expected to have direct and indirect adverse effects to adult and juvenile Olympic mudminnow ranging from mortality to sublethal effects. Direct injury and death to Olympic mutinous would likely occur during some stream crossing construction activities (stream dewatering and fish rescue and relocation, and blockage of upstream migration during construction). Alterations of the riparian and aquatic environment would reduce the ability and availability of slow moving streams to provide suitable aquatic vegetation, thus reducing the fish's ability and success at finding forage in these streams. This could affect the growth and survival of juvenile and adult Olympic mudminnow.

Summary of beneficial effects

Any loss of habitat due to the FPHCP is expected to be limited, and not significantly affect the distribution of the species. Maturation of riparian areas, maintaining and restoring Olympic mudminnow passage, adaptive management, and improved road management practices are all expected from implementation of the FPHCP. Protection of aquatic vegetation; protection of associated wetlands, particularly along slow moving streams, and protection from introductions of non-native fish are important for conservation of the Olympic mudminnow. These management prescriptions are expected to contribute to increasing the likelihood of the long-term survival for the Olympic mudminnow in the FPHCP Action Area.

8.5.7.4 CUMULATIVE EFFECTS

Cumulative effects were addressed in the Comprehensive Cumulative Effects, with respect to the aquatic and riparian environment in Washington State. Additional information regarding cumulative effects for the covered fish species was presented in the section Lentic Guild: Cumulative Effects**.**

8.5.8 Chiselmouth (*Acrochelius alutaceus*)

8.5.8.1 Status of the Species

Description of Species

The chiselmouth is a member of the minnow (Cyprinid) family. Overall, it is drab in coloration, with a dark brown dorsal surface, and light brown sides with many black spots. The body is elongate (average size 150 to 180 millimeters), with a slender caudal peduncle (Scott and Crossman 1973). The caudal fin is distinctly forked and the body is composed of small cycloid scales. The head is blunt with a rounded, blunt snout. Its eyes are relatively large. The mouth is inferior with fleshy upper lips that cover a small cartilaginous plate. The lower lip is covered by a hard cartilaginous sheath with an almost straight cutting edge (Scott and Crossman 1973). In young fish, this cartilaginous edge is often rounded (Wydoski and Whitney 2003). The chiselmouth is the only minnow in Washington with a hard sharp plate on the lower jaw (Wydoski and Whitney 2003).

Historical and Current Range

The historic range of the chiselmouth is unknown at this time. Currently, the chiselmouth is found in the upper Columbia River and its tributaries in Eastern Washington, the Snake River and its tributaries, and the Cowlitz and the Wind River in the lower Columbia River (Wydoski and Whitney 2003).

Essential Habitat Components

Chiselmouth are known to inhabit rivers, streams, and lakes throughout their range (Wydoski and Whitney 2003). In Washington, they seem to prefer large, warm streams and rivers with slow currents, rather than lakes (Wydoski and Whitney 2003; Titus 1996). Juveniles have been associated with shallow pools with large substrate such as cobble and boulders, with no other cover (Wydoski and Whitney 2003). Chiselmouth seem better adapted to lotic rather than lentic environments (Titus 1996). Water temperatures in which juveniles were found ranged between 8.9° C to 29° C (Wydoski and Whitney 2003). Titus (1996) found that juvenile chiselmouth inhabited areas with little or no cover and that were unshaded.

Rosenfeld et al. (2001) typically found young-of-the-year and yearling chiselmouth in shallow backwaters with aquatic macrophytes, and often associated with other juvenile fish such as redside shiners, pikeminnows, and peamouth chubs. In general there is very little information and few studies addressing habitat use of chiselmouth (Titus 1996), and very little is known concerning habitat requirements and the factors that influence distribution (Rosenfeld et al. 2001).

Reproductive Ecology

There appears to be very little information on the reproduction of chiselmouth (Scott and Crossman 1973). Generally they begin spawning around late May and into July, with the peak in early June (Wydoski and Whitney 2003). At the time of spawning water temperatures are between 13 to 18°C (Wydoski and Whitney 2003). Both sexes reach maturity between 4 or 5 years of age and are about 250 millimeters in length (Wydoski and Whitney 2003). Eggs are deposited over rock, rubble or gravel substrates (Titus 1996). Chiselmouth eggs that were incubated at 18°C hatched in 6 days (Titus 1996). There is also documentation of hybridization between northern pikeminnows and chiselmouth. Spawning habits of northern pikeminnow may be similar to that of the chiselmouth. Spawning of chiselmouth has not yet been fully documented.

Movements and Habitat Use

There is very little information on the movements and migrations of chiselmouth. In a study on distribution and abundance of chiselmouth in British Columbia, it was found that a population of spawning chiselmouth migrated 1.5 kilometers upstream into tributary streams (Scott and Crossman 1973). Titus (1996) documented segregation of young-of-the-year (YOY) chiselmouth and older juveniles on a temporal scale that resulted in a shift of habitat use. As the YOY appeared, the older 1+ aged juvenile chiselmouth seemed to move out into deep, fast water that could not be sampled effectively (Titus 1996).

Threats to Survival

Overall there is very little information on the life history of chiselmouth in Washington State. Their population status within the State is relatively unknown at this time. However, incidental information suggests that they are abundant throughout their range (Titus 1996; Segler and Segler 1987). There are no currently no known threats to the species.

8.5.8.2 ENVIRONMENTAL BASELINE (within the FPHCP Action Area)

Chiselmouth inhabit both lakes and streams and occur primarily in eastern Washington, but also in the Cowlitz and Lewis Rivers in western Washington. Population trend data is unknown for the species in Washington.

Role of the FPHCP Action Area for Conservation of the Species

The chiselmouth occurs in the FPHCP Action Area. It also occupies large areas outside of the FPHCP Action Area. The FPHCP Action Area will provide a moderate role in the long-term conservation of the species.

8.5.8.3 EFFECTS OF THE ACTION

General habitat effects to chiselmouth resulting from permit issuance have been summarized above for the Mainstem Guild; however the Salish and longnose suckers is also found in the habitats represented by the Lentic and Low-gradient Guilds.

Riparian prescription effects to chiselmouth

No habitat effects, other than those described in its assoicated guilds, are expected for the chiselmouth.

Summary of sediment effects to Chiselmouth

Sediment would be delivered to chiselmouth habitat from road surface erosion and, to a lesser extent, from hillslope erosion. The FPHCP's incorporation of BMPs and RMAPs would substantially reduce delivery of road surface related sediment to chiselmouth habitats, but it would not prevent all sediment from reaching aquatic habitats occupied by the species. Certain watershed features and road related activities may contribute sediment to fish-bearing streams that are above natural background rates. For example, culvert projects may increase siltation until vegetation has recovered to reduce harmful sediment. Juvenile chiselmouth habitat includes shallow pools with large substrate such as cobble and boulders. Excessive siltation may reduce the availability of this habitat and may affect food resources (algae, diatoms, and aquatic insects) of chiselmouth. When feeding behavior is altered by reduced prey, individual fitness and survival could be affected. However the FPHCP is not expected to contribute to instream sediment loading to the point that chiselmouth would be harmed at more than at a stream reach scale.

Effects from the 20-acre Exemption Rule

Although there is uncertainty regarding how often this rule would be implemented, when it is implemented the 20-acre Exemption Rule would likely adversely affect chiselmouth. In watersheds with a high proportion of 20-acre exempt landowners, this rule would increase the likelihood that large wood recruitment would be inadequate to maintain properly functioning habitat (USFWS & NMFS 2006). There is also the potential for increased sedimentation.

Summary of adverse effects to chiselmouth

The proposed action would have short- to long-term adverse effects on sediment. These effects would be most severe from unbuffered Type Np streams and their downstream effects that result in disruption of natural riparian and aquatic processes and functions in Type F streams. These effects to the aquatic environment may result in impairment of essential foraging behavior of chiselmouth. It is difficult to predict the severity of these effects because little is know about chiselmouth habitat requirements and effects to these fish will vary from activity to activity depending on the specific riparian prescriptions applied, the location, historical management practices, geological characteristics of the watershed, and the biotic community present.

Activities covered under the FPHCP are expected to have direct and indirect adverse effects to adult and juvenile chiselmouth ranging from mortality to sublethal effects. Direct injury and death to chiselmouth would likely occur during some stream crossing construction activities (stream dewatering and fish rescue and relocation, and blockage of upstream migration during construction). Increased sediment levels could reduce available habitat and prey items for chiselmouth. This could affect the growth and survival of juvenile and adult chislemouth.

Summary of beneficial effects

The long-term benefits of the FPHCP are expected to outweigh the short-term, negative affects to chiselmouth. Maturation of riparian areas, maintaining and restoring passage for chiselmouth, adaptive management, and improved road management practices are all expected from implementation of the FPHCP. These management prescriptions are expected to contribute to increasing the likelihood of long-term survival for chiselmouth in the FPHCP Action Area.

8.5.8.4 CUMULATIVE EFFECTS

Cumulative effects were addressed in the **Comprehensive Cumulative Effects**, with respect to the aquatic and riparian environment in Washington State. Additional information regarding cumulative effects for the fish species was presented in the section **Mainstem Guild: Cumulative Effects.**

8.5.9 Redside shiner (*Richardsonius halteatus*)

8.5.9.1 State of the Species

Description of Species

The redside shiner is a rather small and deeply compressed minnow. It has a narrow caudal peduncle that differs from that of the tui chub and it lacks a fleshy keel between the pelvic fins and the anus that differentiates it from the golden shiner (Wydoski and Whitney 2003). Adults are on average 75-130 millimeters in length (Scott and Crossman 1973). They have a relatively long head with a terminal mouth and large eyes. Their caudal fin is deeply forked and they have small rounded pelvic fins and pectoral fins, which are slightly larger than the pelvic (Scott and Crossman 1973). They have small cycloid scales that are steely blue, olive or dark brown to black on the dorsal surface, and have a dark band extending from the snout to the caudal peduncle (Scott and Crossman 1973). During spawning, colors become more vibrant in both sexes. Females turn a golden color above and below the lateral band while males develop a yellow band between the dorsal area and the lateral band.

Historical and Current Range

Historic range is unknown at this time. The range of the redside shiner is found from northern British Columbia eastward into western Alberta, south to western Montana, western Wyoming, and north and northwest Utah, northern Nevada, Oregon, Idaho and Washington. Currently the redside shiner is found in rivers, streams, and lakes throughout Washington State.

Essential Habitat Components

The redside shiner occupies a wide variety of habitats from large rivers to irrigation ditches, ponds, lakes, streams and isolated springs (Wydoski and Whitney 2003). When in rivers or streams, they generally prefer slow to moderate currents (Bond et al. 1988; Wydoski and Whitney 2003). Redside shiners prefer the habitat areas that contain aquatic vegetation (Scott and Crossman 1973; Bond et al. 1988). These areas provide foraging opportunities and refuge from predators.

Reproductive Ecology

Redside shiners begin to spawn in spring or early summer when they are 2 to 3 years old (Wydoski and Whitney 2003). Males arrive on the spawning grounds before the females when water temperatures are 10°C or greater (Scott and Crossman 1973). Males at this time become highly colorful, displaying vibrant orange and yellow colors, where as the female will attain a golden color (Scott and Crossman 1973). Males will also develop nuptial tubercles along their head and upper surface of their paired fins (Scott and Crossman 1973). They apparently have a strong tendency to return to their natal stream. Redside shiners gather in groups of 30-40 individuals to begin spawning. In streams, spawning takes place in riffles less than 102 millimeters deep (Scott and Crossman 1973). Redside shiners are broadcast spawners and do not construct nests. Their eggs are sticky and are deposited over gravel or on vegetation. Eggs are released 10-20 at a time (Scott and Crossman 1973). Spawning can take place in streams or along lakeshores. The length of time to hatching usually depends on water temperature. When water temperatures reach 21°C, hatching can take place in 3 days and, if temperatures are 12°C, hatching can take as long as 15 days (Scott and Crossman 1973). Recently hatched fry will stay along the bottom in the gravel and absorb their egg yolk. If hatched in a stream, fry will drift with the current to a lake or pond or a marginal habitat along the river to rear.

Movements and Habitat Use

Redside shiners are known to exhibit diel and seasonal movements. In lakes during the day, redside shiners are found only in the nearshore areas over shoals that have heavy growth of vegetation (Scott and Crossman 1973). At night, redside shiners move to deeper water but stay close to the surface (Scott and Crossman 1973). The shift of habitat from day to night allows adults to feed on selected items. Adults in the nearshore environment feed on aquatic and terrestrial insects and snails, and at night feed on zooplankton in the deeper pelagic zones of the lake (Wydoski and Whitney 2003). In lakes, the smallest redside shiners are found higher in the water column and closest to the shore, while larger fish are in deeper water and further from the shoreline (Scott and Crossman 1973).

8.5.9.2 ENVIRONMENTAL BASELINE (within the FPHCP Action Area)

The redside shiner occurs throughout eastern and western Washington. Population status for redside shiner in the FPHCP Action Area is unknown. Due to the diversity of habitats it is known to occupy throughout the state, and its ability to outcompete fish in some studies (Wydoski and Whitney 2003), the population may be stable.

Role of the FPHCP Action Area in Conservation of the Species:

The redside shiner has a large distribution in Washington and occurs in the FPHCP Action Area. Suitable habitats for the species occur within the FPHCP Action Area.

8.5.9.3 EFFECTS OF THE ACTION

General habitat effects to redside shiner resulting from the proposed action have been summarized above for the Lentic Guild, although redside shiner are also associated with habitats represented by the Mainstem and Low-gradient Guilds.

Riparian prescription effects to redside shiner

Full riparian and in-stream function likely would not be provided to all habitats occupied by redside shiner. In some stream reaches, the highest quality and most structurally complex habitats may fail to develop due to the potential reduction of large wood recruitment to streams at different time scales and following different riparian management prescriptions. Redside shiners are associated with aquatic vegetation in slow moving water, and, where they are present, modification of these habitats could affect the species. Large wood in freshwater habitats is important for storing and releasing the appropriate sediment for suitable substrate, pool formation and aquatic plant growth.

Sediment effects to redside shiner

Sediment would be delivered to redside shiner habitat from road surface erosion and, to a lesser extent, hillslope erosion. The FPHCP's incorporation of BMPs and RMAPs would substantially reduce road surface erosion to redside shiner habitats, but it would not prevent all sediment from reaching aquatic habitats occupied by the species. Certain watershed features and road use may contribute sediment to fish-bearing streams that are above natural background rates. Culvert projects may increase siltation over short durations, especially until vegetation has recovered. Sediment delivered to streams from roads is likely to have more effects than hillslope erosion due to the magnitude and potentially chronic delivery of road-related sediment to streams. Elevated sediment levels may reduce the availability of aquatic vegetation and prey species for redside shiners and the resulting alteration in food availability could affect individual redside shiner fitness and survival. Los of aquatic vegetation could increase risk of predation for redside shiner. However the FPHCP is not expected to significantly contribute to instream sediment loading to the point that the redside shiner or the aquatic vegetation associated with its habitat would be harmed at more than at a stream reach scale.

Effects from the 20-acre Exemption Rule

Although there is uncertainty regarding how often this rule would be implemented, when it is implemented the 20-acre Exemption Rule would likely adversely affect redside shiner. In watersheds with a high proportion of 20-acre exempt landowners, this rule would increase the likelihood that large wood recruitment would be inadequate to maintain properly functioning habitat (USFWS & NMFS 2006). There is also the potential for increased sedimentation, reduced shade, increased stream temperatures, and increased windthrow. Where these adverse effects occur, essential behaviors associated with foraging, reproduction and growth may be impeded, and redside shiner may occupy the stream at reduced levels and they may have reduced survival.

Summary of adverse effects to redside shiner

The proposed action will have short- to long-term adverse effects on sediment, large wood, and temperature. These effects would be most severe from unbuffered Type Np streams and their downstream effects that result in disruption of natural riparian and aquatic processes and functions in Type F streams. These effects to the aquatic environment may result in impairment of essential foraging, rearing, and spawning behavior of the redside shiner. It is difficult to predict the severity of these effects because habitat limiting factors for this species are not well understood and effects to their habitat would likely vary from activity to activity depending on the specific riparian prescriptions applied, the location of the activity, historical management practices, geological characteristics of the watershed, and the biotic community present.

Activities covered under the FPHCP are expected to have direct and indirect adverse effects to adult and juvenile redside shiners ranging from mortality to sublethal effects. Direct injury and death to redside shiner would likely occur during some stream crossing construction activities (stream dewatering and fish rescue and relocation, blockage of upstream migration during construction). Increased sediment levels could reduce available habitat and prey items for redside shiner. This could affect the growth and survival of juvenile and adult redside shiners.

Summary of beneficial effects

The long-term benefits of the FPHCP are expected to outweigh the short-term, negative affects to redside shiner. The severity of individual effects to redside shiner will vary from activity to activity depending on the specific riparian prescriptions, location, past management practices, geological characteristics of the watershed, and the biotic community present. However, maturation of riparian areas, maintaining and restoring passage for the redside shiner, adaptive management, and improved road management practices are all expected from implementation of the FPHCP. These management prescriptions are expected to contribute to increasing the likelihood of long-term survival for the redside shiner in the FPHCP Action Area.

8.5.9.4 CUMULATIVE EFFECTS

Cumulative effects were addressed in the Comprehensive Cumulative Effects, with respect to the aquatic and riparian environment in Washington State. Additional information regarding cumulative effects for the covered fish species was presented in the section **Lentic Guild: Cumulative Effects**.

8.5.10 Speckled Dace (*Rhinichthys osculus*)

8.5.10.1 Status of the Sepcies

Description of the Species

The speckled dace is a small (average adult size 51 to76 millimeters), robust fish with a blunt triangular head, a small distinct hump behind the head, and a terminal mouth separated from the snout by a groove between the snout and the upper lip (Wydoski and Whitney 2003). It has a short caudal peduncle with a diffuse dark spot. The pelvic and pectoral fins are small and rounded. The lateral line is usually complete, but in some specimens it terminates before the base of the caudal fin (Scott and Crossman 1979). The color is usually a gray or gray-brown with scattered or vague darker flecks or speckles, usually above the midline. The sides are yellowish, turning off-white at the belly. In fish less than 38.1 millimeters in length, there is a single dark band on the side of the body.

Historic and Current Range

Historic range is currently unknown. Speckled dace occur in much of the western United States and in British Columbia, Canada. Currently the speckled dace is found throughout most of eastern and western

Washington. They are apparently absent in the North Cascades on the west side of the crest. On the Olympic Peninsula, the speckled dace is found only along the southern and western boundaries of the Peninsula (Wydoski and Whitney 2003).

Essential Habitat Components

Speckled dace are known to inhabit a variety of habitat types. They have been found in small springs, rushing brooks, pools in intermittent streams, large rivers, and deep lakes. Generally, they prefer colder waters of streams with slow to swift currents and well-oxygenated water (Wydoski and Whitney 2003). Speckled dace can tolerate a wide range of water temperatures (0° C to 28.0° C) and can tolerate temperatures as high as 31° C (Moyle 2002). In Washington, during the summer, they are generally found in streams with temperatures between 12° C and 21°C (averaging 16° C) and with maximum temperatures of 33° C (Wydoski and Whitney 2003).

In lakes, they seek out beaches that are fairly shallow (less than 1 meter in depth) and that receive abundant wave action. On the Olympic Peninsula, speckled dace occupied pool habitat (70 percent of the time), slow runs (20 percent of the time), and riffles (10 percent of the time) (Wydoski and Whitney 2003). Moyle (2002) found that speckled dace were relatively absent in riffles where sculpins were found; when sculpins were absent, speckled dace occupied riffle habitats. Generally, speckled dace occupy areas with abundant cover, such as rocks or rubble, submerged aquatic vegetation, overhanging vegetation, undercut banks, and woody debris (Moyle 2002). These cover types are used by dace for hiding from predators during the day. Moyle (2002) found that speckled dace are generally diurnal; however, they are nocturnal in areas that have larger populations of fish-eating birds. Speckled dace are rarely found singly, but avoid forming large schools (Sigler 1987). Like other dace, the speckled dace is generally adapted for a benthic life history and consumes a variety of benthic aquatic and terrestrial insects.

Reproductive Ecology

Speckled dace mature at age 2 (Wydoski and Whitney 2003). Spawning takes place from June until August, with the peak spawning period in late June (Wydoski and Whitney 2003). Speckled dace generally spawn over clean gravel substrates along the edges of riffles. The spawning sites are used predominantly by males accompanied by few females. Males develop nuptial tubercles on their heads and pectoral fins along with a red-orange coloration on their lips, cheeks, and fins. Male dace surround the female in a large ball and fertilize the eggs as the female releases them. There is sometimes a high adult mortality after spawning is completed (Wydoski and Whitney 2003). The eggs adhere to the gravel and in the interstitial spaces where they develop. Eggs hatch in about 6 days at 18° C to 19° C (Moyle 2002). Larval fish remain within the gravel for an additional 7 to 8 days (Sigler 1987). Fry then move into warm shallow backwaters with large rocks and emergent vegetation to feed and develop.

Movements and Habitat Use

There is little information on the movements of speckled dace. Most information on speckled dace movement is anecdotal from studies of other fish. Peters (USFWS, Personal Communication, 2005) captured speckled dace moving into off-channel pools in the Queets River drainage during a fall study on native salmon. It is unlikely that speckled dace make lengthy migrations into over-wintering habitats or spawning areas. Moyle (2002) states that speckled dace that inhabit lakes have been observed migrating short distances upstream into small stream inlets to spawn.

Threats to Survival

There are currently no known species specific threats to speckled dace at this time. Speckled dace are fairly abundant throughout the state and are considered habitat generalists. Unlike the Fosket speckled dace *(Rhinichthys osculus spp*.) which occurs in one small area in Lake County, Oregon, the speckled dace (*Rhinichthys osculus*) analyzed for this Opinion occurs throughout many areas of the western United States. Detailed population status is currently unknown but is believed to be secure. Common threats to survival of other species of dace have been loss of habitat, pollution, introduction of non-native species, and population fragmentation by either natural or man-made disturbances. Speckled dace, along with other species of dace, are likely an important link in the food chain, serving as a forage fish for larger game and non-game fish. Specific threats to this species in Washington have not been described.

8.5.10.2 ENVIRONMENTAL BASELINE (within the FPHCP Action Area)

The speckled dace has a broad distribution in the FPHCP Action Area and is considered common in Washington (Wydoski and Whitney 2003). They are found in lakes and streams. Population trend in Washington is currently unknown, but with their distribution and ability to occupy various habitats, they are most likely secure at this time.

Role of FPHCP Action Area in Conservation of the species:

The FPHCP Action Area encompasses a significant segment of the range of speckled dace in Washington. The species is also found on Federal and FPHCP covered lands in Washington. The FPHCP Action Area provides important habitats for speckled dace and will contribute to the long-term survival of the species in Washington.

8.5.10.3 EFFECTS OF THE ACTION

General habitat effects to the speckled dace resulting from the proposed action have been summarized above for the Low-Gradient Tributary and the Lentic Guilds.

Riparian effects to speckled dace

Full riparian and in-stream function likely would not be provided to all habitats occupied by speckled dace. In some stream reaches, the highest quality and most structurally complex habitats may fail to develop due to the potential reduction of large wood recruitment to streams at different time scales and following different riparian management prescriptions. Speckled dace area more often found in pools than in riffles. Reduction in natural recruitment of large wood to streams has resulted in reduced stream habitat complexity, including reduced quantity and quality of pools. In the absence of pools, speckled dace may not occupy streams to the extent that they would if pools were present. Large wood in freshwater habitats is important for storing and releasing the appropriate sediment for suitable substrate and to enable aquatic plants to grow. Speckled dace occupy areas with abundant cover, such as rocks or rubble, submerged aquatic vegetation, overhanging vegetation, undercut banks, and woody debris. Many of these cover types are linked to large wood recruitment and are used by dace for hiding from predators. Speckled dace are benthic fish and feed on algae, aquatic insects, and zooplankton. Alterations of the riparian and aquatic environment could reduce the ability of streams to support forage for speckled dace, thus reducing the fish’s ability and success at finding forage in these streams. This could affect the growth and survival of speckled dace.

Along Type Np streams, reductions in shade are likely to occur and water temperature may increase over limited distances as a result of these unbuffered Type Np streams. In some cases, increases in temperature may be delivered downstream to Type F waters and temperatures could be warmed near the confluence of Type Np and F streams.

Sediment effects to speckled dace

Sediment will be delivered to speckled dace habitat from road surface erosion. The FPHCP's incorporation of BMPs and RMAPs will substantially reduce road surface erosion to speckled dace habitat, but it will not prevent all sediment from reaching aquatic habitats occupied by speckled dace. Certain watershed features and road location, design, and use may contribute sediment to fish-bearing streams that are above natural background rates. Sediment delivered to streams from roads is likely to have more effects to speckled dace habitat than hillslope erosion due to the magnitude and potentially chronic delivery of sediment to streams from roads. Primary production processes and benthic habitats may be negatively affected from increased sedimentation, which could affect speckled dace. Individual fitness and survival may be reduced for some fish. Effects are expected at some locations, normally at a stream reach or smaller scale.

Speckled dace are reported to spawn in the summer as late as August. Culvert replacements and installations normally occur in the summer. This work often requires dewatering a short segment of stream, along with work associated with the streambed. Mortality of speckled dace in the vicinity of a culvert project could occur.

Effects from the 20-acre Exemption Rule

Although there is uncertainty regarding how often this rule would be implemented, when it is implemented the 20-acre Exemption Rule would likely adversely affect speckled dace. In watersheds with a high proportion of 20-acre exempt landowners, this rule would increase the likelihood that large wood recruitment would be inadequate to maintain properly functioning habitat (USFWS & NMFS 2006). There is also the potential for increased sedimentation, reduced shade, increased stream temperatures, and increased windthrow. Where these adverse effects occur, essential behaviors associated with foraging, reproduction and growth may be impeded. In situations like these, speckled dace may occupy the stream at reduced levels, which may also affect species which use speckled dace as forage.

Summary of adverse effects to speckled dace

The proposed action will have short- to long-term adverse effects on sediment, large wood, and temperature. These effects to the aquatic environment may result in impairment of essential foraging, rearing, and spawning behavior of speckled dace. It is difficult to predict the severity of these effects because habitat limiting factors for this species are not well understood and effects to their habitat would likely vary from activity to activity depending on the specific riparian prescriptions, the location of the activity, historical management practices, geological characteristics of the watershed, and the biotic community present.

Activities covered under the FPHCP are expected to have direct and indirect adverse effects to adult and juvenile speckled dace ranging from mortality to sublethal effects. Direct injury and death to speckled dace would likely occur during some stream crossing construction activities (stream dewatering, fish rescue and relocation, and blockage of upstream migration during construction). Increased sediment levels could reduce available habitat and prey items for speckled dace. This could affect the growth and survival of juvenile and adult speckled dace.

Summary of beneficial effects

Speckled dace have a broad distribution in the FPHCP Action Area and effects from the FPHCP are not expected to decrease their distribution. Most disturbances from the proposed action are generally expected to be short-term in nature and at a stream reach or less (habitat unit) scale. Disturbance levels are not expected to cause large scale declines in speckled dace abundance or distribution. Given enough time relative to the magnitude of the disturbance, speckled dace are likely to recover from activities attributable to the FPHCP. Maturation of riparian areas, maintaining and restoring speckled dace passage, adaptive management, and improved road management practices are all expected from implementation of the FPHCP. These management prescriptions are expected to contribute to increasing the likelihood that speckled dace survive in the FPHCP Action Area.

8.5.10.4 CUMULATIVE EFFECTS

Cumulative effects were addressed in the **Comprehensive Cumulative Effects**, with respect to the aquatic and riparian environment in Washington State. Additional information regarding cumulative effects for the covered fish species was presented in the **Low-Gradient Tributary** and **Lentic Guilds**.

No additional information is available with respect to cumulative effects for this particular species above those cumulative effects already discussed earlier in this document.

8.5.11 Longnose dace (*Rhinichthys cataractae*) and Nooksack dace (*Rhinichthys cataractae*)

8.5.11.1 Status of the Species

Description of the Species

The longnose dace has a short (average length for adults is 76mm), slender body with a thick caudal peduncle (Wydoski and Whitney 2003). The head is broad and triangular with a long snout overhanging the mouth (Scott and Crossman 1979). The mouth is inferior and nonprotractile with the upper lip attached to the snout (Wydoski and Whitney 2003). The caudal fin is somewhat forked with rounded lobes. The color of the longnose dace is an olive-green to brown along the dorsal surface, with some mottling on the sides, shading to a cream or slivery white on the belly (Sigler and Sigler 1987; Wydoski and Whitney 2003). The lateral line is dark from the gill cover to the base of the caudal fin. This is more apparent in young longnose dace and may be absent in adults. In breeding, males may display an orange-red coloration along the edges of the mouth and cheeks (Sigler and Sigler 1987). This orange-red coloration can also appear at the bases of the pectoral and pelvic fins.

The Nooksack dace is an evolutionary offshoot of the longnose dace and is very close in body shape, size and coloration. The only true differences in the two species can be determined by scale counts along the lateral line and around the caudal peduncle. The longnose dace has 67 along the lateral line and 31 around the caudal peduncle, where as the Nooksack dace has 54 along the lateral line and 24 around the caudal peduncle.

Historic and Current Range

The longnose dace has a broad distribution in North America. Historic information on these two closely related species is sparse and there are conflicting reports on the current distributions in Western Washington. Wydoski and Whitney (2003) state that the longnose dace is located throughout the State. However in a publication by Inglis (1995) with the British Columbia Ministry of Environment, Lands and Parks, Fisheries Branch (BCMELP) states that the geographic distributions of the longnose and the Nooksack dace do not overlap. The current range of the Nooksack dace is limited to areas west of the Cascade Mountains. They are found from the Canadian border south along the eastern edge of Puget Sound. They also found west to the Willapa Hills area and extend north up though the Grays Harbor area and the Chehalis River to the Quillayute River on the western slopes of the Olympic Mountains (Wydoski and Whitney 2003). The longnose dace is reported to be distributed throughout the state (Wydoski and Whitney 2003). It occurs throughout eastern Washington occupying the Columbia, Snake and Spokane Rivers and their tributaries (Wydoski and Whitney 2003). It is also reported to be located on the Olympic Peninsula, but only the southern and western boundaries (Wydoski and Whitney 2003).

Essential Habitat Components

The longnose and Nooksack are both adapted for a benthic life style. The shape of their bodies and their reduced air bladder help them remain close to the bottom of rivers and streams. The longnose and Nooksack dace both inhabit clean, swift flowing streams with gravel, cobble or boulder substrates (Wydoski and Whitney 2003). They both prefer riffle habitats with water flows from 0.91 to 1.83 meters/second (Wydoski and Whitney 2003). In the Olympic Mountains, the longnose dace is generally found in streams whose width is greater than 43 meters (Wydoski and Whitney 2003). However in B.C., the Nooksack dace is generally found in streams whose width is less than 6 meters (BCMELP 1995). The longnose dace is recorded to inhabit streams whose summer temperatures are between 12.8 and 21°C (Wydoski and Whitney 2003). Scott and Crossman (1973) reported that in Canada the longnose dace sometimes inhabits the inshore waters of lakes that have gravel or boulder substrates.

Dace fry are often found along stream margins (Wydoski and Whitney 2003). The fry feed on drift organisms where as the adults feed in the deeper, faster flowing waters (Sigler and Sigler 1987). Dace are often preyed on by trout or other large game fish and utilize the cobble or boulder substrate to hide in. During fall and into winter, longnose dace leave the riffle habitats and possibly move into pools to over-winter (Wydoski and Whitney 2003).

Reproductive Ecology

There is little information on the reproduction habits of the longnose and Nooksack dace. Both of these species mature between 2 to 3 years of age (Wydoski and Whitney 2003). They begin spawning in the late spring to summer (May to July). The male longnose dace does not build a nest but rather establishes a spawning territory and defends if from other males and sometimes females. Male longnose dace during this time will display orange-red spawning colors along its mouth and at the base of their fins. However the male Nooksack dace does not develop spawning colors and also does not establish and defend at spawning territory. Nooksack dace spawning also takes place at night in 7 to 9°C water temperatures. Spawning sites are located in shallow riffles with gravel bottoms (Wydoski and Whitney 2003). Substrate diameter is generally between 50.8 and 152.4 millimeters and comprises about 75 percent of the overall substrate within the spawning territory (Wydoski and Whitney 2003). Water velocity is between 0.46 and 1.0 meter per second with water temperatures around 11.7°C (Wydoski and Whitney 2003).

Movements and Habitat Use

There is very little information on the movements of longnose or Nooksack dace. Wydoski and Whitney (2003) states that the longnose dace is not found in their preferred habitats in the fall or winter months, and that they possibly move into pools or deeper low velocity habitats to over winter.

Threats to Survival

Currently there is no documentation on population trend of the longnose and Nooksack dace in Washington State. In British Columbia, the Nooksack dace is considered critically imperiled due to a very restricted distribution and habitat loss (Peden 2002).

Common citations for threats to survival of native fish throughout the state include: habitat loss (spawning, rearing, foraging), competition with non-native species, pollution, and habitat fragmentation by man made barriers. Both the longnose and Nooksack dace are susceptible to these factors.

8.5.11.2 ENVIRONMENTAL BASELINE (within the FPHCP Action Area)

These two species of dace have a relatively large distribution in Washington as described above. Their occurrence is expected both within and outside of the FPHCP Action Area. Population trends for the two species within the FPHCP Action Area are unknown.

Role of the FPHCP Action Area for the Conservation of the longnose and Nooksack dace

Areas occupied by these species occur both within and outside of the FPHCP Action Area. The FPHCP Action Area will contribute to the long-term conservation of these species.

8.5.11.3 EFFECTS OF THE ACTION

General habitat effects to the longnose and Nooksack dace resulting from the proposed action have been summarized above for the Low-Gradient Tributary and Mainstem Guilds.

Riparian prescription effects to longnose and Nooksack Dace

Full riparian and in-stream function likely would not be provided to all habitats occupied by the longnose and Nooksack dace. In some stream reaches, the highest quality and most structurally complex habitats may fail to develop due to the potential reduction of large wood recruitment to streams at different time scales and following different riparian management prescriptions. Seasonally longnose and Nooksack Dace inhabit stream margins or deep pools. Reduction in natural recruitment of large wood to streams would likely result in reduced stream habitat complexity, including reduced quantity and quality of pools. Large wood in freshwater habitats is important for storing and releasing the appropriate sediment for suitable substrate and to support aquatic plant growth and macroinvertebrate production. Reductions of large wood in streams could result in reduced forage for longnose and Nooksack dace.

The longnose and Nooksack dace prefer temperatures between 55 and 70º F (Wydoski and Whitney 2003). When RMZs achieve their Desired Future Condition, streams within the areas covered by the FPHCP that are occupied by the longnose and Nooksack dace will receive most of the potentially available shade. Along Type Np streams, reductions in shade are likely to occur and water temperature may increase over limited distances as a result of these unbuffered Type Np streams. In some cases, increases in temperature may be delivered downstream to Type F waters and temperatures could be warmed near the confluence of Type Np and F streams. There are situations (yarding corridors, stream-adjacent parallel roads, 20-acre exemptions, and windthrow) where stream shading will be reduced from full ecological potential. In some circumstances there may be adverse effects to the longnose and Nooksack dace due to elevated stream temperatures and the behavior and survival of individual fish may be affected. However, under most timber harvest scenarios, adequate levels of shade are expected for the conservation of dace.

Sediment effects to longnose and Nooksack dace

Sediment will be delivered to longnose and Nooksack dace habitat from road surface erosion. The FPHCP's incorporation of BMPs and RMAPs will substantially reduce road surface erosion to speckled dace habitat, but it will not prevent all sediment from reaching aquatic habitats occupied by speckled dace. Certain watershed features and road location, design, and use may contribute sediment to fish-bearing streams that are above natural background rates. Sediment delivered to streams from roads is likely to have more effects to longnose and Nooksack dace habitat than hillslope erosion due to the magnitude and potentially chronic delivery from roads of sediment to streams. Primary stream productivity and benthic habitat may be negatively affected from increased sedimentation, which could affect longnose and Nooksack dace. Individual fitness and survival may be reduced for some fish. Effects are expected at some locations, normally at a reach or smaller scale.

Culvert and bridge replacement projects often require dewatering a short segment of stream. Because capturing all dace prior to culvert and bridge replacement projects is unlikely, mortality to the longnose and Nooksack dace could occur.

Effects from the 20-acre Exemption Rule

Although there is uncertainty regarding how often this rule would be implemented, when it is implemented the 20-acre Exemption Rule would likely adversely affect longnose and Nooksack dace. In watersheds with a high proportion of 20-acre exempt landowners, this rule would increase the likelihood that large wood recruitment would be inadequate to maintain properly functioning habitat (USFWS & NMFS 2006). There is also the potential for increased sedimentation, reduced shade, increased stream temperatures, and increased windthrow. Where these adverse effects occur, essential behaviors associated with foraging, reproduction and growth may be impeded. In situations like these, longnose and Nooksack dace may occupy the stream at reduced levels, which may also affect species which use longnose and Nooksack dace as forage.

Summary of adverse effects to longnose and Nooksack dace

The proposed action will have short- to long-term adverse effects on sediment, large wood, and temperature. These effects to the aquatic environment may result in impairment of essential foraging, rearing, and spawning behavior of longnose and Nooksack dace. It is difficult to predict the severity of these effects because habitat limiting factors for this species are not well understood and effects to their habitat would likely vary from activity to activity depending on the specific riparian prescriptions, the location of the activity, historical management practices, geological characteristics of the watershed, and the biotic community present.

Activities covered under the FPHCP are expected to have direct and indirect adverse effects to adult and juvenile longnose and Nooksack dace ranging from mortality to sublethal effects. Direct injury and death to longnose and Nooksack dace would likely occur during some stream crossing construction activities (stream dewatering and fish rescue and relocation, and blockage of upstream migration during construction). Increased sediment levels could reduce available habitat and prey items forlongnose and nooksack dace. This could affect the growth and survival of juvenile and adult longnose and Nooksack dace.

Summary of beneficial effects to longnose and Nooksack dace

The FPHCP prescriptions are expected to contribute to increasing the likelihood that longnose and Nooksack dace survive in the FPHCP Action Area. Maturation of riparian areas, maintaining and restoring longnose and Nooksack dace passage, adaptive management, and improved road management practices are all expected from implementation of the FPHCP. Most disturbances from the proposed action are generally expected to be short-term in nature and at a stream reach or less (habitat unit) scale. Disturbance levels are not expected to cause large scale declines in longnose and Nooksack dace abundance or distribution. Given enough time relative to the magnitude of the disturbance, longnose and Nooksack dace are likely to recover from activities attributable to the FPHCP.

8.5.11.4 CUMULATIVE EFFECTS

Cumulative effects were addressed in the **Comprehensive Cumulative Effects**, with respect to the aquatic and riparian environment in Washington State. Additional information regarding cumulative effects for the fish species was presented in the section **Low-Gradient Tributary and Mainstem Guilds: Cumulative Effects.**

8.5.12 Leopard dace (*Rhinichthys falcatus*) and Umatilla dace (*Rhinichthys umitilla*)

8.5.12.1 Status of the Species

Description of the Species

The leopard dace and the Umatilla dace are very similar in appearance. Previously they were considered to be a subspecies of the speckled dace. The Umatilla dace is still not considered a separate species by the American Fisheries Society (Robins et al. 1991), but new evidence supports the separation of the Umatilla dace from the leopard dace (Wydoski and Whitney 2003). For this Opinion, they are considered two separate species.

The leopard dace has a small (average size of adult 75 millimeters), elongate body that is slightly heavy before the dorsal fin (Scott and Crossman 1979). The head is triangular shaped with a bluntly rounded snout and a slightly overhanging small mouth with conspicuous barbels at each corner, which are longer than the barbels on the speckled dace (Scott and Crossman 1979). It has a deeply forked caudal fin, and rounded, small pectoral fins. The leopard dace is generally light in coloration. It has many large irregularly shaped spots on a rather yellowish background along its sides and darker coloration on its dorsal surface (Wydoski and Whitney 2003).

The overall general description of the Umatilla dace is very similar to that of the leopard dace. However there are several distinguishing characteristics that separate the two fish. The leopard dace has conspicuous fleshy attachments to the rays of its pectoral fins, whereas the fleshy attachments in the Umatilla dace are less developed (Wydoski and Whitney 2003). The leopard dace has many irregular dark spots along their sides, whereas the Umatilla dace has dark blotches that are nearly continuous along their lateral line (Wydoski and Whitney 2003). The mouth of the Umatilla dace is only slightly inferior whereas the leopard dace's mouth is completely inferior (Wydoski and Whitney 2003).

Historic and Current Range

The historic range of the leopard and Umatilla dace is unknown at this time. Currently both species have a very spotty and disjunct distribution which is confined to the Columbia River system (Wydoski and Whitney 2003). The leopard dace has been found in the lower, mid, and upper Columbia River, and in the Snake, Similkameen and Yakima Rivers (Wydoski and Whitney 2003). The Umatilla dace has been found in the Columbia, Similkameen, Kettle, Yakima, Okanogan, Colville and Snake Rivers, along with possible populations in the Methow and Wenatchee Rivers (Wydoski and Whitney 2003).

Essential Habitat Components

The leopard and Umatilla dace share similar habitats throughout their range. They both are primarily found in stream habitats, however the leopard dace has been know to inhabit lakes as well (Wydoski and Whitney 2003). Generally leopard dace have been found to occupy streams with current velocities less than 0.5 meters/second (Scott and Crossman 1979). The Umatilla dace is generally found in current velocities less than that of leopard dace. Both species are benthic in their behaviors. They both occupy relatively productive, low elevation streams with large cobble or rubble substrates with temperatures between 15 and 18°C in late summer (Wydoski and Whitney 2003). Umatilla dace seem to prefer cobble substrates that are clean of sediment whereas leopard dace are associated with cobble covered with fine sediment (Wydoski and Whitney 2003). In British Columbia, 0-age leopard dace have been collected from backwater pools at depths less than 0.50 meters, whereas adults generally occupy habitats 0.90 meters or deeper (Wydoski and Whitney 2003). Umatilla dace have been found along stream banks in shallow water < 1 meter deep where juveniles can forage and hide in dense mats of algae (Wydoski and Whitney 2003). Adult and sub-adult Umatilla dace are found in deeper habitats (Wydoski and Whitney 2003). At night, adult leopard dace move from deep water to shallow water and juveniles move from shallow to deep habitats (Wydoski and Whitney 2003). Young leopard dace feed primarily on dipterous larva and switch to aquatic larva and terrestrial insects as they get older (Scott and Crossman 1979).

Reproductive Ecology

Very little is known about the reproductive ecology of leopard and Umatilla dace, but they are probably similar. Generally, leopard dace spawn in May and July and Umatilla dace are thought to spawn in early to mid July (Wydoski and Whitney 2003). Spawning probably takes place in riffles where several males spawn with one female. Adhesive eggs are then broadcast over a gravel substrate. Males remain at the spawning site possibly to spawn again (Wydoski and Whitney 2003).

Movements and Habitat Use

There is little known about the movements of leopard and Umatilla dace. Wydoski and Whitney (2003) state that some juvenile leopard dace have been known to move at night into deeper water, and that some adults will also move at night into shallow water. There seems to be no information on movements associated with spawning or overwintering.

Threats to Survival

The leopard and Umatilla dace were listed as a "state candidate" species by the Washington State Department of Fish and Wildlife due to their limited range and unknown status. Some frequently cited threats to their continued survival are habitat loss or alterations, pollution, sedimentation of spawning or foraging areas, and reservoir operations which could cause rapid water fluctuations (Wydoski and Whitney 2003).

Leopard dace generally occur in streams with clean substrates of rock, boulders, and cobbles where the water velocity is strong enough to prevent gravel from becoming embedded (Wydoski and Whitney 2003). They are sometimes found in lakes. Sedimentation of streams has been suggested as a potential factor in degrading habitat for leopard dace (Wydoski and Whitney 2003).

In British Columbia, Canada, the Umatilla dace is considered a vulnerable species because of its small range (www.royalbcmuseum.bc.ca). The construction of dams has apparently been partially responsible for declines in British Columbia and may be a threat in Washington. The process of eutrophication may also pose a threat, while the placement of rocks in dike construction may increase available habitat (www.royalbcmuseum.bc.ca).

8.5.12.2 ENVIRONMENTAL BASELINE (within the FPHCP Action Area)

Umatilla dace are confined to the Columbia basin in eastern Washington and are usually associated with low elevation, slow moving streams (Wydoski and Whitney 2003). The distribution of the leopard dace includes the Columbia basin in eastern Washington, and the lower Columbia River downstream to the Cowlitz River system. Leopard dace have been reported from the Hanford reach of the Columbia.

Population trends of the Umatilla and leopard dace are unknown in the FPHCP Action Area. The distribution of both species is considered "spotty" by Wydoski and Whitney (2003). Leopard dace were considered rare in an electrofishing sample the Yakima River.

Role of FPHCP Action Area in Conservation of species:

The FPHCP Action Area encompasses only a moderate portion of the species range within Washington. The species occurs both within and outside of the FPHCP Action Area. The FPHCP Action Area will provide a moderate level of conservation for these two species of dace. However, there are major areas the species occurs that are outside of the FPHCP Action Area and are not influenced by the proposed action.

8.5.12.3 EFFECTS OF THE ACTION

General habitat effects to Umatilla and leopard dace resulting from the proposed action have been summarized above for the Low-Gradient Tributary and Lentic Guilds.

Riparian prescription effects to Umatilla and leopard dace

Full riparian and in-stream function likely would not be provided to all habitats occupied by the Umatilla and leopard dace. In some stream reaches, the highest quality and most structurally complex habitats may fail to develop due to the potential reduction of large wood recruitment to streams at different time scales and following different riparian management prescriptions. Reduction in natural recruitment of large wood to streams would likely result in reduced stream habitat complexity, including reduced quantity and quality of pools. Large wood in freshwater habitats is important for storing and releasing the appropriate sediment for suitable substrate and to support aquatic plant growth and macroinvertebrate production. Reductions of large wood in streams could result in reduced forage for Umatilla and leopard dace.

Leopard dace have been reported from streams with cool water that ranges from 59 to 64 ° C in late summer. When RMZs achieve their Desired Future Condition, streams within the areas covered by the FPHCP that are occupied by the longnose and Nooksack dace will receive most of the potentially available shade. Along Type Np streams, reductions in shade are likely to occur and water temperature may increase over limited distances as a result of these unbuffered Type Np streams. In some cases, increases in temperature may be delivered downstream to Type F waters and temperatures could be warmed near the confluence of Type Np and F streams. There are situations (yarding corridors, stream-adjacent parallel roads, 20 acre exemptions, and windthrow) where stream shading will be reduced from full ecological potential and in some circumstances there may be adverse effects to the Umatilla and leopard dace due to elevated stream temperatures and the behavior and survival of individual fish may be affected. However, under most timber harvest scenarios, adequate levels of shade are expected for the conservation of dace.

Sediment effects to Umatilla and leopard dace

Sediment will be delivered to Umatilla and leopard dace habitat from road surface erosion. The FPHCP's incorporation of BMPs and RMAPs will substantially reduce road surface erosion to Umatilla and leopard dace, but it will not prevent all sediment from reaching aquatic habitats occupied by speckled dace. Certain watershed features and road location, design, and use may contribute sediment to fish-bearing streams that are above natural background rates. Sediment delivered to streams from roads is likely to have more effects to Umatilla and leopard dace habitat than hillslope erosion due to the magnitude and potentially chronic delivery of sediment from roads to streams. Primary stream productivity and benthic habitat may be negatively affected from increased sedimentation, which could affect Umatilla and leopard dace. Individual fitness and survival may be reduced for some fish. Effects are expected at some locations, normally at a reach or smaller scale.

Culvert and bridge replacement projects often require dewatering a short segment of stream. Mortality of Umatilla and leopard dace in the vicinity of a culvert project could occur.

Effects from the 20-acre Exemption Rule

Although there is uncertainty regarding how often this rule would be implemented, when it is implemented the 20-acre Exemption Rule would likely adversely affect Umatilla and leopard dace. In watersheds with a high proportion of 20-acre exempt landowners, this rule would increase the likelihood that large wood recruitment would be inadequate to maintain properly functioning habitat (USFWS & NMFS 2006). There is also the potential for increased sedimentation, reduced shade, increased stream temperatures, and increased windthrow. Where these adverse effects occur, essential behaviors associated with foraging, reproduction and growth may be impeded. In situations like these, Umatilla and leopard dace may occupy the stream at reduced levels, which may also affect species which use Umatilla and leopard dace as forage.

Because capturing all dace prior to culvert and bridge replacement projects is unlikely mortality to the Umatilla and leopard dace is likely occur during these projects.

Summary of adverse effects to Umatilla and leopard dace

The proposed action will have short- to long-term adverse effects on sediment, large wood, and temperature. These effects to the aquatic environment may result in impairment of essential foraging, rearing, and spawning behavior of Umatilla and leopard dace. It is difficult to predict the severity of these effects because habitat limiting factors for this species are not well understood and effects to their habitat would likely vary from activity to activity depending on the specific riparian prescriptions, the location of the activity, historical management practices, geological characteristics of the watershed, and the biotic community present.

Activities covered under the FPHCP are expected to have direct and indirect adverse effects to adult and juvenile Umatilla and leopard dace ranging from mortality to sublethal effects. Direct injury and death to Umatilla and leopard dace would likely occur during some stream crossing construction activities (stream dewatering, fish rescue and relocation, and blockage of upstream migration during construction). Increased sediment levels could reduce available habitat and prey items for Umatilla and leopard dace. This could affect the growth and survival of juvenile and adult Umatilla and leopard dace.

Summary of beneficial effects to Umatilla and leopard dace

The FPHCP prescriptions are expected to contribute to increasing the likelihood that Umatilla and leopard dace survive in the FPHCP Action Area. Maturation of riparian areas, maintaining and restoring Umatilla and leopard dace passage, adaptive management, and improved road management practices are all expected from implementation of the FPHCP. Most disturbances from the proposed action are generally expected to be short-term in nature and at a stream reach or less (habitat unit) scale. Disturbance levels are not expected to cause large scale declines in Umatilla and leopard dace abundance or distribution. Given enough time relative to the magnitude of the disturbance, Umatilla and leopard dace are likely to recover from activities attributable to the FPHCP.

8.5.12.4 CUMULATIVE EFFECTS

8.5.13 Northern Pikeminnow (*Ptychocheilus oregonensis*)

8.5.13.1 Status of the Species

Description of the Species

The northern pikeminnow is a large (305 millimeters when mature) long- lived, slow growing piscivorous minnow with an elongate and somewhat laterally compressed body (Scott and Crossman 1973). The head between the eyes is somewhat low gradienttened. It has a long snout and a large terminal mouth. Its caudal fin is forked with pointed upper and lower lobes. All the fins are clear or opaque in color except when in breeding. Fins of males during this time will turn a yellow or yellow-orange color. Males can also develop nuptial tubercles on the head, back and on the pelvic and pectoral fins (Scott and Crossman 1973). Their cycloid scales are small and the color is generally a dark green or greenish-brown color on their dorsal surface. This color becomes lighter along the sides turning a white or cream color on their belly.

Historical and Current Range

The historic range of the northern pikeminnow is unknown at this time. Current distribution of northern pikeminnow includes the Columbia and Snake River mainstem and tributaries, the Puget Sound drainage, and scattered lakes and streams along the coastal drainages north to about Lake Ozette (Wydoski and Whitney 2003). The Olympic Peninsulas northern and eastern drainages do not seem to contain populations of northern pikeminnows (Wydoski and Whitney 2003).

Essential Habitat Components

Northern pikeminnows inhabit lakes, rivers and streams and prefer habitats with slow to moderate currents (Wydoski and Whitney 2003). In lakes they inhabit shallow areas during the summer or move to the surface areas of the pelagic zone in order to occupy areas with preferred water temperatures. During winter they also seek out preferred temperatures by moving into the deeper sections of the lake. The larval form of the northern pikeminnow has been found to rear in habitats with low current, low turbidity and warm water. Habitat areas such as shorelines with fine sediment and backwaters both can provide larval pikeminnows with adequate vegetation, warmer water and enhanced food availability (Gadomski et al. 2001a).

In the Columbia River system, northern pikeminnows have adapted to their varied habitat conditions, which has allowed them to flourish despite the operations of the hydropower system. Northern pikeminnows prey heavily on juvenile salmonids and this predation is often highest around dams (Friesen and Ward 1999). Gadomiski et al. (2001) found that although the impoundment of the Columbia River system had decreased the amount of complex side-channel habitats and backwater nurseries, it has increased the availability of possible low-velocity, main-channel shoreline rearing habitats.

Reproductive Ecology

Male pikeminnows mature at age 3 and females at age 4 (Wydoski and Whitney 2003) when they are around 300 millimeters in length. Males are the first to arrive at the spawning areas where they develop a dark lateral line that runs from their snout to their caudal fin. Their fins will also change to an orange or yellow color and nuptial tubercles will develop on the heads and fins of males.

In late May to July, when water temperatures are between 14 and 18°C, males and females will congregate in large schools over gravel, cobble or rubble substrates in lakes, rivers or streams to spawn (Wydoski and Whitney 2003). Optimal spawning areas will contain gravel, cobble or rubble with enough water velocity to keep the area clean but also will add some protection so that the spawning adults can maintain position (Gadomske et al. 2001). Northern pikeminnow have been observed ascending tributaries to get to optimal spawning areas (Gadomske et al. 2001). Nests are not constructed and females quickly release their eggs over the spawning area where as many as a few hundred to several thousand male pikeminnows fertilize them. The adhesive eggs fall to the bottom and stick to the substrate. No parental care is given to the developing eggs. Spawning depends on temperature and may affect the developing larval fish growth and survival. The eggs hatch in about 7 days (Wydoski and Whitney 2003). Larval pikeminnows will then drift downstream into habitats with slow current, ample vegetation, sandy substrate, and warm temperatures (Gadomski et al. 2001a).

Movements and Habitat Use

Although larval pikeminnows are poor swimmers after hatching, they are able to locate suitable rearing habitat during their drift downstream with the current. They feed on invertebrates until they are big enough to shift to other nearby habitats. In lakes, larval pikeminnows are able to actively seek out suitable habitat. Adults usually select spawning sites that are close to adequate rearing areas. Lakes, rivers, or stream rearing habitats generally contain the same types of conditions need for larval pikeminnows to mature.

The movements of adult northern pikeminnow are also a result of foraging. In summer, adult pikeminnows patrol the shallows or move into the surface waters of the pelagic zone of lakes (Wydoski and Whitney 2003). These areas contain terrestrial insects, small fish species and some plankton (Scott and Crossman 1973). During fall and winter, the northern pikeminnow will move into deeper waters where fish become their primary food item (Scott and Crossman 1973).

Threats to Survival

The northern pikeminnow has been identified as the most abundant predator on outmigrating juvenile salmonids in the mid-Columbia River (West 2001). The northern pikeminnow is widely distributed throughout the Columbia basin (Gadomski et al. 2001a). The impoundment of the Columbia River has created suitable habitat for pikeminnow so that they have become more abundant in these areas.

Factors that can negatively affect the survival of northern pikeminnow are similar to that of all native coldwater species. Destruction of habitat (spawning, rearing, foraging and overwintering), competition with introduced species, predation by introduced species, pollution, habitat and population fragmentation, natural abrupt changes in climate and over-harvesting by man, all play a roll in reducing populations. However, there are no currently known threats that are a risk to the population in Washington.

8.5.13.2 ENVIRONMENTAL BASELINE (within the FPHCP Action Area)

We are unaware of detailed population estimates for the northern pikeminnow in the FPHCP Action Area. An aggressive northern pikeminnow removal program began in 1990's in the lower Columbia River, and yet the population remains productive in that system. The condition of the species in the FPHCP Action Area appears healthy.

Role of the FPHCP Action Area in Conservation of the Species

Suitable habitat for the northern pikeminnow occurs throughout the FPHCP Action Area. The FPHCP Action Area provides an important conservation role for the long-term survival of the species.

8.5.13.3 EFFECTS OF THE ACTION

General habitat effects to northern pikeminnow resulting from the proposed action have been summarized above for the River system Guild. They are also found in habitat associated with Mainstem and Low-Gradient Tributary Guilds.

Riparian prescription effects to northern pikeminnow

Full riparian and in-stream function likely would not be provided to all habitats occupied by the northern pikeminnow. In some stream reaches, the highest quality and most structurally complex habitats may fail to develop due to the potential reduction of large wood recruitment to streams at different time scales and following different riparian management prescriptions. Reduction in natural recruitment of large to streams would likely result in reduced stream habitat complexity, including reduced quantity and quality of pools. Large wood in freshwater habitats is important for storing and releasing the appropriate sediment for suitable substrate and to support aquatic plant growth and macroinvertebrate production. Reductions of large wood in streams could result in reduced forage for northern pikeminnow.

When RMZs achieve their Desired Future Condition, streams within the areas covered by the FPHCP that are occupied by the northern pikeminnow will receive most of the potentially available shade. Along Type Np streams, reductions in shade are likely to occur and water temperature may increase over limited distances as a result of these unbuffered Type Np. In some cases, increases in temperature may be delivered downstream to Type F waters and temperatures could be warmed near the confluence of Type Np and F streams. There are situations (yarding corridors, stream-adjacent parallel roads, 20 acre exemptions, and windthrow) where stream shading will be reduced from full ecological potential and in some circumstances there may adverse effects to northern pikeminnow due to elevated stream temperatures and the behavior and survival of individual fish may be affected. However, under most timber harvest scenarios, adequate levels of shade are expected for the conservation of northern pikeminnow.

Sediment effects to northern pikeminnow

Sediment will be delivered to northern pikeminnow habitat from road surface erosion. The FPHCP's incorporation of BMPs and RMAPs will substantially reduce road surface erosion to speckled dace habitat, but it will not prevent all sediment from reaching aquatic habitats occupied by northern pikeminnow. Certain watershed features and road location, design, and use may contribute sediment to fish-bearing streams that are above natural background rates. Sediment delivered to streams from roads is likely to have more effects to northern pikeminnow habitat than hillslope erosion due to the magnitude and potentially chronic delivery from roads of sediment to streams. Primary stream productivity and benthic habitat may be negatively affected from increased sedimentation, which could affect northern pikeminnow. Individual fitness and survival may be reduced for some fish. Effects are expected at some locations, normally at a reach or smaller scale.

Culvert and bridge replacement projects often require dewatering a short segment of stream. Mortality of northern pikeminnow in the vicinity of a culvert project would probably occur.

Effects from the 20-acre Exemption Rule

Although there is uncertainty regarding how often this rule would be implemented, when it is implemented the 20-acre Exemption Rule would likely adversely affect northern pikeminnow. In watersheds with a high proportion of 20-acre exempt landowners, this rule would increase the likelihood that large wood recruitment would be inadequate to maintain properly functioning habitat (USFWS & NMFS 2006). There is also the potential for increased sedimentation, reduced shade, increased stream temperatures, and increased windthrow. Where these adverse effects occur, essential behaviors associated with foraging, reproduction and growth may be impeded. In situations like this, northern pikeminnow may occupy the stream at reduced levels.

Because capturing all northern pikeminnow prior to culvert and bridge replacement projects is unlikely, mortality to the northern pikeminnow could occur during these projects.

Summary of adverse effects to northern pikeminnow

The proposed action will have short- to long-term adverse effects on sediment, large wood, and temperature. These effects to the aquatic environment may result in impairment of essential foraging, rearing, and spawning behavior of northern pikeminnow. It is difficult to predict the severity of these effects because effects to their habitat would likely vary from activity to activity depending on the specific riparian prescriptions, the location of the activity, historical management practices, geological characteristics of the watershed, and the biotic community present.

Activities covered under the FPHCP are expected to have direct and indirect adverse effects to adult and juvenile northern pikeminnow ranging from mortality to sublethal effects. Direct injury and death to northern pikeminnow would likely occur during some stream crossing construction activities (stream dewatering, fish rescue, and relocation, blockage of upstream migration during construction). Increased sediment levels could reduce available habitat and prey items for northern pikeminnow. This could affect the growth and survival of northern pikeminnow. In general the population is well distributed and healthy in Washington, and no further effects to the species, other than those analyzed above, are anticipated.

Summary of beneficial effects to northern pikeminnow

The FPHCP prescriptions are expected to contribute to increasing the likelihood that northern pikeminnow survive in the FPHCP Action Area. Maturation of riparian areas, maintaining and restoring northern pikeminnow passage, adaptive management, and improved road management practices are all expected from implementation of the FPHCP. Most disturbances from the proposed action are generally expected to be short-term in nature and at a reach or less (habitat unit) scale. Disturbance levels are not expected to cause large scale declines in northern pikeminnow abundance or distribution.

8.5.13.4 CUMULATIVE EFFECTS

Cumulative effects were addressed in the **Comprehensive Cumulative Effects** section, with respect to the aquatic and riparian environment in Washington State. Additional information regarding cumulative effects for the covered fish species was presented in the section Mainstem, Lentic and River System Guilds**: Cumulative Effects.**

No Additional information is available with respect to cumulative effects for this particular species above those cumulative effects already discussed earlier in this document.

8.5.14 Lake chub (*Cauesius plumbeus*) and Tui chub (*Gila bicolor*)

8.5.14.1 Status of the Species

Description of the Species

The lake chub is similar in appearance to the speckled dace (Wydoski and Whitney 2003). Lake chub have an elongated body with a long caudal peduncle and have an average length of approximately 100 millimeters (Scott and Crossman 1973). They have a short head with a bluntly rounded snout with a threadlike barbel at the corners of the mouth. Their cycloid scales can be silvery in color. The color of their backs can be a pale olive to olive-brown, brown, dark brown or black with a white belly (Scott and Crossman 1973). Males and females will develop nuptial tubercles on the head and dorsal surface, although female tubercles are less developed. Males will also often develop splashes of red or red-orange coloration on the underside and on the pectoral fins, however this varies with region.

The tui chub has a thick caudle peduncle and is similar in appearance to that of the goldfish or carp, however it lacks the long dorsal fin and spinous rays (Wydoski and Whitney 2003). It has large scales which can be variable in color, shape and size. It is often a deep olive on its dorsal surface becoming lighter along the sides and white on the belly. The scales can also have a brassy reflection. The fins are olive and tinted with red. The young have a narrow dark stripe along the lateral line (Scott and Crossman 1973). It has a pointed head and rather large eyes with a small terminal and slightly oblique mouth.

Historic and Current Range

Lake chub occupy the northern half of North America (Wydoski and Whitney 2003). In Washington, it is found in the Columbia River system. It was recorded in Twin Lake in Snohomish County in the 1950's, however, it is unknown if they still exist at that location (Wydoski and Whitney 2003).

Tui chub occur in several areas of California, Nevada, Oregon, and Washington. In Washington, they are found in reservoirs, ponds, potholes, and warm, slow-moving reaches of lower Crab Creek about 5 and 10 miles downstream from the Potholes Reservoir (Wydoski and Whitney 2003) in the Columbia River basin.

Essential Habitat Components

Lake chub inhabit lakes and streams, but prefer lakes (Wydoski and Whitney 2003). Lake populations use tributary streams for spawning and spend the majority of the year near the bottom of lakes. Much of what is known about this species is from Canada, where it has a wide distribution, and data available are from widely scattered regions. If lakes are not available they have been known to occupy deep areas of large rivers.

Much of the information on the life history of the tui chub comes from California and Utah where there are several isolated populations of tui chub subspecies. They generally prefer lakes, ponds and slow moving streams. They can tolerate highly alkaline lakes with pH's ranging between 9 to 11, and low dissolved oxygen levels as low as 50 percent saturation, and even lower in cool water (<25 percent saturation) (Moyle 2002). They prefer sandy substrates with beds of aquatic plants (Wydoski and Whitney 2003; Moyle 2002). Young tui chub will form schools and swim parallel to the shore in shallow water or congregate in heavy aquatic vegetation (Sigler and Sigler 1987). Maximum temperature limit of the tui chub was reported to be 33°C from the Klamath River in California (range 32 to 34°C) (Wydoski and Whitney 2003). During the spring, tui chub will migrate to shallow water and then return to deeper water during the fall and winter (Wydoski and Whitney 2003).

Reproductive Ecology

There is very little information on the reproductive ecology of the lake chub and all data is currently known from a few studies conducted in Canadian waters. Lake chub usually begin to spawn in early spring, migrating from lakes into small tributaries (Scott and Crossman 1973). Water temperatures at the beginning of spawning can be between 14 and 19°C. They don't construct nests; eggs are deposited by broadcast spawning over coarse gravel, small rubble, and rocks in shallow water (Wydoski and Whitney 2003). Lake chub are thought to mature by their third or fourth year and probably not survive beyond 5 years (Scott and Crossman 1973).

The reproductive information on the tui chub comes from studies conducted in California, Oregon and Utah. Tui chub spawn from late April to June during their third year of life. Water temperatures at this time are between 13 and 16°C (Wydoski and Whitney 2003). The eggs are deposited in shallow water (less than 1.5 meters deep) over beds of aquatic vegetation or algae-covered rocks and gravel (Moyle

2002). Often, in Lake Tahoe, large swirling aggregations of tui chub, with several males to one female, deposit eggs over sandy substrates (Moyle 2002). Eggs hatch in about 10 to 12 days. Fry are approximately 1.25 centimeters in length and stay close to aquatic vegetation (Wydoski and Whitney 2003).

Movements and Habitat Use

Lake chub migrate from the lake environment to spawn in small tributaries (Scott and Crossman 1973). Length of their migration is unknown. They have also been captured in deeper parts of the lake during summer.

Tui chub in California migrate to shallow waters during spring to spawn. The extent of this migration and habitat used is unknown. Tui chub are known to travel in schools and stay in deeper waters during the winter months (Wydoski and Whitney 2003).

Threats to Survival

Both species of chub appear to have very small, limited distributions in Washington State. Their population status is unknown. The lake chub was listed as a "state candidate" species in 1998 due to its apparent, sparse distribution (Wydoski and Whitney 2003). The tui chub is also confined to small parts of the Columbia Basin, which is its most northern part of its native range (Wydoski and Whitney 2003). Both of these species could be vulnerable to extirpation from introduced warm-water fish. Forest practice activities are expected to have little effect on their abundance and distribution.

8.5.14.3 ENVIRONMENTAL BASELINE (within the FPHCP Action Area)

Tui Chub occur in a small area of the Columbia basin in reservoirs, ponds, potholes, and warm, slow moving reaches of lower Crab Creek. The species does not occur in the FPHCP Action Area.

The lake chub also has a limited distribution in Washington, of which some of it may be in the FPHCP Action Area. It spends much of its life in lakes, but move into streams for spawning (Wydoski and Whitney 2003). Population status of the species is currently unknown in the FPHCP Action Area.

Role of the FPHCP Action Area in Conservation of the species:

The Tui chub does not occur in the FPHCP Action Area and will be unaffected by the FPHCP. The Lake chub may occur in the FPHCP Action Area. The FPHCP Action Area may provide a minor conservation role for long-term conservation of the lake chub.

8.5.14.4 EFFECTS OF THE ACTION

General habitat effects to Tui and lake chub resulting from the proposed action have been summarized above for the Mainstem and Lentic Guilds. They also occur in habitat associated with the River System Guild.

Summary of effects to Tui chub

No effects to the Tui chub are expected from the FPHCP, because they are very limited in distribution and do not occur in an area that would be affected by the FPHCP..

Summary of riparian prescription effects to lake chub

No effects from the riparian prescriptions, other than those described in its assoicated guilds, are anticipated for the lake chub.

Summary of sediment effects to lake chub

Lake chub deposit their eggs by broadcast spawning over coarse gravel, small rubble, and rocks in shallow water. Sediment could be delivered to lake chub spawning habitat from road surface erosion. The FPHCP's incorporation of BMPs and RMAPs will substantially reduce road surface erosion to lake chub habitat, but it will not prevent all sediment from reaching aquatic habitats occupied bylake chub. Certain watershed features and road location, design, and use may contribute sediment to fish-bearing streams that are above natural background rates. Primary stream productivity and benthic habitat may be negatively affected from increased sedimentation, which could affect lake chub. Individual fitness and survival may be reduced for some fish. Effects are expected at some locations, normally at a stream reach or smaller scale.

Culvert and bridge replacement projects often require dewatering a short segment of stream. Mortality of lake chub in the vicinity of a culvert project would probably occur.

Effects from the 20-acre Exemption Rule

Although there is uncertainty regarding how often this rule would be implemented, when it is implemented the 20-acre Exemption Rule would likely adversely affect lake chub.. In watersheds with a high proportion of 20-acre exempt landowners, this rule would increase the likelihood that large wood recruitment would be inadequate to maintain properly functioning habitat (USFWS & NMFS 2006). There is also the potential for increased sedimentation, reduced shade, increased stream temperatures, and increased windthrow. Where these adverse effects occur, essential behaviors associated with foraging, reproduction and growth may be impeded. In situations like this, lake chub may occupy the stream at reduced levels.

Because capturing all lake chub prior to culvert and bridge replacement projects is unlikely mortality to lake chub is likely occur during these projects.

Summary of adverse effects to lake chub

The proposed action will have short- to long-term adverse effects on sediment. These effects to the aquatic environment may result in impairment of essential spawning behavior oflake chub. It is difficult to predict the severity of these effects because effects to their habitat would likely vary from activity to activity depending on the specific riparian prescriptions, the location of the activity, historical management practices, geological characteristics of the watershed, and the biotic community present.

Activities covered under the FPHCP are expected to have direct and indirect adverse effects to adult and juvenile northern lake chub ranging from mortality to sublethal effects. Direct injury and death to lake chub would likely occur during some stream crossing construction activities (stream dewatering and fish rescue and relocation, blockage of upstream migration during construction. Effects are expected to be limited to very short sections of streams, at reach levels or less. Although spawning success may be reduced in some circumstances, but it is not expected to affect populations of the lake chub at the watershed level. Resilience of the lake chub population will remain unaffected by the FPHCP.

Summary of beneficial effects to lake chub

The FPHCP prescriptions are expected to contribute to increasing the likelihood that lake chub survive in the FPHCP Action Area. Maturation of riparian areas, maintaining and restoring lake chub passage, adaptive management, and improved road management practices are all expected from implementation of the FPHCP. Most disturbances from the proposed action are generally expected to be short-term in nature and at a reach or less (habitat unit) scale.

8.5.14.5 CUMULATIVE EFFECTS

Cumulative effects were addressed in the **Comprehensive Cumulative Effects**, with respect to the aquatic and riparian environment in Washington State. Additional information regarding cumulative effects for the covered fish species was presented in the section **Lentic Guild: Cumulative Effects.**

No additional information is available with respect to cumulative effects for these particular species above those cumulative effects already discussed earlier in this document.

8.5.15 Peamouth (*Mylocheilus caurinus*)

8.5.15.1 Status of the Species

Description of the Species

Adult peamouth have an elongate body averaging 100 to 150 millimeters in length (Scott and Crossman 1973). Their mouth is slightly inferior due to a slightly overhanging snout (Scott and Crossman 1973). There is a small barbel at each corner of the mouth and a small axillary process at the origins of the pelvic fins (Wydoski and Whitney 2003). During breeding, males will develop nuptial tubercles on their heads, gill covers, and back. They are red around the mouth, cheeks and operculums back to their pectoral fins and along their sides. Breeding individuals will develop red lower lips and lateral red stripes (Scott and Crossman 1973). Males will often have a green colored back while the females will be brown. Mature individuals can be a silvery color with two dark lateral bands, a dark green or brown back and white underside.

Historic and Current Range

Peamouth occur in British Columbia and Alberta, Canada, Montana, Idaho, Oregon, and Washington. In Washington they occur in coastal and Puget Sound watersheds, Columbia River and it tributaries, and in eastern Washington. However, they are absent along the northern and eastern slopes of the Olympic Peninsula (Wydoski and Whitney 2003).

Essential Habitat Components

Although widespread in Washington, very little is known about the behavior and habitat of peamouth. They are know to occur in both lakes and streams and can even tolerate seawater (Wydoski and Whitney 2003). The young are known to inhabit shallow water in the spring, summer, and fall. Often, peamouth will inhabit shallow areas that are covered in ice during the winter (Nishimoto 1973). Adults tend to be deeper during the day and move to shallow areas at night (Wydoski and Whitney 2003). Peamouth are generally found where the water is the warmest (Wydoski and Whitney 2003). Adults feed primarily on benthic organisms, and juveniles feed on zooplankton (Nishimoto 1973).

Reproductive Ecology

Very little is known about the reproductive behavior of peamouth. Most accounts of peamouth reproductive ecology come from studies done in the Lake Washington basin (Schultz 1935; Nishimoto 1973). Males from Lake Washington reach maturity at age 3, and females at 4 years (Nishimoto 1973). Spawning often takes place along lake shorelines or in tributaries, but neither has been seen or recorded. Large schools of about 60,000 adult peamouth have been seen migrating up the Cedar River, approximately 7.4 and 14.5 kilometers from the mouth (Tabor, Personal Communication, , 2005). Water temperatures during this time in the river and lake were approximately 12.0 °C (Wydoski and Whitney 2003). Eggs are found to be attached to stone and rubble and hatch between 7 and 8 days at 12.2°C (Scott and Crossman 1973; Wydoski and Whitney 2003).

Movements and Habitat Use

Very little is known about the overall movements and habitat use of peamouth. They make migrations to spawning areas during late spring and early summer (Nishimoto 1973; Scott and Crossman 1973); however the extent is still unknown. Their movements during this time are thought to occur during certain moon phases and may only last one or two days (24 to 48 hours) (Tabor 2005). During the early summer newly hatched young have been seen moving in schools along lake shorelines and into bays where there are warmer water temperatures, preferred food, and abundant aquatic vegetation (Nishimoto 1973). As they increase in size they then begin to move into deeper waters in late summer (Scott and Crossman 1973). Adult peamouth spend much of their lives in deeper waters of Lake Washington, only moving off the bottom to feed on mysid shrimp higher in the water column (Wydoski and Whitney 2003). Some populations of peamouth in other parts of their range make greater movements at night and during the day due to lack of predators (Nishimoto 1973).

Threats to Survival

Peamouth have a broad distribution in Washington, but information on their abundance is limited. Specific threats to the species are unknown at this time. Peamouth in Lake Washington have been studied, but their population status remains unknown. Tabor (2005) noted that during a snorkel survey in the spring of 1999 he and other biologists observed approximately 50,000 to 60,000 peamouth adults migrating up the Cedar River, presumably to spawn. Population trends in Washington are unknown.

8.5.15.2 ENVIRONMENTAL BASELINE (within the FPHCP Action Area)

The peamouth occurs throughout much of western and eastern Washington. Population trend for the species is currently unavailable.

Role of the FPHCP Action Area in Conservation of the Species:

The peamouth has a large distribution in Washington and occurs in the FPHCP Action Area in suitable habitats. The FPHCP Action Area provides an important role for long-term conservation of the species.

8.5.15.3 EFFECTS OF THE ACTION

General habitat effects to peamouth resulting from the proposed action have been summarized above for the Lentic Guild.

Summary of sediment effects to peamouth

Sediment would be delivered to peamouth habitat from road surface erosion, and to a lesser extent, hillslope erosion. The FPHCP's incorporation of BMPs and RMAPs will substantially reduce road surface erosion to peamouth habitats, but it will not prevent all sediment from reaching aquatic habitats occupied by the species. Certain watershed features and road use may contribute sediment to fish-bearing streams that are above natural background rates. Culvert projects may increase siltation over short durations. Sediment delivered to streams from roads is likely to have more effects to the species than hillslope erosion due to the magnitude and potentially chronic delivery of sediment to streams. Excessive siltation may affect food resources (zooplankton, aquatic and terrestrial insects) of peamouth. Feeding behavior may be altered under some circumstances, affecting individual fitness and survival. Effects are expected to be limited to a stream reach or smaller scale and not affect the population as a whole. It is unlikely that distribution of the species will be reduced.

Summary of adverse effects to peamouth

The proposed action would have short- to long-term adverse effects on sediment. These effects would be most severe from unbuffered Type Np streams and their downstream effects that result in disruption of natural riparian and aquatic processes and functions in Type F streams. These effects to the aquatic environment may result in impairment of essential foraging behavior of peamouth. It is difficult to predict the severity of these effects because little is know about peamouth habitat requirements and effects to these fish will vary from activity to activity depending on the specific riparian prescriptions applied, the location, historical management practices, geological characteristics of the watershed, and the biotic community present.

Activities covered under the FPHCP are expected to have direct and indirect adverse effects to adult and juvenile peamouth ranging from mortality to sublethal effects. Direct injury and death to peamouth would likely occur during some stream crossing construction activities (stream dewatering and fish rescue and relocation, blockage of upstream migration during construction). Increased sediment levels could reduce available habitat and prey items for chiselmouth. This could affect the growth and survival of juvenile and adult peamouth.

Summary of beneficial effects

The long-term benefits of the FPHCP are expected to outweigh the short-term, negative affects to peamouth. The severity of individual effects to will vary from activity to activity depending on the location, past management practices, geological characteristics of the watershed, and the biotic community present. However, maturation of riparian areas, maintaining and restoring peamouth passage, adaptive management, and improved road management practices are all expected from implementation of the FPHCP. These management prescriptions are expected to contribute to increasing the likelihood of long-term survival for peamouth in the FPHCP Action Area.

The FPHCP is not expected to reduce the chance of long-term survival of the peamouth in the FPHCP Action Area.

8.5.15.4 CUMULATIVE EFFECTS

Cumulative effects were addressed in the **Comprehensive Cumulative Effects** section, with respect to the aquatic and riparian environment in Washington State. Additional information regarding cumulative effects for the covered fish species was presented in the section **Lentic Guild: Cumulative Effects.**

No additional information is available with respect to cumulative effects for this particular species above those cumulative effects already discussed earlier in this document.

8.5.16 Largescale sucker (*Catostomous macrocheilus*)

8.5.16.1 Status of the Species

Description of the Species

The largescale sucker is a long, dark, and noticeably counter-shaded member of the sucker family. The main characteristic that distinguishes it from the other members of the sucker family is that it lacks notches in the corners of the mouth. The mouth is subterminal, protrusible, lacks teeth, and is not overhung by the snout (Wydoski and Whitney 2003). It has large lips, and the lower lip is deeply incised with coarse, oval papillae and has a complete cleft. The caudal fin is moderately long and well forked, and the anal fin is long and pointed. The largescale sucker has large cycloid scales that increase in size from the head to the tail. Its color is blue-gray to olive, beginning just below the lateral line and covering the entire dorsal surface. Below the lateral line, the color is creamy-white. During breeding, the male largescale sucker develops nuptial tubercles along the lower lobe of the caudal and anal fin. The female sometimes develops tubercles that are not as pronounced as in males.

Historic and Current Range

The historic range is currently unknown at this time. The species occurs from British Columbia and Alberta, Canada, Oregon, Idaho, Montana and Washington (Wydoski and Whitney 2003). The largescale sucker is found throughout Washington. On the Olympic Peninsula it is found in a few streams and lakes in the southern and western portions of the Peninsula and is absent from the north and eastern portions of the Peninsula. In the Columbia River basin, it is the predominant species of sucker, comprising 94 percent of sucker species (Wydoski and Whitney 2003).

Essential Habitat Components

The largescale sucker is found in lakes, streams, and large rivers (Wydoski and Whitney 2003). Adults are benthic and generally found in shallow water. They are sometimes found at the mouths of streams that are entering a lake, or in quiet shallow backwaters of rivers. In the spring, lake-dwelling largescale suckers are usually found in shallow bays. Larval largescale suckers are generally pelagic. In the Columbia River near the Hanford Reach, they can also be found along the shoreline in low-velocity water at night. The young are pelagic until they are about 18 millimeters in length (Scott and Crossman 1979). As fry, largescale suckers tend to occupy pools and backwaters with mud and cobble substrates. Fry generally form large schools in weedy shoreline areas of lakes and the backwaters of rivers and streams. They occupy the shallows during the daytime and move to deeper water at night. They inhabit waters with a wide range of temperatures throughout the year. Black (1953) determined the upper lethal water temperature for largescale suckers to be 29° C.

Reproductive Ecology

Spawning takes place from April to June (or possibly early July), depending on location. Males are generally mature at age three, and females can mature at age four or five. Age at maturity can also be dependent upon location. Largescale suckers generally move from lakes and large rivers into smaller streams or tributaries to spawn (Sigler and Sigler 1987). Spawning takes place in shallow-water riffles, along the edges of streams and rivers, and in the tail-outs of pools (Wydoski and Whitney 2003). Spawning substrate is generally composed of fine gravel, sand, and silt. In the Cedar River at Renton, largescale suckers spawned in 1-meter deep water in low to moderate current (Wydoski and Whitney 2003). Spawning takes place during the day; however, in streams and rivers with little to no cover, spawning often occurs during the night. Water temperatures during spawning vary by location. In the Columbia River at the Hanford Reach, spawning occurs in water temperatures between 12° C and 15° C, while in the Pend Oreille River, spawning occurs between 8° C and 13° C (Wydoski and Whitney 2003). Spawning can take place along lake shores that have adequate substrate and wave action. Females broadcast their eggs as several males fertilize them. The eggs are adhesive and stick to the substrate after they are released, and remain adhered to the substrate for approximately 2 weeks. After hatching, the larval largescale suckers drift for 1 to 3 days in the current until they find a quiet backwater or lake shore in which to rear.

Movements and Habitat Use

Largescale suckers occupy specific habitats at various stages throughout their lives. During the larval stage, largescale suckers exhibit a pelagic life phase and move throughout the surface waters of the Columbia River shoreline at night (Wydoski and Whitney 2003). As they grow in size and become fry, they move to deeper waters and begin their benthic life phase. They then use inshore habitat during the day and move into deeper waters at night. As adults they reverse this behavior and are more abundant along the shallows of the shoreline at night than during the day (Wydoski and Whitney 2003).

Adult largescale suckers tagged in Lake Roosevelt and on the Pend Oreille River were generally recaptured (74 percent to 90 percent) at or near the tagging site (within 9.6 kilometers) (Wydoski and Whitney 2003). However, in a tagging study on the Columbia River in British Columbia, very few (20 percent) were recaptured at the tagging site (Wydoski and Whitney 2003). Some tagged fish moved greater distances (approximately 40 kilometers downstream and 49.6 kilometers upstream) (Wydoski and Whitney 2003).

During the spawning season, adult largescale suckers move from large rivers and lakes into smaller rivers or streams to spawn. In the Lake Washington Basin, groups of largescale suckers are regularly observed moving out of Lake Washington and into the Cedar River to spawn. Similar migrations occur in the Columbia River in early summer. However the extent of these regularly observed seasonal movements of largescale suckers are for the most part unknown.

THREATS TO SPECIES

There are currently no known threats to the largescale sucker in Washington. The species has a broad distribution in Washington and occupies a diversity of habitats. They are likely an important species in the food web of northwest fauna.

8.5.16.2 ENVIRONMENTAL BASELINE (within the FPHCP Action Area)

The largescale sucker is found throughout the FPHCP Action Area and is the most-widely distributed sucker in Washington State. It is the predominant species of sucker within the Columbia River and its tributaries (Wydoski and Whitney 2003). The largescale sucker is found in lakes, streams, and large rivers (Wydoski and Whitney 2003). In 1981, the population of largescale suckers in the Columbia River was estimated to be 9,297 per mile in June, and 7,670 per mile in July (Wydoski and Whitney 2003). Population trends in Washington are currently unknown.

Role of the FPHCP Action Area in Conservation of the Species

The largescale sucker has a broad distribution in Washington and is found both within and outside of the FHPC Action Area. The FPHCP Action Area provides important habitats for the largescale sucker in Washington.

8.5.16.3 EFFECTS OF THE ACTION

General habitat effects for the largescale sucker resulting from the proposed action have been summarized above for the Lentic Guild. The largescale sucker occupies lakes and streams and also uses habitat found in the River System, Mainstem and Low-gradient Guilds.

Summary of sediment effects to largescale sucker

Sediment would be delivered to largescale sucker habitat from road surface erosion, and to a lesser extent, hillslope erosion. The FPHCP's incorporation of BMPs and RMAPs will substantially reduce road surface erosion to sucker habitats, but it will not prevent all sediment from reaching aquatic habitats occupied by the species. Certain watershed features and road use may contribute sediment to fish-bearing streams that are above natural background rates. Culvert projects may increase siltation over short durations, especially until vegetation has recovered to reduce harmful sediment. Some fish may die as a result of dewatering stream segments to replace culverts.

Sediment delivered to streams from roads are likely to have more effects to the species than hillslope erosion due to the magnitude and potentially chronic delivery of sediment to streams. Excessive siltation may affect food resources (algae, diatoms, aquatic insects, crustaceans, and snails) of largescale sucker. Feeding behavior may be altered under some circumstances affecting individual fitness and survival. Effects are expected to be limited to a stream reach or smaller scale.

Summary of adverse effects to largescale sucker

The proposed action will have short- to long-term adverse effects on sediment. These effects to the aquatic environment may result in impairment of essential spawning behavior oflake chub. It is difficult to predict the severity of these effects because effects to their habitat would likely vary from activity to activity depending on the specific riparian prescriptions, the location of the activity, historical management practices, geological characteristics of the watershed, and the biotic community present.

Activities covered under the FPHCP are expected to have direct and indirect adverse effects to adult and juvenile largescale sucker ranging from mortality to sublethal effects. Direct injury and death to largescale sucker would likely occur during some stream crossing construction activities (stream dewatering, fish rescue and relocation, and blockage of upstream migration during construction). Effects are expected to be limited to very short sections of streams, at stream reach levels or less. Although spawning success may be reduced in some circumstances, it is not expected to affect populations of the largescale sucker at the watershed level. Persistence of the largescale sucker population will remain unaffected by the FPHCP.

Summary of beneficial effects

The long-term benefits of the FPHCP are expected to outweigh the short-term, negative affects to largescale sucker. The severity of individual effects will vary from action to action depending on the location, past management practices, geological characteristics of the watershed, and the biotic community present. However, maturation of riparian areas, maintaining and restoring largescale sucker passage, adaptive management, and improved road management practices are all expected from implementation of the FPHCP. These management prescriptions are expected to contribute to increasing the likelihood of long-term survival for largescale sucker in the FPHCP Action Area.

8.5.16.4 CUMULATIVE EFFECTS

Cumulative effects were addressed in the **Comprehensive Cumulative Effects** section, with respect to the aquatic and riparian environment in Washington State. Additional information regarding cumulative effects for the covered fish species was presented in the section **Lentic Guild: Cumulative Effects.**

No additional information is available with respect to cumulative effects for the largescale sucker above those cumulative effects already discussed earlier in this document.

8.5.17 Longnose Sucker (*Catostomus catostomus*)

8.5.17.1 Status of the Species

Salish Sucker (*Catostomus carli* – species pending)
Note: The longnose and Salish suckers are very similar and were thought to be the same species. The status of the Salish sucker is still in question, but it is most likely an offshoot from the longnose sucker. They are morphologically distinguishable and their distribution does not overlap in Washington.

Description of Species

The longnose sucker is distinguished from other suckers by having a long snout that overhangs a subterminal mouth. The mouth is protrusible, suctorial, moderately small and lacking teeth. The lips are large with coarse, long, oval papillae. The lower lip has a complete cleft and may have one row of papillae crossing at the base. The top of the snout is sometimes concave over the mouth. The body is somewhat elongate and torpedo-shaped, with a long anal fin and moderately forked caudal fin. Small cycloid scales cover the body, becoming more crowded and smaller toward the head and larger on the caudal peduncle. The color of the longnose sucker is dark olive with brassy, gray or black reflections on the dorsal surface, below the eye on the head, and on the upper sides. Ventrally, and along the lower sides, the color becomes a creamy white. During breeding, both the male and female develop a broad mid-lateral band of vivid rose color. Above this band, the color may change to black or green-gold or coppery brown in females. A yellow-orange color on the undersurface of the head and mouth develops. The belly may become bright white to pink. The edges of fins develop a pale red or amber with pink color.

The description of the Salish sucker is very similar to that of the longnose sucker. They do, however, differ in a few morphological characteristics. In the Salish sucker, the snout is slightly shorter than that of the longnose sucker, and the body is somewhat deeper (Wydoski and Whitney 2003). The lateral-line scale count of the Salish sucker ranges between 84 to 86, while the longnose sucker has average scale counts that range between 103 to107 (Wydoski and Whitney 2003).

Historic and Current Range

The longnose sucker occurs across much of North America. In Washington, the longnose sucker is currently found throughout the Columbia River system from about the mouth of the Yakima River upstream. The historic range of the longnose sucker most likely covered the entire Columbia River system before the construction of dams.

The Salish sucker is currently found in northwest Washington and the Fraser River system in British Columbia, Canada (Pearson 1998). In western Washington it is found in the Nooksack River, Lake Whatcom, Twin Lakes of the Stilliguamish River system, the Green River, and Lake Cushman of the Skokomish River system (Pearson 1998). The historic range of this species is currently unknown.

Essential Habitat Components

The longnose and the Salish suckers occupy similar habitats throughout their range. They both occur in cold water lakes and lowland streams with associated ponds and in major rivers. They are found in a variety of habitats, depths, and velocities. Adults are generally found in deeper water and offshore during the day, while younger fish are in shallow weedy areas of lakes. Juvenile Salish suckers are most often found among in-stream vegetation or along stream banks with overhanging vegetation (Blood 1993). Young-of-the-year suckers are found in habitats similar to adult habitats, but with more overhanging vegetation cover (Pearson 1998). In the Yellowstone system, fry tended to occupy small shallow pools in streams and tended to spend their first summer in streams (Wydoski and Whitney 2003). During the summer, longnose and Salish suckers are found in slow-water, off-channel backwaters, protected lagoons, and bays with silt and sandy substrates, aquatic vegetation and ample riparian cover (Pearson 1998). The Committee on the Status of Endangered Wildlife in Canada (COESWIC) found that, in British Columbia, the Salish sucker was found in deep marshy headwaters with heavy cover and was often caught in waters where temperatures were above 20° C in the summer (COSEWIC 2002). Black (1953) found that lethal temperatures to the longnose sucker were between 26.5° C and 27° C.

Reproductive Ecology

Spawning generally starts during the spring and can last until late summer. Both species have similar spawning behaviors and select similar spawning habitat. The longnose and Salish suckers generally spawn in swift riffles of small streams over gravel substrate (Pearson 1998), although in-lake spawning has also been observed in shallow lakeshore areas (Scott and Crossman 1979). Spawning generally begins when water temperatures reach a specific point, and spawning temperatures and timing can vary as to location. For the Salish sucker in British Columbia, spawning begins when temperatures are between 7° C and 8° C (Pearson 1998), and can last until late August when temperatures are as high as 20° C (Wydoski and Whitney 2003). The longnose sucker was found to begin spawning in British Columbia when water temperatures reached 5° C (Scott and Crossman 1979).

Suckers move upstream out of lakes or larger rivers into small shallow streams to spawn. This movement is often done at night (Scott and Crossman 1979). Spawning takes place as several male suckers accompany a single female to the spawning area. The female broadcasts her eggs as the males fertilize them. The eggs are adhesive and settle onto and between the gravel substrate. Eggs that are on top of the gravel are usually eaten by other fish. After spawning is completed, females return to the slower portions of the stream or back into the lake, while the males remain at the site to possibly spawn again. The eggs hatch in about 2 weeks at water temperatures of 5° C to 10° C (COSEWIC 2002). Fry remain in the gravel for a further 1 to 2 weeks (Pearson 1998).

Movements and Habitat Use

Little is known about the movements and habitat use of the longnose and Salish suckers. Spawning migrations of suckers into smaller headwater streams, from lakes or rivers, has been documented in the longnose sucker (Scott and Crossman 1979), but the extent of this migration and the specific habitat used is unknown at this time.

Observations of local movements of Salish suckers indicate they become more active and have greater movements at night (COSEWIC 2002). This is in contrast to their behavior during the day, where they seek out dense cover in which to hide. Some nightly movements of Salish suckers are extensive, as some fish have been observed moving several hundred meters downstream before returning to their daytime hiding area (COSEWIC 2002).

Threats to Survival

Possible threats to the survival of both species include commonly cited factors, such as pollution of streams, loss of riffle habitat, interactions with non-native species, forest-removal, farming activities, removal of cover elements, alteration of stream flow, and lethal temperature effects. In British Columbia, these factors have caused the Salish sucker to become endangered. The Salish sucker is listed in British Columbia as endangered by COSEWIC due to their restricted distribution and habitat degradation as a result of human land uses (McPhail and Taylor 1999).

8.5.17.2 ENVIRONMENTAL BASELINE (within the FPHCP Action Area)

The Salish and longnose sucker both have significant components of their distribution within the FPHCP Action Area. The longnose sucker is found in coldwater lakes and streams and the Salish sucker inhabits lowland streams and associated ponds (Wydoski and Whitney 2003). These types of aquatic habitats are commonly associated with the proposed action. Population trend of the longnose sucker is unknown.

The Salish sucker in British Columbia, Canada, has declined in abundance, apparently due to impacts from urbanization. In Washington, the Salish sucker was historically reported from Bertrand Creek, Cave, and Fishtrap Creek in the Nooksack watershed. Surveys more recently conducted by the WDFW did not find the fish in these streams (Wydoski and Whitney 2003). These particular streams are substantially influenced by agricultural practices.

Role of FPHCP Action Area in Conservation of species:

Salish and longnose sucker occur throughout the FPHCP Action Area. The FPHCP Action Area provides suitable habitats for these two species and is important for the long-term conservation of these two species.

8.5.17.3 EFFECTS OF THE ACTION

General habitat effects to the Salish sucker resulting from the proposed action have been summarized above for the Lentic and Mainstem Guilds. General habitat effects to the longnose sucker resulting from from the proposed action have been summarized above for the Lentic, Mainstem and Low-Gradient Tributary Guilds.

Riparian prescription effects to Salish and longnose suckers

Full riparian and in-stream function likely would not be provided to all habitats occupied by Salish and longnose suckers. In some stream reaches, the highest quality and most structurally complex habitats may fail to develop due to the potential reduction of large wood recruitment to streams following different riparian management prescriptions. Large wood in freshwater habitats is important for storing and releasing the appropriate sediment for development of suitable substrate, pool formation and aquatic plant growth. Large wood is also used by the Salish and longnose sucker for cover and reduced large wood may result in increased predation.

The longnose sucker has been reported to use coldwater lakes and streams (Wydoski and Whitney 2003). When RMZs achieve their Desired Future Condition, streams within the areas covered by the FPHCP that are occupied by the Salish and longnose suckers will receive most of the potentially available shade. Along Type Np streams, reductions in shade are likely to occur and water temperature may increase over limited distances as a result of these unbuffered Type Np streams. In some cases, increases in temperature may be delivered downstream to Type F waters and temperatures could be warmed near the confluence of Type Np and F streams. There are situations (yarding corridors, stream-adjacent parallel roads, 20 acre exemptions, and windthrow) where stream shading will be reduced from full ecological potential and in some circumstances there may be adverse effects to the Salish and longnose suckers due to elevated stream temperatures and the behavior and survival of individual fish may be affected. However, under most timber harvest scenarios, adequate levels of shade are expected for the conservation of the suckers.

Sediment effects to Salish and longnose suckers

Sediment would be delivered to Salish and longnose suckers habitat from road surface erosion and, to a lesser extent, from hillslope erosion. The FPHCP's incorporation of BMPs and RMAPs would substantially reduce delivery of road surface related sediment to Salish and longnose suckers habitats, but it would not prevent all sediment from reaching aquatic habitats occupied by the species. Certain watershed features and road related activities may contribute sediment to fish-bearing streams that are above natural background rates. For example, culvert projects may increase siltation until vegetation has recovered to reduce harmful sediment. Juvenile Salish and longnose suckers habitat includes shallow pools with large substrate such as cobble and boulders. Excessive siltation may reduce the availability of this habitat and and may affect food resources (algae, diatoms, and aquatic insects) of Salish and longnose suckers. When feeding behavior is altered by reduced prey, individual fitness and survival could be affected. However the FPHCP is not expected to contribute to instream sediment loading to the point that Salish and longnose suckers would be harmed at more than at a stream reach scale.

Effects from the 20-acre Exemption Rule

Although there is uncertainty regarding how often this rule would be implemented, when it is implemented the 20-acre Exemption Rule would likely adversely affect Salish and longnose suckers. In watersheds with a high proportion of 20-acre exempt landowners, this rule would increase the likelihood that large wood recruitment would be inadequate to maintain properly functioning habitat (USFWS & NMFS 2006). There is also the potential for increased sedimentation, reduced shade, increased stream temperatures, and increased windthrow. Where these adverse effects occur, essential behaviors associated with foraging, reproduction and growth may be impeded, and Salish and longnose suckers may occupy the stream at reduced levels and they may have reduced survival.

Summary of adverse effects to Salish and longnose suckers

The proposed action would have short- to long-term adverse effects on sediment, large wood, and temperature. These effects would be most severe from unbuffered Type Np streams and their downstream effects that result in disruption of natural riparian and aquatic processes and functions in Type F streams. These effects to the aquatic environment may result in impairment of essential foraging, rearing, and spawning behavior of Salish and longnose suckers. It is difficult to predict the severity of these effects because little is know about Salish and longnose suckers habitat requirements and effects to these fish will vary from activity to activity depending on the specific riparian prescriptions applied, the location, historical management practices, geological characteristics of the watershed, and the biotic community present.

Activities covered under the FPHCP are expected to have direct and indirect adverse effects to adult and juvenile Salish and longnose suckers ranging from mortality to sublethal effects. Direct injury and death to Salish and longnose suckers would likely occur during some stream crossing construction activities (stream dewatering, fish rescue and relocation, and blockage of upstream migration during construction). Increased sediment levels could reduce available habitat and prey items for Salish and longnose suckers. This could affect the growth and survival of juvenile and adult Salish and longnose suckers.

Summary of beneficial effects

The long-term benefits of the FPHCP are expected to outweigh the short-term, negative affects to Salish and longnose suckers. The severity of individual effects to Salish and longnose suckers will vary from activity to activity depending on the specific riparian prescriptions, location, past management practices, geological characteristics of the watershed, and the biotic community present. However, maturation of riparian areas, maintaining and restoring passage for Salish and longnose suckers, adaptive management, and improved road management practices are all expected from implementation of the FPHCP. These management prescriptions are expected to contribute to long-term survival for Salish and longnose suckers in the FPHCP Action Area.

8.5.17.4 CUMULATIVE EFFECTS

Cumulative effects were addressed in the **Comprehensive Cumulative Effects** section, with respect to the aquatic and riparian environment in Washington State. Additional information regarding cumulative effects for the Salish and longnose sucker was presented in the sections **Lentic, Mainstem and Low-Gradient Tributary Guilds: Cumulative Effects.**

No additional information is available with respect to cumulative effects for this particular species above those cumulative effects already discussed earlier in this document.

8.5.18 Bridgelip Sucker (*Catostomus columbianus*) and Mountain Sucker (*Catostomus platyrhynchus*)

8.5.18.1 Status of the Species

Description of the Species

Mountain sucker

The mountain sucker is a relatively small member of the sucker family. It has a short head with a subterminal mouth. The mouth is characterized by fleshy protrusible lips with numerous large papillae on the lower lip, while the upper lip has very few to no papillae. The mouth has deep lateral notches at the juncture of the upper and lower lips and a shallow cleft in the middle of the lower lip. The lower lip has two semicircular bare areas with round cartilaginous plates. The color of the mountain sucker is usually brown to olive-green along the dorsal surface and sides becoming white to yellow ventrally.

Bridgelip sucker

The bridgelip sucker is similar to the mountain sucker. It also has a subterminal mouth with fleshy protrusible lips. There are weak notches at the corners of the mouth rather than the deep lateral notches of the mountain sucker. The upper and lower lips both have numerous papillae. The lower lip is also not completely cleft. The color of the bridgelip is a dark brown to olive along its dorsal surface. The sides are somewhat mottled and paler brown becoming white or pale yellow on its belly. The male will often have a prominent orange lateral band along its side, especially during breeding season.

Historic and Current Range

Both the mountain and bridgelip sucker's historic range is unknown at this time. Currently they are both found mainly within the Columbia River system (Wydoski and Whitney 2003). The Mountain sucker occurs in the Black Hills of South Dakota, Idaho, Nevada and several other western states. The mountain sucker occupies the lower and mid Columbia River. It has also been found in the Cowlitz, Yakima and the Wentachee Rivers. It also occupies the Snake and Palouse Rivers.

The bridgelip sucker's range includes the lower, mid, and upper Columbia River and a majority of its tributaries (Wydoski and Whitney 2003). It has been found in the Cowlitz, Yakima, Snake, Wenatchee, Okanogan, Spokane and Walla Walla Rivers.

Essential Habitat Components

Mountain sucker

Mountain suckers are primarily found in mountain streams less than 12-meters wide with clear, cold water, and moderate gradients (Wydoski and Whitney 2003; Moyle 2002). They are also sometimes found in lakes, reservoirs and large rivers (Wydoski and Whitney 2003). They have been found in water temperatures from 13 to 21°C with a max of 27.8°C during the summer (Wydoski and Whitney 2003). They generally prefer streams that contain a mix of gravel, sand, and rubble, or large boulder substrate (Wydoski and Whitney 2003; Moyle 2002). They often seek out pools with dense cover elements such as large wood and undercut banks (Moyle 2002). In swift water they will occupy areas behind large rocks or logs (Moyle 2002; Hauser 1969). Young mountain suckers are generally found in shallow water with slow to moderate currents and ample cover elements such as aquatic vegetation, logs, undercut banks and rocks (Wydoski and Whitney 2003). They are sometimes found in intermittent side channels with very little flow and shallow depths (Hauser 1969). They will also seek out areas that have heavy algal growth in which to hide from predators (Sigler 1987). Older juvenile mountain suckers tend to occupy areas adjacent to pools (Wydoski and Whitney 2003). Adult mountain suckers are often found at the margins of runs and will move into deeper water if disturbed (Hauser 1969). Mountain suckers will also segregate from other catostomids forming small isolated schools (Moyle 2002; Scott and Crossman 1979). Mountain suckers eat a variety of diatoms, algae and aquatic insects. Juveniles generally eat more aquatic insects. Adults will seek out deep water habitats, such as pools, to overwinter in (Wydoski and Whitney 2003), and during the spring and early winter adults are usually found adjacent to pools (Hauser 1969).

Bridgelip sucker

Bridgelip suckers occupy small cold streams and large river habitats. Bridgelip sucker fry are found in inshore areas off the main river current and large young-of-the-year suckers occupy shallow pools with mixed mud and rock substrate (Dauble 1980). Adults and sub-adults tend to occupy the tails-outs of pools, at the ends of riffles and above large boulders (Dauble 1980). Bridgelip suckers are often in deep, swifter water during the day and move into slower shallower waters near shore at night (Wydoski and Whitney 2003). Bridgelip suckers are also common in backwater pools (Wydoski and Whitney 2003).

Reproductive Ecology

Mountain suckers spawn in small streams in riffles below pools from June to July in water temperatures from 11 to 19°C (Wydoski and Whitney 2003; Moyle 2002). Females mature at age three and males mature at age two (Wydoski and Whitney 2003). Males are distinguished from females by secondary sexual characteristics such as enlarged anal fin with large, pointed, cone-shaped tubercles, while the anal fin of the female is small and has medium-sized tubercles (Hauser 1969). Females are also larger and live longer than males (Moyle 2002). During spawning, males outnumber the females. Eggs are sticky and are deposited on the gravel (Moyle 2002). Females will then leave the spawning area after laying all their eggs, while the male remains to spawn multiple times (Wydoski and Whitney 2003).

The bridgelip sucker spawns in mid April to mid June with the peak spawning in May in water temperatures between 8 and 13°C (Dauble 1980). Female bridgelip suckers seek out substrate composed of pebbles, gravel, cobble and sand, and construct a redd in flowing water (Wydoski and Whitney 2003). Eggs are deposited in the redd and covered with the surrounding substrate by the female. There can be a 50 percent post spawning mortality in bridgelip suckers (Wydoski and Whitney 2003).

Movements and Habitat Use

Very little is known about the movements and habitat use of the mountain and bridgelip suckers. Both species are known to migrate or move to spawning areas (Wydoski and Whitney 2003; Dauble 1980; Moyle 2002), but it is unclear to what extent. It is know that the mountain sucker will move to and overwinter in areas of deep water and then move from these areas in the spring (Wydoski and Whitney 2003; Hauser 1969). The bridgelip sucker is also known to move from larger rivers into smaller tributaries to spawn and then back again (Wydoski and Whitney 2003). The literature suggests that spawning and locating overwintering habitat is an important factor in determining the extent of movement for both species, however the extent is still unknown.

Threats to Survival

In Washington, the mountain sucker is currently listed as a "state candidate" species listed in 1998 due to its unknown distribution and population status (Wydoski and Whitney 2003). In other western states such as California and Wyoming, the mountain sucker has had a reduction in their historic range. This reduction in the population is due to several commonly cited factors. There has been a loss of essential spawning habitat in streams above reservoirs, degradation of habitat associated with irrigation practices, degradation and loss of riparian habitats, and competition and predation by non-native species (Wydoski and Whitney 2003).

The bridgelip sucker is currently not listed on either State or Federal lists. Its population is somewhat unknown but seems to be abundant throughout its range.

8.5.18.2 ENVIRONMENTAL BASELINE (within the FPHCP Action Area)

Mountain suckers are found in the Columbia River basin in clear, cold water of mountain streams, generally less than 40 feet wide (Wydoski and Whitney 2003). The types of habitats that the mountain sucker are associated with are found in the FPHCP Action Area. Population trends for the species within the FPHCP Action Area are currently unknown at this time.

In Washington, bridgelip suckers are found in tributaries in the upper and mid Columbia River basin (Wydoski and Whitney 2003). The bridgelip sucker is more common than the mountain sucker, and in Oregon, is considered a habitat "generalist". The bridgelip sucker has a broader distribution in Washington than the mountain sucker. It is expected to occur within the FPHCP Action Area. It is considered common in the Yakima River (Wydoski and Whitney 2003). Population trends for the bridgelip sucker in the FPHCP Action Area are currently unknown at this time.

Role of FPHCP Action Area in Conservation of species:

The mountain and bridgelip sucker occur in the FPHCP Action Area. Suitable habitat occurs for both species in the FPHCP Action Area. The FPHCP Action Area provides an important role for conservation for these two species.

8.5.18.3 EFFECTS OF THE ACTION

General habitat effects for the mountain sucker as a result of the proposed action have been summarized above for the Low-Gradient Tributary Guild, but this species is also found in habitat similar to that described for the Mainstem and Steep Guilds. The effects to the bridgelip sucker were described above for the Mainstem Habitat Association, but this species may also be affected as described for the Low-Gradient Tributary Guild.

Riparian prescription effects to mountain and bridgelip suckers

Full riparian and in-stream function likely would not be provided to all habitats occupied by mountain and bridgelip suckers. In some stream reaches, the highest quality and most structurally complex habitats may fail to develop due to the potential reduction of large wood recruitment to streams following different riparian management prescriptions. The mountain and bridgelip suckers prefer streams that contain a mix of gravel, sand, and rubble, or large boulder substrate and often seek out pools with dense cover elements such as large wood and undercut banks. Young mountain suckers are generally found in shallow water with slow to moderate currents and ample cover elements such as aquatic vegetation, logs, undercut banks and rocks (Wydoski and Whitney 2003). Adult mountain sucker have been reported to use deep pools in winter and smaller fish are observed near obstructions such as logs. Large wood in freshwater habitats is important for storing and releasing the appropriate sediment for development of suitable substrate, pool formation, providing cover, aquatic plant growth, and macroinvertebrate production. Reductions in large wood recruitment to streams may result in habitat modifications that increase risk of predation, reduce forage, and reduce the survival or fitness of individual suckers.

Bridgelip and mountain sucker require cool water for survival. The mountain sucker is associated with cool water of mountain streams and preferred summer temperatures are between 55 and 70° F. Bridgelip suckers have been reported spawning in April and May in 46 to 55 ° F temperatures. When RMZs achieve their Desired Future Condition, streams within the areas covered by the FPHCP that are occupied by the mountain and bridgelip suckers will receive most of the potentially available shade. Along Type Np streams, reductions in shade are likely to occur and water temperature may increase over limited distances as a result of the unbuffered Type Np stream reaches. In some cases, increases in temperature may be delivered downstream to Type F waters and temperatures could be warmed near the confluence of Type Np and F streams. There are situations (yarding corridors, stream-adjacent parallel roads, 20-acre exemptions, and windthrow) where stream shading will be reduced from full ecological potential. In some circumstances there may be adverse effects to the mountain and bridgelip suckers due to elevated stream temperatures and the behavior and survival of individual fish may be affected. Water temperature increases may be a factor in inter-specific competition, and abundance of these sucker species could be reduced in some cases.

Sediment effects to mountain and bridgelip suckers

Sediment would be delivered to mountain and bridgelip sucker habitat from road surface erosion and, to a lesser extent, from hillslope erosion. The FPHCP's incorporation of BMPs and RMAPs would substantially reduce delivery of road surface related sediment to the suckers habitats, but it would not prevent all sediment from reaching aquatic habitats occupied by these species. Certain watershed features and road related activities may contribute sediment to fish-bearing streams that are above natural background rates. For example, culvert projects may increase siltation until vegetation has recovered to reduce harmful sediment. Juvenile mountain and bridgelip sucker habitat includes shallow pools with large substrate such as cobble and boulders. Excessive siltation may reduce the availability of this habitat and and may affect food resources (algae, diatoms, and aquatic insects) of the suckers. When feeding behavior is altered by reduced prey, individual fitness and survival could be affected. However, the FPHCP is not expected to contribute to instream sediment loading to the point that mountain and bridgelip suckers would be harmed at more than at a stream reach scale.

Effects from the 20-acre Exemption Rule

Although there is uncertainty regarding how often this rule would be implemented, when it is implemented the 20-acre Exemption Rule would likely adversely affect mountain and bridgelip suckers. In watersheds with a high proportion of 20-acre exempt landowners, this rule would increase the likelihood that large wood recruitment would be inadequate to maintain properly functioning habitat (USFWS & NMFS 2006). There is also the potential for increased sedimentation, reduced shade, increased stream temperatures, and increased windthrow. Where these adverse effects occur, essential behaviors associated with foraging, reproduction and growth may be impeded, and mountain and bridgelip suckers may occupy the stream at reduced levels and they may have reduced survival.

Summary of adverse effects to mountain and bridgelip suckers

The proposed action would have short- to long-term adverse effects on sediment, large wood, and temperature. These effects would be most severe from unbuffered Type Np streams and their downstream effects that result in disruption of natural riparian and aquatic processes and functions in Type F streams. These effects to the aquatic environment may result in impairment of essential foraging, rearing, and spawning behavior of mountain and bridgelip suckers. Feeding behavior may be altered under some circumstances affecting individual fitness and survival. Pool depth could be reduced, modifying habitat use and ultimately survival. It is difficult to predict the severity of these effects because effects to these fish will vary from activity to activity depending on the specific riparian prescriptions applied, the location, historical management practices, geological characteristics of the watershed, and the biotic community present.

Activities covered under the FPHCP are expected to have direct and indirect adverse effects to adult and juvenile mountain and bridgelip suckers ranging from mortality to sublethal effects. Direct injury and death to suckers would likely occur during some stream crossing construction activities (stream dewatering, fish rescue and relocation, and blockage of upstream migration during construction). Increased sediment levels could reduce available habitat and prey items for mountain and bridgelip suckers. This could affect the growth and survival of juvenile and adult mountain and bridgelip suckers.

Summary of beneficial effects

The long-term benefits of the FPHCP are expected to outweigh the short-term, negative affects to mountain and bridgelip suckers. The severity of individual effects to these suckers will vary from action to action depending on the specific riparian prescriptions, location, past management practices, geological characteristics of the watershed, and the biotic community present. However, maturation of riparian areas, maintaining and restoring passage for mountain and bridgelip suckers, adaptive management, and improved road management practices are all expected from implementation of the FPHCP. These management prescriptions are expected to contribute to long-term survival for mountain and bridgelip suckers in the FPHCP Action Area.

8.5.18.4 CUMULATIVE EFFECTS

Cumulative effects were addressed in the **Comprehensive Cumulative Effects** section, with respect to the aquatic and riparian environment in Washington State. Additional information regarding cumulative effects for the mountain sucker was presented in the section **Low-Gradient Tributary Guild: Cumulative Effects.** Additional information regarding cumulative effects for the bridgelip sucker was presented in the section **Mainstem Guild.**

However, external factors related to global climate change may begin to pose an increasing threat to mountain sucker populations over the next century. Because the temperatures of small mountain streams are affected most strongly by air temperatures, projected global warming could have a profound effect on the distribution of many aquatic species (Issak 2003), including the mountain sucker.

8.5.19 Three-spine stickleback (*Gasterosteus aculeatus*)

8.5.19.1 Status of the Species

Description of Species

One of the most widespread fishes of the world (Wydoski and Whitney 2003), three-spine sticklebacks in Washington are considered abundant throughout their range. They tend to disappear from streams, ponds, lakes, estuaries, wetlands, and rivers that are heavily altered or polluted, or that have been subject to introductions of non-native predatory fish (Moyle 2002).

The three-spine stickleback is a small (average length 50 millimeters), laterally compressed, spindle-shaped fish with several bony plates along the side of its body. It has three prominent and separated spines on its back and sharp pelvic fins which are modified into spines. It has a narrow caudle peduncle, large eyes, and a terminal mouth that slants upward. There are two forms of the three-spine stickleback, an anadromous and freshwater form. The color of the three-spine stickleback can be variable given location. The fresh water form is usually olive to dark green on its back and sides, and has white or golden bellies. During breeding, males usually have blue sides and bright red bellies which extend to the underside of its head. They will also have iridescent blue or green eyes. Females, during breeding, are a pale green or brown along their backs and sides with silvery bellies.

Historic and Current Range

Within Washington State, the three-spine stickleback is found in inland lakes, streams, rivers, bays, ponds, and tidal marshes. It is also found throughout much of the Columbia River drainage and its tributaries up to and including Lake Chelan (Wydoski and Whitney 2003). The most-eastern location occurs in Lake McCoy, which is close to the confluence of the Spokane River with the Columbia River (Wydoski and Whitney 2003). It is also found throughout the Puget Sound drainage, the Chehalis River drainage, along the coast, and the Strait of Juan de Fuca. However, it is absent from the eastern section (Hood Canal) of the Olympic Peninsula (Wydoski and Whitney 2003).

Essential Habitat Components

The three-spine stickleback is a weak swimmer. It inhabits ponds, lakes, and sheltered coastal bays. In streams and rivers, it seeks shallow, weedy pools, and backwaters with little to no flow (Moyle 2002, Wydoski and Whitney 2003). They also occupy areas along the edges of streams and rivers where emergent plants are located and the current is slow. The substrates of these habitats are usually characterized by gravel, sand, and mud (Moyle 2002). Three-spine sticklebacks are visual feeders and require clean, clear water to locate prey, which are various forms of invertebrates. They feed on organisms living on the bottom, in aquatic vegetation, or floating on or near the surface, and will eat almost any type of insect. In the marine environment, the species occurs in the Pacific Ocean, Puget Sound, and brackish waters of coastal streams (Wydoski and Whitney 2003).

Reproductive Ecology

Three-spine sticklebacks spawn in fresh water that has shallow, weedy areas and sandy substrates. The marine form moves into shallow regions of estuaries before it moves into fresh water. Males develop breeding colors shortly before spawning. Spawning begins in May and goes to July and sometimes into August. The marine form begins spawning in early June (Wydoski and Whitney 2003). The male stickleback sets up a territory close to aquatic vegetation that he uses to construct a nest. The nest is in the shape of a ball with a tunnel through the middle. The nest is kept together by glue-like kidney secretions. Nests are usually 15 to 40 centimeters apart. The male then entices a passing female into the nest to lay her eggs. The freshwater form can lay 100 to 150 eggs, while the marine form can lay 250 to 350 in the nest (Wydoski and Whitney 2003). The male then swims in the nest and fertilizes the eggs. The females usually die a short time after spawning. The male then guards the nest from predators and incubates the eggs by fanning water through the nest with its fins. The eggs hatch in about 7 days at 18°C (Wydoski and Whitney 2003). The fry will remain in the nest for a couple of days while the male guards them. The fry exhibit rapid growth during their first year that slows in their second year (Scott and Crossman 1973). Sexual maturity is reach during their first year. Most males die after defending the young, however some do spawn again in their second year. They can live a maximum of 4 years, however, in Washington, 90 percent only live one year, and the remainder a second year (Wydoski and Whitney 2003).

Movements and Habitat Use

The three-spine stickleback has two basic forms, the marine and the freshwater form. The marine form migrates into freshwater to spawn, but the extent of this migration is unknown. Since sticklebacks are poor swimmers, they can be easily displaced during high waterflows. During such events, they will often move into the slow-water areas of the flood plain to take refuge. When the waters subside, the fish will then move back into their original habitats (Wydoski and Whitney 2003).

Threats to Species

Stickleback appears to be abundant within the FPHCP Action Area. However, the species disappeared quickly after brown bullhead were introduced into lakes on Vancouver Island and in the Frasier valley (Wydoski and Whitney 2003).

8.5.19.2 ENVIRONMENTAL BASELINE (within the FPHCP Action Area)

The three-spine stickleback has a broad distribution in North America. In Washington, three-spine stickleback are found in inland lakes, streams, rivers, bays, ponds, and tidal marshes. It is also found through much of the Columbia River drainage and its tributaries up to and including Lake Chelan (Wydoski and Whitney 2003).

Detailed population data for the species in Washington is unavailable. However, the species is broadly distributed in various habitat types (marine, estuaries, slow moving streams, lakes, and wetlands) across the FPHCP Action Area.

Role of the FPHCP Action Area for Conservation of the Species

The FPHCP Action Area provides suitable habitat for three-spine stickleback. The FPHCP Action Area will contribute to the long-term conservation of the species.

8.5.19.3 EFFECTS OF THE ACTION

General habitat effects to the three-spine stickleback resulting from the proposed action have been summarized above for the Lentic Guild and the nearshore habitat association. The area also found in habitat represented by the Low-Gradient Guild.

Riparian prescription effects to three-spine stickleback

Full riparian and in-stream function likely would not be provided to all habitats occupied by three-spine stickleback. Large wood in freshwater habitats is important for storing and releasing the appropriate sediment to develop and provide suitable substrate, pool formation, instream cover, aquatic plant growth, and macroinvertebrate production. Reductions in large wood recruitment to streams may result in habitat modifications that increase risk of predation, reduce forage, and reduce the survival or fitness of individual three-spine stickleback. Three spine stickleback are visual feeders and require clean, clear water to locate prey, which are various forms of invertebrates.

Sediment effects to three-spine stickleback

Sediment would be delivered to three-spine stickleback habitat from road surface erosion and, to a lesser extent, from hillslope erosion. The FPHCP's incorporation of BMPs and RMAPs would substantially reduce delivery of road surface related sediment to three-spine stickleback habitat, but it would not prevent all sediment from reaching aquatic habitats occupied by the species. Certain watershed features and road related activities may contribute sediment to fish-bearing streams that are above natural background rates. For example, culvert projects may increase siltation until vegetation has recovered to reduce harmful sediment. Excessive sedimentation may increase turbidity and since three-spine sticklebacks are visual feeders their ability to locate food resources may be affected. When feeding behavior is altered, individual fitness and survival could be affected. However the FPHCP is not expected to contribute to instream sediment loading to the point that three-spine sticklebacks would be harmed at more than a stream reach scale.

Effects from the 20-acre Exemption Rule

Although there is uncertainty regarding how often this rule would be implemented, when it is implemented the 20-acre Exemption Rule would likely adversely affect three-spine sticklebacks. In watersheds with a high proportion of 20-acre exempt landowners, this rule would increase the likelihood that large wood recruitment would be inadequate to maintain properly functioning habitat (USFWS & NMFS 2006). There is also the potential for increased sedimentation. Where these adverse effects occur, essential behaviors associated with foraging, and growth may be impeded, and three-spine sticklebacks may occupy the stream at reduced levels.

Summary of adverse effects to three-spine sticklebacks

The proposed action would have short- to long-term adverse effects on sediment, large wood, and temperature. These effects would be most severe from unbuffered Type Np streams and their downstream effects that result in disruption of natural riparian and aquatic processes and functions in Type F streams. These effects to the aquatic environment may result in impairment of essential foraging behavior of three-spine sticklebacks, which may affect individual fitness and survival. It is difficult to predict the severity of these effects because effects to these fish will vary from activity to activity depending on the specific riparian prescriptions applied, the location, historical management practices, geological characteristics of the watershed, and the biotic community present.

Activities covered under the FPHCP are expected to have direct and indirect adverse effects to adult and juvenile three-spine sticklebacks ranging from mortality to sublethal effects. Direct injury and death to three-spine sticklebacks would likely occur during some stream crossing construction activities (stream dewatering, fish rescue and relocation, and blockage of upstream migration during construction).

Increased sediment levels could reduce available habitat, foraging ability, and prey items for three-spine sticklebacks. This could affect the growth and survival of juvenile and adult three-spine sticklebacks.

Summary of beneficial effects

The long-term benefits of the FPHCP are expected to outweigh the short-term, negative affects to three-spine sticklebacks. The severity of individual effects to three-spine sticklebacks will vary from activity to activity depending on the specific riparian prescriptions, location, past management practices, geological characteristics of the watershed, and the biotic community present. However, maturation of riparian areas, maintaining and restoring passage for three-spine sticklebacks, adaptive management, and improved road management practices are all expected from implementation of the FPHCP. These management prescriptions are expected to contribute to long-term survival for three-spine sticklebacks in the FPHCP Action Area.

8.5.19.4 CUMULATIVE EFFECTS

Cumulative effects were addressed in the Comprehensive Cumulative Effects section, with respect to the aquatic and riparian environment in Washington State.

No additional information is available with respect to cumulative effects for this particular species above those cumulative effects already discussed earlier in this document.

8.5.20 Sand Roller (Percopsis transmontana)

8.5.20.1 Status of the Species

Description of the Species

The sand roller is one of two species of the family Percopsidae found only in the Columbia River system. It is a small fish less than 127mm with a relatively large head and a small ventral mouth adapted for bottom feeding (Scott and Crossman 1973). Their body is thicker toward the front then tapering to a narrow caudle peduncle after the dorsal fin. Their fins are relatively small with a distinct forked caudle fin. Sand rollers also have a small opaque adipose fin. They are very cryptic in coloration. They have spots in the margins of their caudle fins and males can turn very dark in coloration during mating season. Overall they have a mottled look with a small lighter underside sometimes a whitish-yellow.

Historical and Current Range

Information on the historic range of the sand roller is unknown at this time. The sand roller is endemic to the Columbia River system below Crescent Bar, which is about 37km upstream from the I-90 bridge (Wydoski and Whitney 2003). It has been collected from the Columbia, Yakima, Cowlitz and the Snake Rivers (Wydoski and Whitney 2003). Sand rollers seem to be more common in the lower Columbia River downstream of the John Day Reservoir (Wydoski and Whitney 2003).

Essential Habitat Components

Little is known about the sand rollers behavior and habitat. Sand rollers are known to inhabit quiet backwater and off channel areas of rivers and large streams (Wydoski and Whitney 2003). They prefer quiet areas that have lots of cover such as undercut banks, tree roots, and small debris jams (Wydoski and Whitney 2003). Substrate is usually a mix of sand and cobble, or large gravel. During the day they remain hidden within the various cover types. At night, sand rollers will move out onto the sandy substrate areas, and have been observed in shallow sand depressions at depths of 4 meters (Gray and Dauble 1976). Sand rollers have been found in water temperatures from 2.5 to 20.5°C and as deep as 21.7 meters (Gray and Dauble 1976; Wydoski and Whitney 2003).

Reproductive Ecology

Information on the reproductive ecology of sand rollers is limited. Sand rollers mature between ages two to three (Wydoski and Whitney 2003). In the Columbia River, they begin spawning in June and finish in mid July (Wydoski and Whitney 2003). Spawning most likely takes place over sandy gravel substrates when water temperatures are between 14 and 16°C (Gray and Dauble 1976). Sand rollers are also thought to spawn in the reservoirs of the Columbia River (Wydoski and Whitney 2003). Sand rollers in the Snake River in Idaho are thought to spawn in small tributaries streams and then return to larger rivers (Wydoski and Whitney 2003). Emergent fry are between 15 and 18 millimeters and have been collected in mid-August (Gray and Dauble 1976).

Movements and Habitat Use

Little is known about the movements of sand rollers. They are believed to undertake migrations for spawning, moving from larger streams or rivers into smaller tributaries for spawning (Wydoski and Whitney 2003). Sand rollers are known to have diel movements when feeding from daytime cover to open areas of sand or gravel in the tail-out of pools or riffles at night, or move from deeper water in the daytime to shallow areas in search of food at night (Wydoski and Whitney 2003).

Threats to Survival

Little information exists on the current and historic population status of the sand roller. In the Columbia River non-native species (Walleye, smallmouth bass, and catfish) have been documented to prey on sand rollers (Lee et al. 1997). Between 1987 and 1991 sand roller numbers were estimated to be approximately 3,000 fish per square mile in the Columbia River (Wydoski and Whitney 2003). A potential factor influencing sand roller abundance may be stream cover. Studies on the Yakima River by Patten et al. (1970) found sand roller to be absent from sites that once harbored sand roller. The cause was discovered to be that low flows had exposed the cover used by sand roller, such as undercut banks and tree roots. The small sand roller is dependent upon adequate cover elements to escape from predators during the day. They also appear to use cover for their territories (Wydoski and Whitney 2003). Eliminating these cover elements may affect the abundance of sand roller, both due to their territorial nature and the need for cover as protection from predators. Instream cover (LWD, boulders) may be an important habitat component for this species in the Columbia River and the small tributaries the species uses.

8.5.20.2 ENVIRONMENTAL BASELINE (within the FPHCP Action Area)

The sand roller occurs in the Columbia River to depths of 71 feet (Wydoski and Whitney 2003). It also occurs in small streams associated with tree roots and debris and without this cover it may be prone to predation (Wydoski and Whitney 2003).

Population trends are unknown for the species in the Washington. Sand roller are common in the Columbia River downstream of the John Day Reservoir but are less abundant upstream (Wydoski and Whitney 2003). Sand roller density has been shown to be quite variable. For example, in the Dalles pool of the Columbia River sand roller densities ranged between 10 and 15 fish per square mile during 1988 – 1991 and between 400 to 3,000 fish per square mile from 1989 -1991 for the John Day pool (Wydoski and Whitney 2003). The reason for this variation is unknown.

Role of FPHCP Action Area in Conservation of species:

The FPHCP Action Area appears to be important for the long-term conservation of the species. Although it is highly likely that many of the streams it occupies will not be directly influenced by forest practices, there will be some places it is subject to the proposed action.

8.5.20.3 EFFECTS OF THE ACTION

General habitat effects to the sand roller resulting from the proposed action have been summarized above for the River System and Low gradient Tributary Guilds.

Riparian prescription effects to Sand roller

Full riparian and in-stream function likely would not be provided to all habitats occupied by sand roller. In some stream reaches, the highest quality and most structurally complex habitats may fail to develop due to the potential reduction of large wood recruitment to streams following different riparian management prescriptions. Sand rollers prefer quiet areas that have lots of cover such as undercut banks, tree roots, and small debris jams, and during the day they remain hidden within the various cover types(Wydoski and Whitney 2003). Large wood in freshwater habitats is important for storing and releasing the appropriate sediment for development of suitable substrate, pool formation, providing cover, aquatic plant growth, and macroinvertebrate production. Reductions in large wood recruitment to streams may result in habitat modifications that increase risk of predation, reduce forage, and reduce the survival or fitness of individual sand rollers.

When RMZs achieve their Desired Future Condition, streams within the areas covered by the FPHCP that are occupied by the sand roller will receive most of the potentially available shade. Along Type Np streams, reductions in shade are likely to occur and water temperature may increase over limited distances as a result of the unbuffered Type Np stream reaches. In some cases, increases in temperature may be delivered downstream to Type F waters and temperatures could be warmed near the confluence of Type Np and F streams. There are situations (yarding corridors, stream-adjacent parallel roads, 20-acre exemptions, and windthrow) where stream shading will be reduced from full ecological potential and in some circumstances there may adverse effects to the sand roller due to elevated stream temperatures and the behavior and survival of individual fish may be affected. Water temperature increases may be a factor in inter-specific competition and abundance of the sand roller could be reduced in some cases.

Sediment effects to sand roller

Substrate used by the sand roller is usually a mix of sand and cobble, or large gravel. Sediment would be delivered to sand roller habitat from road surface erosion and, to a lesser extent, from hillslope erosion. The FPHCP's incorporation of BMPs and RMAPs would substantially reduce delivery of road surface related sediment to the sand roller habitat, but it would not prevent all sediment from reaching aquatic habitats occupied by the species. Certain watershed features and road related activities may contribute sediment to fish-bearing streams that are above natural background rates. For example, culvert projects may increase siltation until vegetation has recovered enough to reduce delivery of harmful sediment.

Excessive siltation may reduce the availability of this habitat and and may affect food resources. When feeding behavior is altered due to reduced prey, individual fitness and survival could be affected.

Effects from the 20-acre Exemption Rule

Although there is uncertainty regarding how often this rule would be implemented, when it is implemented the 20-acre Exemption Rule would likely adversely affect the sand roller. In watersheds with a high proportion of 20-acre exempt landowners, this rule would increase the likelihood that large wood recruitment would be inadequate to maintain properly functioning habitat (USFWS & NMFS 2006). There is also the potential for increased sedimentation, reduced shade, increased stream temperatures, and increased windthrow. Where these adverse effects occur, essential behaviors associated with foraging, reproduction and growth may be impeded, and sand roller may occupy the stream at reduced levels and they may have reduced survival.

Summary of adverse effects to sand roller

The proposed action would have short- to long-term adverse effects on sediment, large wood, and temperature. These effects would be most severe from unbuffered Type Np streams and their downstream effects that result in disruption of natural riparian and aquatic processes and functions in Type F streams. These effects to the aquatic environment may result in impairment of essential foraging, rearing, and spawning behavior of sand roller. Feeding behavior may be altered under some circumstances affecting individual fitness and survival. Available suitable substrate could be reduced, modifying habitat use and ultimately survival. It is difficult to predict the severity of these effects because effects to these fish will vary from activity to activity depending on the specific riparian prescriptions applied, the location, historical management practices, geological characteristics of the watershed, and the biotic community present. Many of the aquatic habitats the species resides in will see little to no effect from the proposed action.

Activities covered under the FPHCP are expected to have direct and indirect adverse effects to adult and juvenile sand roller ranging from mortality to sublethal effects. Direct injury and death to sand roller would likely occur during some stream crossing construction activities (stream dewatering, fish rescue and relocation, and blockage of upstream migration during construction). Increased sediment levels could reduce available habitat and prey items for sand roller. This could affect the growth and survival of individual juvenile and adult sand rollers.

Summary of beneficial effects

The long-term benefits of the FPHCP are expected to outweigh the short-term, negative affects to sand rollers. The severity of individual effects to sand rollers will vary from activity to activity depending on the specific riparian prescriptions, location, past management practices, geological characteristics of the watershed, and the biotic community present. However, maturation of riparian areas, maintaining and restoring passage for sand rollers, adaptive management, and improved road management practices are all expected from implementation of the FPHCP. These management prescriptions are expected to contribute to long-term survival for sand rollers in the FPHCP Action Area.

8.5.20.4 CUMULATIVE EFFECTS

Cumulative effects were addressed in the **Comprehensive Cumulative Effects** section, with respect to the aquatic and riparian environment in Washington State. Additional information regarding cumulative effects for the covered fish species was presented in the section **River System and Low gradient Tributary Guilds: Cumulative Effects.**

No additional information is available with respect to cumulative effects for this particular species above those cumulative effects already discussed earlier in this document.

8.5.21 Native Sculpins (*Cottus spp.*)

Coastrange *C. aleuticus*
Reticulate *C. perplexus*
Riffle *C. gulosus*
Prickly *C. asper*
Shorthead *C. confusus*
Torrent *C. rhotheus*
Margined *C. marginatus*
Mottled *C. bairdi*
Paiute *C. beldingi*
Slimy *C. cognatus*

8.5.21.1 Status of the Species

Description of the Species

The sculpins are the most difficult species of freshwater fish to identify due to their small size and the great variation in morphological characteristics which tend to overlap throughout their family (Wydoski and Whitney 2003). In general, all have a rather large head and mouth with numerous small teeth. Their bodies taper from their head to the caudal peduncle, which may be narrow or thick at the connection of the caudal fin. There is an absence of true scales which makes their bodies smooth, but occasionally, as in the prickly sculpin, they may have rough patches of skin. The coloration of each species depends on physiological state, sexual maturation, and the general color of the substrate (Wydoski and Whitney 2003). Overall they are drab in color and variably mottled. Breeding males are often much darker than females, often having an entirely black body. They are very adapted to living life on the bottom of lakes, and streams due to the absence of an air bladder and dorsally set eyes. They have fanlike pectoral fins and long narrow pelvic fins located between the pectoral fins (Moyle 2002). They have two dorsal fins, the first is generally short in length with soft spines, and the second, is longer with rays (Moyle 2002).

Historical and Current Range

The current distributions of the 10 species of native sculpins are separated into three distinct groups: (1) the western Washington group has three species of sculpin, the coastrange, reticulate, and riffle; these species only occur west of the Cascade crest; (2) the east/west group contains the prickly, shorthead, and torrent sculpins that range on both sides of the Cascade Mountains; (3) the eastern Washington group that contains the margined, mottled, Paiute and slimy sculpins. These species only occur east of the Cascade Mountains.

Coastrange Sculpin: Is found along the entire Olympic Peninsula, throughout the Puget Sound and up the Columbia River to at least the Bonneville Dam (Wydoski and Whitney 2003).

Reticulate Sculpin: Is found in the Willapa Hills, along the southern and western boundaries of the Olympic Peninsula, the Cowlitz and Lewis Rivers, and as far north as the Green River, Washington, which is the limit of its most northern distribution (Wydoski and Whitney 2003).

Riffle Sculpin: Is found in coastal streams of the Willapa Hills northward along the western and northern slopes of the Olympic Mountains and in southern Puget Sound. It is generally uncommon in the Columbia River drainage, but it is found as far inland as the mouths of the Cowlitz and Kalama Rivers (Wydoski and Whitney 2003).

Prickly Sculpin: Is found throughout the Olympic Peninsula, Willapa Hills, and Puget Sound. It also is found throughout the Columbia River, Okanogan River, and Crab Creek systems (Wydoski and Whitney 2003).

Shorthead Sculpin: Is found in Puget Sound and Columbia River drainages. It is known specifically to inhabit the Snoqualmie, Green, and Carbon River drainages, tributary streams of southern Hood Canal, Cedar, Issaquah and Swamp creeks of the Lake Washington drainage (McPhail 1967; Wydoski and Whitney 2003), and several rivers on the Olympic Peninsula. The northern range of the shorthead sculpin in Puget Sound stops abruptly at the Snohomish River, which is probably due to historic glaciation patterns (McPhail 1967).

Torrent Sculpin: Is found along the west slopes of the Olympic Mountain south along the west coast to the mouth and up the Columbia River. It is generally found south of the Skagit River throughout Puget Sound. It is also found in rivers and streams along the east slopes of the Cascade Mountains and in the northern tributaries of the Columbia and Spokane Rivers in northeastern Washington (Wydoski and Whitney 2003).

Margined Sculpin: The margined sculpin has the smallest range of any fish species in the state of Washington, and is confined only to the Tucannon and Walla Walla drainages (Mongillo and Hallock 1998).

Mottled Sculpin: Is found east of the Cascade Mountains in the Columbia, Snake, and Yakima River basins (Wydoski and Whitney 2003).

Piaute Sculpin: Is currently found only in the Yakima, Wenatchee, Walla Walla, and Tucannon Rivers (Wydoski and Whitney 2003).

Slimy Sculpin: Is currently restricted to Lake Chelan and tributaries of the upper Columbia River (the Kettle and Pend Oreille Rivers) (Wydoski and Whitney 2003).

Essential Habitat Components

Coastrange Sculpin: The coastrange sculpin is generally found in medium or large streams with a moderate to rapid current. Usually they inhabit areas with cobble or gravel substrates. In the Cedar River, coastrange sculpin less than 50 millimeters total length (TL) tended to inhabit gravel substrates, and larger fish tended to inhabit cobble substrates (Tabor et al. 1998). Coastrange sculpin also inhabit the shoreline and deeper benthic areas of lakes and are also occasionally found in estuaries. Generally, prickly sculpin inhabit pools and other slow-water habitat, and coastrange sculpin inhabit riffles. However, in upstream reaches where prickly sculpin does not exist, coastrange sculpin are found in both pools and riffles. Some researchers have suggested that coastrange sculpin may directly compete with juvenile coho salmon (*O. kisutch*) (Mason and Machodori 1976). In experimental troughs, Ringstad

(1974) found that at high stream densities, coastrange sculpin could reduce coho salmon growth. However, at natural stream densities, they did not limit juvenile coho salmon growth.

Also a dwarf, pelagic form of coastrange sculpin occurs in Lake Washington, Washington (Larson and Brown 1975), and Cultus Lake, British Columbia (Ricker 1960; Coffie 1998). These fish are morphologically different from coastrange sculpin.

Reticulate Sculpin: The reticulate sculpin is found in pools, riffles, and runs throughout its range. They generally prefer small, coastal headwater streams with slow currents (Moyle 2002). However, this may depend upon the presence or absence of other species of sculpin. Finger (1982) found that in Oregon streams, reticulate sculpin were found to inhabit both pools and riffles and have higher densities near cover. Where they co-existed with other species, they generally occupied pools and had lower densities (Finger 1982). On the Olympic Peninsula, reticulate sculpins were found to occupy 75 percent of pools, 30 percent of runs, and 10 percent of riffles in small coastal streams (Wydoski and Whitney 2003). They are found associated with all types of substrate, such as sand, gravel, boulders and rubble. They were found in water temperatures between 9 and 22°C with a maximum water temperature of 15°C (Mongillo and Hallock 1997). They are known to tolerate water temperatures as high as 30°C, but generally prefer summer temperatures less than 20°C (Moyle 2002). They occurred in streams from 5 to >100 meters wide, with gradient between 1.3 to 3.5 percent (Mongillo and Hallock 1997). Immature reticulate sculpins were often found in run habitats (Mongillo and Hallock 1997). Reticulate sculpins have also been know to tolerate salinities of about 18 parts per thousand, or about half that of pure seawater (Moyle 2002; Mongillo and Hallock 1997).

Riffle Sculpin: The riffle sculpin is commonly found in quiet waters and slow riffles of small streams and backwaters of large rivers. Riffle sculpin also inhabit ponds and small lakes. It prefers water temperatures < 16°C but survived temperatures up to 28°C in the laboratory (Wydoski and Whitney 2003). On the Olympic Peninsula, it was collected at an average elevation of 108 meters (range 11-494 meters), water temperature of 14.6°C (range 11-21°C), and average gradient of 1.3 percent in streams ranging in width from 2.1 to greater than 100 meters (Mongillo and Hallock 1997). It is found in areas having a variety of substrates, but generally in those with sand or gravel bottoms (Wydoski and Whitney 2003). The spectrum of stream habitat riffle sculpin occupy is broadest when other sculpin species are absent (Moyle 2002).

Prickly Sculpin: The prickly sculpin is commonly found in lakes, ponds, and quiet waters of rivers. In Lake Washington, prickly sculpin inhabit all depths, from the shoreline to depths > 60 meters (E. Warner, Muckleshoot Indian Tribe, Personal Communication). Prickly sculpin typically only inhabit the lower reaches of most rivers. For example, in the Cedar River, prickly sculpin only inhabit the lower 9 kilometers (R. Tabor, USFWS, unpublished data). On the Olympic Peninsula, prickly sculpin were collected at an average elevation of 23 meters, the lowest average elevation of all cottid species (Mongillo and Hallock 1997). Prickly sculpin can also be abundant in estuaries, in salinities as high as 24 ppt. Prickly sculpin prefer water temperatures from 10-18°C, but they have been found in water as high as 28°C. However, Black (1953) found that temperatures of 23 to 27°C were lethal for prickly sculpin. In the Cedar River and along the shoreline of Lake Washington, large prickly sculpin (> 125 millimeters in total length) prefer boulder and large cobble substrate. Smaller sculpin tend to inhabit smaller substrates. In offshore benthic areas, large prickly sculpin inhabit open areas with fine sediment. During the day, prickly sculpin are found close to cover, while at night they move into more open areas. Prickly sculpin are more active at night.

Shorthead Sculpin: Shorthead sculpin commonly inhabit small, cool (less than 16°C), headwater streams (generally >450 meters elevation in western Oregon and >760 meters in eastern Oregon) (Wydoski and Whitney 2003), but may also be found in large rivers (e.g., Columbia River and Cedar River). Shorthead sculpin have been found in water temperature as high as 24 °C (Wydoski and Whitney 2003). In streams on the Olympic Peninsula, shorthead sculpin were observed in areas having an average stream gradient of 3.2 percent, elevation 369 meters (range 171-804 meters), and water temperature 13.2°C (range10-17°C); (Mongillo and Hallock 1997).

Common habitat for shorthead sculpin are high gradient riffles with a rubble or gravel bottom (Wydoski and Whitney 2003), but are also frequently found in runs and pools, especially where other fishes are not present (Finger 1982; Mongillo and Hallock 1997). Above Cedar Falls on the Cedar River, shorthead sculpin are the only cottid present and they inhabit a wide variety of habitat types including the shoreline and deep benthic areas of Chester Morse Reservoir (R. Tabor, USFWS, unpublished data). Shorthead sculpin were collected in water as deep as 30 meters. Below Cedar Falls, shorthead sculpin coexist with four other species of cottids and appear to be spatially segregated. In this river reach, shorthead sculpin were primarily found in riffle habitat. They were rarely found in pool or shoreline habitats. In the Low gradient River in British Columbia, shorthead sculpin appear to be spatially segregated from slimy sculpin (*C. cognate*) (Hughes and Peden 1984). However, unlike in Washington, shorthead sculpin inhabit the downstream reaches of the Low gradient River. This is probably because slimy sculpin inhabit the coldest and most northerly locations of any North American cottid.

Torrent Sculpin: The torrent sculpin is found primarily in streams >2.5 meters, but it also occurs in lakes along the shoreline (Scott and Crossman 1973; Wydoski and Whitney 2003). In streams of the Olympic Peninsula, torrent sculpin were present in all of three habitat types sampled, but preferred riffles and runs over pools, and were observed in areas with stream gradients ranging from 0.1 to 3.5 percent, elevations 5-502 meters (average 100 meters), water temperatures 11-22°C (average 15.9°C), and stream widths 7.5-100.0 meters (Mongillo and Hallock 1997). The torrent sculpin was only found where rock was present in the Marys River, Oregon (Finger 1982).

Margined Sculpin: Preferred margined sculpin habitats include pools and slow moving glides in headwater tributaries at all seasons (Wydoski and Whitney 2003). They generally avoid habitats with high velocities. They are generally found where water temperatures are between 5 and 19°C, with a maximum water temperature of 24°C (Wydoski and Whitney 2003). Adults are often found in deeper and faster waters than juveniles over small gravel and silt substrates. They tend to avoid larger gravel, cobble or boulders. Margined sculpins can be found in streams between 6 and 18 meters wide (Wydoski and Whitney 2003). Overall, these types of habitat selections do not change over seasons (Mongillo and Hallock 1998).

Mottled Sculpin: Mottled sculpin occur in both streams and lakes. They are generally found in clear, cool mountain streams with fast to moderate currents (Sigler and Sigler 1987). They generally prefer coarse gravel, small loose rocks and rubble substrates and tend to avoid sand and silt (Sigler and Sigler 1987). However, when in the lake environment they are often found with sand, clay and mud substrates (Sigler and Sigler 1987; Scott and Crossman 1979). Mottled sculpin are often found where summer water temperatures are between 13 and 18°C, with a maximum temperature of 21.1°C (Sigler and Sigler 1987). They tend to occupy streams with depths of 0.60 meters or less (Sigler and Sigler 1987), but will move to deeper water during the winter (Wydoski and Whitney 2003). Mottled sculpin often use aquatic vegetation as cover along with large rocks. They also feed at night in open areas and return to this cover during the day to hide (Wydoski and Whitney 2003).

Piaute Sculpin: Piaute sculpin are found in both streams and lakes. They tend to prefer streams with slight to moderate gradient (<1.8 percent), wider than 6.1 meters (Wydoski and Whitney 2003), and are generally absent from high-gradient headwaters and low-gradient warm water streams (Moyle 2002). They prefer riffle habitats with rubble or large gravel substrates (Sigler and Sigler 1987), and water temperatures below 20°C. In Lake Tahoe, Paiute sculpin are associated with aquatic macrophyte beds in deep water and also shallow inshore areas (Moyle 2002). They generally are in waters less than 60 meters but have been found as deep as 210 meters (Moyle 2002). Paiute sculpins tend to avoid torrent sculpins if found in the same stream. Paiute sculpins will burrow into the gravel during the day to avoid torrent sculpins and emerge at night to feed (Wydoski and Whitney 2003). During the winter and spring months where water velocities are at there highest in Washington, Paiute sculpin will occupy the riffle habitats where as torrents will move into quieter waters (Wydoski and Whitney 2003).

Slimy Sculpin: There is little information on habitat requirements of the slimy sculpin. They are known to inhabit deep waters of lakes and rocky or gravelly portions of cool streams (Scott and Crossman 1973). When in streams they occupy shallow riffles. Slimy sculpin have been sampled from Lake Pend Oreille in Idaho at depths of 305 meters (Wydoski and Whitney 2003).

Reproductive Ecology

Coastrange Sculpin: In Oregon, coastrange sculpin spawn when they are three years old. In the Cedar River, sculpin less than 60 millimeters in total length have been observed with eggs, suggesting some fish may be sexually mature before age three. Spawning takes place in the spring, sometime between February and June. In Oregon, the peak spawning months are March and April (Bond 1963). Eggs are deposited under rocks and are adhesive, orange, and less than 1.5 millimeters in diameter. A male sculpin protects the nest and may spawn with several females. Egg counts in females range from 260 to 830, depending on the size of the fish. The larval coastrange sculpin are pelagic and do not become bottom-dwelling for 32-35 days after hatching (Scott and Crossman 1973).

Reticulate Sculpin: The reticulate sculpin matures at two years of age and spawns during the spring when water temperatures are in excess of 6 or 7°C (Moyle 2002). Reticulate sculpin spawn in riffles when other species of sculpin are absent or in slower-flowing areas when other species are present in riffles (Moyle 2002). Adhesive eggs are deposited under rocks and the male guards the nest until the eggs have hatched and the fry have left the area (Wydoski and Whitney 2003). Often male sculpins will spawn with more than one female as indicated by several clusters of eggs at various stages of development (Wydoski and Whitney 2003). The average number of eggs for a two year old female is 170 and 280 for a three year old (Wydoski and Whitney 2003). When the fry have hatched they remain close to the nest getting protection from the male sculpin. Only after leaving the nest do they begin a benthic existence.

Riffle Sculpin: The riffle sculpin matures at two years of age and spawns in late February, March and April, with nests made in rotting logs and under rocks in swift riffles (Millikan 1968; Moyle 2002). A male sculpin usually protects the nest. Eggs are 2.5 millimeters in diameter, adhesive and pale yellow to deep orange. Egg counts in females range from 100 to 450, depending on the size of the fish (Bond 1963; Millikan 1976). Moyle (1976) states that more than one female spawns in a nest, as egg counts in nests range from 460 to greater than 1,000. Eggs hatch in 11 to 24 days, depending on water temperature. In summer, juveniles grow about 5 millimeters per month, reaching 30 millimeters by the end of summer. A few weeks after hatching and attaining about 6 millimeters in total length, fry assume a benthic existence (Millikan 1968).

Prickly Sculpin: Some prickly sculpin become sexually mature at age 1 (12 percent in males, 50 percent in females) and by age 2 over 90 percent are sexually mature (Rickard 1980). Spawning takes place in the spring. In Washington, spawning usually occurs in April and May. In other parts of their range, spawning varies depending on latitude. Nests are usually under rocks or logs in areas with slow water velocities. A male sculpin protects the nest and may spawn with several females. Eggs are adhesive and slightly more than 1 millimeter in diameter. Egg counts in females range from 700 to 9,590, depending on the size of the fish (Kresja 1967a; Rickard 1980). Eggs hatch in 11 days at 15°C to 24 days at 10°C. After hatching, the young begin swimming at once and remain pelagic for 30 to 35 days. They may form large schools (Northcote and Hartman 1959). After the pelagic period, juvenile prickly sculpin settle to the bottom. In Lake Washington during their June transition phase from a pelagic to a benthic existence, they appear to be particularly vulnerable to predators, especially yellow perch (*Perca flavescens*) (Tabor and Chan 1996b).

Shorthead Sculpin: In general, shorthead sculpin will spawn during spring after maturing at age 2-3. Egg production in shorthead sculpin is considered low compared to other sculpin (Bond 1963). In Swamp and Boise Creeks, Washington, egg production was reported as 50 in a 60-millimeter female and 220 in a 75-millimeter and 85-millimeter female (Wydoski and Whitney 2003). Like Piute (*C. beldingi*) and torrent sculpin (*C. rhotheus*), shorthead sculpin probably spawn under stones in swift water. A few weeks after hatching, sculpin adapt a generally benthic lifestyle, which is maintained through the remainder of the fish's life history.

Torrent Sculpin: Little is known about the life cycle patterns of torrent sculpin. Wydoski and Whitney (2003) reported the following information on torrent sculpin spawning biology and behavior. Wydoski and Whitney (2003) state that torrent sculpin can reach a size of 150 millimeters in total length and live as long as six years. The torrent sculpin becomes sexually mature after reaching two years of age, and spawns in late spring under stones in swift water. In a tributary to the Columbia River, it was reported to migrate upstream in late January to late April, spawn and then move downstream in May and June. The number of eggs per female appears to vary, depending on locality. In the Yakima River, females of different ages produced 156 eggs at age two, 226 at age three, 221 at age four, and 370 at age five. In the Newaukum Creek, females produced 165 eggs at age two, 258 at age three, and 320 at age four.

Margined Sculpin: Currently there is little known about the breeding behavior of the margined sculpin. They are known to spawn in May and June when water temperatures are between 12.8 and 16.1°C (Mongillo and Hallock 1998). They seem to prefer pools, but will sometimes spawn in glides and low gradient riffles (Mongillo and Hallock 1998). Males undergo a darkening of their color often turning completely black at this time. Eggs are deposited under rocks like most sculpin species, and the male remains to guard the nest, often fanning the egg clusters with his caudal fin (Mongillo and Hallock 1998).

Mottled Sculpin: The mottled sculpin matures at two years of age (Wydoski and Whitney 2003). Male mottled sculpins will turn almost black in color and develop an orange-yellow margin on their first dorsal fin. Females however do not change color during breeding. Spawning season starts around February and can last until June. Water temperatures around this time vary from 3.9 to 11.1°C and can be up to 15°C (Wydoski and Whitney 2003). Males perform a swimming display to female sculpin to initiate them to deposit their eggs. Female mottled sculpin in the Yakima River had an average of 65 eggs for two year olds, 135 for a three year olds, and 176 for four year olds (Wydoski and Whitney 2003). Eggs were deposited in clusters of 20 to 150 under rocks or overhanging ledges in rapid or slow moving clear water. Females leave after spawning while the males remain to spawn again and to protect the eggs. Eggs hatch in about 20 to 30 days at 10 to 15.6°C water temperature (Wydoski and Whitney 2003). Hatchlings remain close to the nest for a short time before venturing out into other parts of the stream.

Paiute Sculpin: Paiute sculpin mature at two or three years of age. Spawning begins in May and lasts until June, but it largely depends on water temperature. In Lake Tahoe, Paiute sculpin spawn from early May until August, and select wave swept littoral areas just off the mouths of creeks (Moyle 2002). Nesting sites are generally constructed away from bedrock and mud substrates. In streams, the Paiute sculpin selects riffles to spawn in (Sigler and Sigler 1987). During spawning males develop a pale yellow spot on their caudal peduncle near the posterior base of the second dorsal fin (Wydoski and Whitney 2003). Females deposit small (1.5 to 2.0 millimeters) eggs in clusters on the underside of rocks and overhangs where the male guards them, much like other species of sculpins; however, multiple spawning seems to be uncommon since on average only 100 to 200 eggs are found in any one nest site. Female Paiute sculpin in the Yakima River system had an average of 37 eggs for a 38.1-millimeter sculpin, and 181 for a 76.2-millimeter sculpin (Wydoski and Whitney 2003). Generally, the number of eggs per female increases with size and age. Length of incubation is currently unknown. Hatchlings are about 10 millimeters in length and move to the gravel floor of the nest and remain there for one to two weeks before moving out into the current at night and dispersing downstream (Moyle 2002).

Slimy Sculpin: Very little is known about the spawning behavior and habitats of the slimy sculpin (Scott and Crossman 1973). Most accounts come from Koster (1936) who described some of the spawning habits of slimy sculpins in the waters of northern New York (Scot and Crossman 1973). They generally spawn in the spring when water temperatures are between 5 and 10°C (Scott and Crossman 1973). The male slimy sculpin turns dark in coloration and develops a margin of orange along the first dorsal fin (Wydoski and Whitney 2003). Eggs from the female are deposited under a rock and guarded by the male. Often as is with other species of sculpin, there is multiple spawning by the male. A gravid female 101.6 millimeters in length held about 1,400, (2.3-2.6 millimeter) eggs (Scott and Crossman 1973). Eggs hatch in about four weeks at 7.7 °C (Scott and Crossman 1973).

Movements and Habitat Use

Sculpins are well adapted to having a sedentary, benthic life style and are not developed to make long extended movements and migrations. Sculpins do, however, exhibit four basic movements/ migrations which may vary according to species and location. Mostly, the movements of sculpins are restricted to short foraging movements, spawning, the dispersal of larval sculpins after hatching, and moving into overwintering habitats (Moyle 2002; Wydoski and Whitney 2003). In some capacity, sculpins are know to move to overwintering habitats and foraging areas, and some adult species are known to migrate to spawning areas as are the newly hatched larvae to rearing areas.

Coastrange Sculpin: In California, the coastrange sculpin in small streams migrate downstream during winter to spawn close to an estuary where their larvae will live (Moyle 2002). Coastrange sculpin larvae often drift into a lake or estuary where they live a pelagic life before transforming into juveniles and moving to a benthic lifestyle (Moyle 2002; Wydoski and Whitney 2003). The coastrange along with the slimy sculpin have also been observed in Alaska moving to forage on the eggs of spawning sockeye salmon. The sculpins in this area seem to predict the arrival of the sockeye salmon rather than just reacting to their presence (Foote and Brown 1998). It also seems likely that they must be arriving from relatively large distances, given the high peak in sculpin densities (Foote and Brown 1998).

Reticulate Sculpin: Currently there is no information on the movements of the reticulate sculpin.

Riffle Sculpin: Little is know about the movements and migrations of the riffle sculpin. They are generally considered to have poor dispersal abilities, given their narrow habitat requirements, benthic larvae that do not move far after hatching, and scattered distribution (Moyle 2002).

Prickly Sculpin: The prickly sculpin is known to make downstream migrations to spawning areas which are usually close to an estuary, pool or lake, where the hatched larvae and juveniles can rear. Some populations of prickly sculpin migrate from freshwater to brackish water to spawn (Wydoski and Whitney 2003). After spawning the adults move back upstream. Larval prickly are usually washed downstream where they transform into juvenile sculpins and settle onto the bottom and move into areas with plenty of food and cover, in some cases making extensive upstream migrations (Moyle 2002). This downstream migration of adults and upstream migration of juveniles is typical of coastal populations (Moyle 2002). At night, prickly sculpin move into open areas away from their daytime cover to forage (Wydoski and Whitney 2003). Prickly sculpin also move into deeper water to overwinter.

Shorthead Sculpin: Currently there is no information on the movements of the shorthead sculpin.

Torrent Sculpin: In Washington State, the torrent sculpin is known to move upstream on spawning migrations from late January to late April, and downstream after spawning, in May and June (Wydoski and Whitney 2003). The extent of these migrations is currently unknown.

Margined Sculpin: Currently there is no information on the movements of margined sculpin.

Mottled Sculpin: During the summer months, the mottled sculpin inhabits shallow water that is 0.15 to 0.9 meters deep, but moves to deeper water during the winter (Wydoski and Whitney 2003).

Paiute Sculpin: The Paiute sculpin is generally a sedentary sculpin. During the day it occupies habitats that contain rubble and large gravel substrates to hide or burrow in (Wydoski and Whitney 2003). At night it emerges and begins to forage. In Lake Tahoe, California, Paiute sculpin were found in shallow inshore areas and to depths of 122 to 213.4 meters (Moyle 2002).

Slimy Sculpin: There is no information on the movements of slimy sculpin in Washington State. In Alaska's Lake Iliamna, slimy sculpin were found with coastrange sculpin feeding on the eggs of spawning sockeye salmon. The numbers of sculpin dramatically increased over the course of the salmon spawning run on Woody Island and decreased in a less dramatic fashion after completion of spawning (Foote and Brown 1998).

Threats to Survival

Bond (1963) discusses factors likely influencing the abundance and distribution of sculpin, and reports sculpin numerically dominate the fish fauna in many streams in the northwestern United States. Despite their overall abundance and fairly wide distribution, sculpins are probably less abundant in many areas than they formerly were. They are fairly sensitive indicators of high-quality water and stream habitats (Moyle 2002). Their disappearance from, or low abundance in, a stream reach may be indicative of land use practices, such as water diversions, logging, grazing or general urbanization, that degrade stream environments (Moyle 2002). Harvey (1986) indicated high sedimentation rates could reduce populations of sculpin. This suggests that populations of sculpin may be negatively impacted by some land-use practices. In Washington, coastrange sculpin, prickly sculpin, riffle sculpin, shorthead sculpin, torrent sculpin, reticulate and mottled sculpin are widespread, but there is no information on population trends. The Paiute and slimy sculpin each have limited distribution in eastern Washington and seem to be abundant within that distribution, but there is also no information on population trends. The margined sculpin also has a limited distribution in an extremely small area of southeastern Washington. Its habitat, however, has been degraded through development, agriculture, logging and channelization (Wydoski and Whitney 2003). The margined sculpin is currently listed as a "sensitive species" in Washington, and as "sensitive" in Oregon (Mongillo and Hallock 1998).

8.5.21.2 ENVIRONMENTAL BASELINE (within the FPHCP Action Area)

The margined sculpin has the smallest range of any fish in Washington. Its current distribution is from the Walla Walla and Tucannon watershed in southeastern Washington (Mongillo and Hallock 1998). The upper watershed of the Tucannon River and upper North Fork of the Touchet River are on the Umatilla National Forest, and are not subject to the proposed action. Stream reaches on National Forest lands are in relatively good condition in comparison to conditions downstream on private lands (Smith, 2005) However, many of the observations of the species come from non-Federal lands and may be subject to the proposed action. Many of these streams are currently in a degraded condition, such as the Walla Walla, Mill Creek, lower Tucannon, and South Fork Touchet watersheds (Mongillo and Hallock 1998). Irrigation, agriculture, urbanization, and logging have been responsible for habitat degradations. High fine sediment loading from agricultural practices and water withdrawls from private lands are causing deleterious effects to salmonids in the Walla Walla basin (Smith, 2005).

The coastrange, prickly, shorthead, riffle, reticulate, and torrent sculpins have relatively large distributions across Washington. However, a substantial part of their ranges occur on Federal lands, including national forests and national parks. These areas will not be subject to the proposed action, but other substantial areas do occur within the FPHCP Action Area.

The mottled and Piute sculpin occur in eastern Washington. The Piute sculpin occurs in the Yakima, Wenatchee, Walla Walla, and Snake Rivers and their tributaries. The mottled sculpin occurs in Columbia, Yakima and Snake River basins. West of the Cascade Mountains, 8 mottled sculpin were found in Lacama Creek, a tributary to the Cowlitz River. Both of these species will have a significant portion of the ranges subject to the proposed action. They also inhabit other watershed that occur on Federal lands and won't be exposed to the proposed action.

The slimly sculpin occurs in eastern Washington in the Lake Chelan and tributaries and the upper Columbia River (Pond Oreille and Kettle Rivers). Federal ownership occurs over significant portions of these areas, but not all. As such, the proposed action will involve many areas where the species occurs.

There is a broad range of ownerships and aquatic conditions within the FPHCP Action Area for the 10 species of sculpin. These conditions have been described above in various areas of the Opinion. Sculpin are likely an important fish in ecosystem health in the FPHCP Action Area. Sculpins provide forage for other fish, including Dolly Varden and bull trout. Sculpins are also known to consume salmon eggs and other fish (Wydoski and Whitney 2003). In suitable habitats, sculpins can be abundant and are important in the food chain and in degraded habitat, sculpins may respond negatively. Many factors beyond aquatic habitat may influence local sculpin abundance.

Sculpins are often reported in fish species assemblages in Washington. However, we are unaware of Cottid population trends across watersheds within the FPHCP Action Area.

Role of the FPHCP Action Area for Conservation of the Species:

The FPHCP Action Area encompasses a significant segment of the range of sculpin in Washington. The FPHCP Action Area provides an important conservation role for these species. High quality aquatic habitats within the FPHCP Action Area are necessary for the long-term survival of sculpins in Washington.

8.5.21.3 EFFECTS OF THE ACTION

General habitat effects to sculpin resulting from the proposed action have been summarized above for the Guilds that the 10 species of sculpin are assigned. The sculpins are found across the habitat associations that have been analyzed in this Opinion. The following species and their Guilds as follows: Steep Tributary Guild – shorthead sculpin; Low-Gradient Tributary Guild – riffle sculpin; Mainstem Tributary Guild – Paiute sculpin; Lentic Guild – prickly, coastrange, and torrent sculpins; River System Guild – mottled sculpin. Although the sculpins may have been assigned a specific guild, they will occur across different guilds. For example, the coastrange sculpin, although assigned to the Lentic Guild, may also occur in the Mainstem or Low-Gradient tributary habitat associations. The Slimy sculpin has been found in lakes (Lentic association) and in streams.

Summary of Riparian Prescription Effects to Sculpins

Full riparian and in-stream function likely would not be provided to all habitats occupied by sculpins. In some stream reaches, the highest quality and most structurally complex habitats may fail to develop due to the potential reduction of large wood recruitment to streams following different riparian management prescriptions. Some sculpin are found at higher densities near cover. Where they co-existed with other species, some species of sculpin often occupied pools. Large wood in freshwater habitats is important for storing and releasing the appropriate sediment for development of suitable substrate, pool formation, providing cover, aquatic plant growth, and macroinvertebrate production. Reductions in large wood recruitment to streams may result in habitat modifications that increase risk of predation, reduce forage, and reduce the survival or fitness of individual sculpin.

Sculpin generally prefer summer temperatures less than 20°C. When RMZs achieve their Desired Future Condition, streams within the areas covered by the FPHCP that are occupied by the sculpin will receive most of the potentially available shade. Along Type Np streams, reductions in shade are likely to occur and water temperature may increase over limited distances as a result of the unbuffered Type Np stream reaches. In some cases, increases in temperature may be delivered downstream to Type F waters and temperatures could be warmed near the confluence of Type Np and F streams. There are situations (yarding corridors, stream-adjacent parallel roads, 20 acre exemptions, and windthrow) where stream shading will be reduced from full ecological potential and in some circumstances there may adverse effects to the sculpin due to elevated stream temperatures and the behavior and survival of individual fish may be affected. Water temperature increases may be a factor in inter-specific competition and abundance of the sculpin could be reduced in some cases.

Sediment effects to sculpin

Substrate used by the sculpin is usually a mix of sand and cobble, or large gravel. Some species tended to inhabit gravel substrates, and larger fish tended to inhabit cobble substrates. For example, Paiute sculpins will burrow into the gravel during the day to avoid torrent sculpins and emerge at night to feed. Sediment would be delivered to sculpin habitat from road surface erosion and, to a lesser extent, from hillslope erosion. The FPHCP's incorporation of BMPs and RMAPs would substantially reduce delivery of road surface related sediment to the sculpin habitat, but it would not prevent all sediment from reaching aquatic habitats occupied by the species. Certain watershed features and road related activities may contribute sediment to fish-bearing streams that are above natural background rates. For example, culvert projects may increase siltation until vegetation has recovered enough to reduce delivery of harmful sediment. Excessive siltation may reduce the availability of this habitat and and may affect food resources. When feeding behavior is altered by reduced prey, individual fitness and survival could be affected.

Effects from the 20-acre Exemption Rule

Although there is uncertainty regarding how often this rule would be implemented, when it is implemented the 20-acre Exemption Rule would likely adversely affect the sculpin. In watersheds with a high proportion of 20-acre exempt landowners, this rule would increase the likelihood that large wood recruitment would be inadequate to maintain properly functioning habitat (USFWS & NMFS 2006). There is also the potential for increased sedimentation, reduced shade, increased stream temperatures, and increased windthrow. Where these adverse effects occur, essential behaviors associated with foraging, reproduction and growth may be impeded, and sculpin may occupy the stream at reduced levels and have reduced survival.

Summary of adverse effects to sculpin

The proposed action would have short- to long-term adverse effects on sediment, large wood, and temperature. These effects would be most severe from unbuffered Type Np streams and their downstream effects that result in disruption of natural riparian and aquatic processes and functions in Type F streams. These effects to the aquatic environment may result in impairment of essential foraging, rearing, and spawning behavior of sculpin. Feeding behavior may be altered under some circumstances affecting individual fitness and survival. Available suitable substrate could be reduced, modifying habitat use and ultimately survival. It is difficult to predict the severity of these effects because effects to these fish will vary from activity to activity depending on the specific riparian prescriptions applied, the location, historical management practices, geological characteristics of the watershed, and the biotic community present.

Activities covered under the FPHCP are expected to have direct and indirect adverse effects to adult and juvenile sculpin ranging from mortality to sublethal effects. Direct injury and death to sculpin would likely occur during some stream crossing construction activities (stream dewatering, fish rescue and relocation, and blockage of upstream migration during construction). Increased sediment levels could reduce available habitat and prey items for sculpin. This could affect the growth and survival of juvenile and adult sculpins.

Summary of beneficial effects

The long-term benefits of the FPHCP are expected to outweigh the short-term, negative affects to sculpins. Maturation of riparian areas, maintaining and restoring passage for sculpins, adaptive management, and improved road management practices are all expected from implementation of the FPHCP. These management prescriptions are expected to contribute to long-term survival for sculpins in the FPHCP Action Area.

8.5.21.4 CUMULATIVE EFFECTS

Cumulative effects were addressed in the Comprehensive Cumulative Effects section, with respect to the aquatic and riparian environment in Washington State. Additional information regarding cumulative effects for the covered fish species was presented in the sections: Steep tributary association, Low-

Gradient tributary association, Mainstem association, Lentic association, River system association, and Isolated populations.

No additional information is available with respect to cumulative effects for the following sculpin species: shorthead sculpin, riffle sculpin, Paiute sculpin, prickly sculpin, reticulate sculpin, coastrange sculpin, torrent sculpin, mottled sculpin, slimy sculpin, and margined sculpin.

8.5.22 Longfin Smelt (*Spirinchus thaleichthys*)

8.5.22.1 Status of the Species

Description of the Species

The longfin smelt has a laterally compressed, elongate body which is rarely over 150 millimeters in length as an adult (Scott and Crossman 1979). It has a rather large oblique mouth, no axillary processes at the base of its pelvic fins, long pectoral fins, and a rounded adipose fin (Wydoski and Whitney 2003). Its scales are moderately large cycloid scales. Its color can be dusky color to olive-brown along its dorsal surface becoming silvery along its sides and below. Young longfin smelt are translucent with two rows of large black spots (Scott and Crossman 1979).

Historic and Current Range

The longfin smelt is generally an anadromous species of smelt living most of its life in salt water, only moving into freshwater streams and rivers to spawn. In Washington State, the anadromous form of the longfin smelt is found along the coast, in the Strait of Juan de Fuca and within Puget Sound. However, there is a single landlocked population of longfin smelt that resides within Lake Washington. This population completes its entire life cycle within this freshwater system.

The following information applies to that of the landlocked, Lake Washington form only of longfin smelt.

Essential Habitat Components

In Lake Washington, longfin smelt live predominately in open waters of the lake, only moving into a few of the tributaries during spawning. They generally occupy areas where the temperature is below 18°C (Wydoski and Whitney 2003). Juveniles tend to occur between 11 and 22 meters below the surface from July to December. From January to June, juveniles are often found near the bottom below 18 meters during the day and move at night to depths between 11 to 22 meters (Wydoski and Whitney 2003). Adults occur between 11 and 22 m below the surface at night and move to deeper waters during the day, occupying depths between 18 and 37 meters (Wydoski and Whitney 2003).

Reproductive Ecology

The longfin smelt has a strong spawning run on even years and weak spawning runs on odd years (Wydoski and Whitney 2003). Spawning begins by mid January and lasts until mid April. There are at least five tributaries in which the longfin smelt spawns, the Cedar River being the largest and most important. The others are Coal Creek, Juanita, May and McAleer Creeks (Wydoski and Whitney 2003). Spawning almost always takes place at night in water temperatures between 4.4 and 7.2°C. Migrating smelt go as far as 1.6 kilometers upstream in the Cedar River but mostly stay within 0.6 kilometers of the mouth to spawn. Female smelt only spawn once, whereas males may return to spawn again. Females produce an average of 1,550 eggs, 0.65 to 1.0 millimeters in size (Chigbu and Sibley 1994). Spawning generally takes place in fairly shallow water (0.1 to 0.8 meters deep) with most spawning being between 0.4 and 0.6 meters deep with 0.3 to 0.6 meters/second water velocity. Eggs are deposited on sandy or grave substrates or rocks and aquatic plants (Scott and Crossman 1979). Time until eggs hatch largely depends on water temperature. Eggs hatch in approximately 40 days in water 7°C, 29 days between 8 and 9°C, and 25 days between 9 and 11°C. After hatching, the larval fish move into the main current and are transported downstream to the lake.

Movements and Habitat Use

The longfin smelt in Lake Washington exhibit both diel and seasonal movements. Diel movements are dependant on two factors: age and season. As stated previously, between July and December, juvenile longfin smelt occur between 11 and 22 meters below the surface. Adults are also at this depth at night, but move to deeper water (18 to 37 meters) during the day (Wydoski and Whitney 2003). From January to June, juveniles are near the bottom (below 18 meters) during the day and move upward at night to depths between 11 and 22 meters below the surface, as do the adults (Wydoski and Whitney 2003). During their second year of life, longfin smelt have well defined patterns of migration, using deeper waters during the day and shallower waters at night. This pattern also follows that of their prey, the mysid shrimp.

Threats to Survival

Since the late 1960's the biomass of the longfin smelt in Lake Washington has increased. Chigbu (2000) found that longfin smelt in Lake Washington made up less than 12 percent of planktivorous species sampled in the late 1960's. Twenty years later, longfin smelt made up 58 to 84 percent of planktivorous species in the lake. This overall increase in the smelt biomass is thought be a product of reduced flows in the Cedar River (the smelt's main spawning site) that have enabled a greater number of spawned smelt eggs to hatch and survive. High flows in the Cedar River have been linked to lower numbers of smelt for the odd-year class, which is four times lower in population than that of the even-year class. Evidence has shown a negative relationship with high flows in the Cedar River during spawning that resulted in decreased survival of spawned eggs (Chigbu 2000). Chigbu (2000) found that Cedar River discharge greater than 28-cubic meters/second occurred more frequently during odd years than even years. An increase in discharge during both even and odd years in the Cedar River, coupled with the fact that the longfin smelt is only found within Lake Washington, may be a factor influencing long-term abundance.

8.5.22.2 ENVIRONMENTAL BASELINE (within the FPHCP Action Area)

The landlocked longfin smelt resides in Lake Washington. Lake Washington is primarily surrounded by city parks and urban development and not within the FPHCP Action Area. The fish spawn in tributaries within 0.7-mile of the lake (Wydoski and Whitney 2003). There are very few lands covered by the proposed action within this close proximity to the lake. However, there are lands upstream in the Cedar River watershed that are part of the FPHCP Action Area. The Lake Washington population appears healthy.

Role of the FPHCP Action Area for conservation of the species:

The FPHCP Action Area provides a very limited role in the long-term conservation for this species. These fish occur in an urbanized landscape and the FPHCP will have very little influence over their survival.

8.5.22.3 EFFECTS OF THE ACTION

As described above, the longfin smelt occurs in Lake Washington and spawns in tributaries very close to the lake. For this Opinion, longfin smelt are assigned to the Isolated Population Guild. However, the most relevant effects to this species may be in the Lentic Guild.

Riparian prescription effects to longfin smelt

It is not anticipated that riparian prescriptions, other than as described in the Isolated Population and Lentic Guilds, will adversely affect longfin smelt.

Sediment effects to longfin smelt

Sediment could potentially be delivered to longfin smelt habitats from road surface erosion. Installing culverts may contribute sediment to habitats occupied by longfin smelt, especially until vegetation has re-established to minimize it. Certain watershed features and road use may contribute sediment to spawning habitats. Excessive siltation may affect egg survival.

Summary of adverse effects to longfin smelt

The longfin smelt is an isolated population. Isolated populations of species are prone to extirpation from catastrophic events, both natural or man-caused. Frequent and severe disturbances could also affect the lake Washington longfin smelt population. Implementation of the FPHCP will not increase the risk of a catastrophic event to the Lake Washington longfin smelt population. Effects from the FFHCP will not be of the duration or magnitude to reduce the chance of this species persisting.

Summary of beneficial effects to longfin smelt

The benefits of the FPHCP are expected to contribute to the long-term survival of the longfin smelt. As riparian areas mature, roads are managed with watershed processes in mind, adaptive management is applied, and fish blockages are removed, longfin smelt should benefit from improvements in watershed functions. The FPHCP will have little influence on the species long-term survival.

8.5.22.4 CUMULATIVE EFFECTS

Cumulative effects were addressed in the **Comprehensive Cumulative Effects** section, with respect to the aquatic and riparian environment in Washington State. Additional information regarding cumulative effects for the covered fish species was presented in the section **Lentic Guild: Cumulative Effects.**

No additional information is available with respect to cumulative effects for this particular species above those cumulative effects already discussed earlier in this document.

8.5.23 Burbot (*Lota lota*)

8.5.23.1 Status of the Species

Description of the Species

The burbot is the only freshwater member of the cod family (Gadidae) (Wydoski and Whitney 2003). The burbot has an elongated body with a single barbel on the chin and a long second dorsal fin, which can be 6-times longer than the first dorsal fin (Morrow 1980). The burbot has a low gradienttened head with a long snout, a terminal mouth, and prominent tubes extending from each nostril (Morrow 1980). The burbot has short, rounded pectoral fins and a rounded caudal fin. The burbot has small cycloid scales embedded in the skin. The color can be yellowish to brown to dark olive green on the dorsal and sides of the body. The sides tend to be mottled or blotchy with a dark line along the anal fin margin. The ventral surface can be a pale yellow to white. Pelvic fins tend to be pale in color while the other fins tend to be dark or mottled. In Washington State, burbot have been known to live up to 10 years and have an average length of 50 centimeters (Wydoski and Whitney 2003). The oldest burbot recorded was captured in Keechelus Lake and was 19 years old and over 74 centimeters in total length (Bonar et al. 1997).

Historical and Current Range

In North America burbot are found from Alaska to Oregon and east to Connecticut, and in Canada (Wydoski and Whitney 2003). Information on the historical distribution of burbot in Washington State is sparse. Populations of burbot likely originated from the southern unglaciated portion of the Columbia River following the last glaciation (Bonar et al. 1997). The current distribution consists of 11 deepwater lakes of the Columbia River system: Banks, Bead, Chelan, Cle Elum, Franklin D. Roosevelt, Kachess, Keechelus, Osoyoos, Plamer, Rufus Woods, and Sullivan Lakes (Bonar et al. 1997, as cited in Wydoski and Whitney 2003). There seems to be no evidence of burbot populations west of the Cascade crest. The western-most population of burbot occurs in Lake Keechelus in the Cascade Mountains.

Essential Habitat Components

Burbot inhabit large (290 ha to 32,000 ha), deep, oligotrophic or mesotrophic lakes and reservoirs, and portions of the Spokane and Columbia Rivers (Wydoski and Whitney 2003). These habitats are generally located at higher elevations or are in the northeastern portion of the State. The elevations of lakes that burbot inhabit range from 280 to 877 meters above sea level (Bonar et al. 1997). Burbot are photo-negative and prefer to be near the bottom, especially during the summer (Bonar et al. 1997). During the winter, when water temperatures are low, burbot move into shallower waters, but only during the night (Bonar et al. 1997). Burbot forage nocturnally at various depths, depending on the time of year. Optimum water temperatures are reported to be between 16° C and 18° C (Scott and Crossman 1973).

Reproductive Ecology

Burbot spawn in lakes or slow-moving sections of rivers. Spawning begins in winter and can last until early spring (Bonar et al. 1997). Burbot spawn at night when water temperatures are between 0.6° C and 2° C (Scott and Crossman 1973). Spawning takes place in shallow sections of lakes or rivers often under the ice, although there is some evidence that deep-water spawning can occur (Scott and Crossman 1973). Males are the first to arrive on the spawning sites (Wydoski and Whitney 2003). Mature individuals, depending on location, are usually between two and six years of age (Bonar et al. 1997). In the presence of a female, male burbots swim around her, forming a large “ball” with the female in the center (Bonar et al. 1997). The female broadcasts her eggs (sometimes up to 1.4 million depending on length of the female), over the substrate, and the males then fertilize them. The fertilized eggs are not sticky but are demersal and contain an oil globule (Morrow 1980). After spawning, the parents do not care for the eggs, and return to the deeper portions of the lake or river. The fertilized eggs settle onto the substrate where they develop for up to 71 days at water temperatures between 0° C and 4° C and hatch at temperatures of 6° C to 6.5° C (Morrow 1980; Scott and Crossman 1973).

Movements and Habitat Use

The migratory patterns of burbot are somewhat unknown (Morrow 1980). They do migrate into spawning areas during the winter, remaining through spring, and post-spawning movement into tributaries and upstream in rivers in late winter or early spring has been documented (Scott and Crossman 1973). The migrations that burbot make, pre- and post-spawning, are not believed to be of any great distance.

Overall burbot are sedentary, only moving to forage or to seek optimal temperatures or light conditions. Burbot generally remain within the deep portions of lakes and rivers (Mecklenburg et al. 2002; Scott and Crossman 1973). During the summer months, burbot usually remain in the hypolimnetic region of lakes (Scott and Crossman 1973). The optimal water temperatures for burbot are between 16° C to 18° C, with 23° C being their upper temperature limit (Scott and Crossman 1973). During the summer, burbot move into shallower water at night to feed. Burbot are photo-negative and prefer low light conditions (Wydoski and Whitney 2003). They are inactive during the day and only begin to move around dusk. Depending on the season, burbot may move throughout the night to forage (Wydoski and Whitney 2003). Overall, burbot use a small foraging area which changes little from year-to-year.

Threats to Survival

There is very little information to suggest that the original distribution of burbot is different than the present, and it is therefore difficult to make an assessment of decline in their populations (Bonar et al. 1997). Burbot are subject to similar threats as other native fish, such as overharvest, pollution, man-made barriers and habitat fragmentation, competition with non-native species for resources, and climate change (Bonar et al. 1997). Forest practices may not provide a substantial risk to survival of burbot.

8.5.23.2 ENVIRONMENTAL BASELINE (within the FPHCP Action Area)

There are 11 known burbot populations in Washington State, of which one is considered healthy (Lake Roosevelt), one is considered critical (Banks Lake), and the status of the remaining nine populations are unknown (Bonar et al. 1997). They are unknown to occur in western Washington.

Role of the FPHCP Action Area for Conservation of the Species

Some of the lakes that are occupied by burbot are slightly influenced by the FPHCP. Generally, the FPHCP will have little influence to burbot. The FPHCP Action Area provides a minor role in the long-term conservation of burbot.

8.5.23.3 EFFECTS OF THE ACTION

General habitat effects to burbot from the proposed action have been summarized above for the Lentic and River System Guilds. No additional effects from riparian prescriptions or sediment are expected for this species.

Summary of adverse effects to burbot

There may be some sediment effects from the FPHCP to habitats occupied by burbot. Sediment that may affect burbot is most likely to come from road crossings of Type S and F streams. These effects are expected to be very minor and not influence the population or distribution in the FPHCP Action Area.

8.5.23.4 CUMULATIVE EFFECTS

Cumulative effects were addressed in the **Comprehensive Cumulative Effects**, with respect to the aquatic and riparian environment in Washington State. Additional information regarding cumulative effects for the fish species was presented in the section **Lentic Guild: Cumulative Effects.**

No Additional information is available with respect to cumulative effects for this particular species above those cumulative effects already discussed earlier in this document.

8.5.24 White Sturgeon (*Acipenser transmontanus*)

8.5.24.1 Status of the Species

Description of the Species

The white sturgeon is the largest sturgeon in North America; specimens have measured up to 6.1 meters long (Scott and Crossman 1973). It has a short rounded snout with four barbels which are closer to the end of the snout than the mouth. Male white sturgeons have longer pointed snouts than females, which have smaller more rounded snouts (Wydoski and Whitney 2003). Their mouths have highly protrusible lips that lack teeth (Moyle 2002). White sturgeons have no scales and are covered with very minute dermal denticles and isolated rows of large, diamond-shaped bony plates or scutes (Scott and Crossman 1973). The white sturgeon have 4 to 8 scutes between the pelvic and anal fin in two rows, and lateral scutes number between 38 and 48 (Wydoski and Whitney 2003). They have a heterocercal caudal fin, a dorsal fin with one spine that is far back over the anal fin, and large rounded pectoral fins. Their dorsal body surface color above the lateral scutes is light grey, grey-brown or pale olive color, while the ventral body color below the lateral scutes is pale grey to white. The fins tend to be dusky to opaque grey in color.

Historic and Current Range

White sturgeon are found in marine and fresh waters from California to Alaska. Historically, the white sturgeon inhabited the entire Columbia River from the mouth upstream into Canada, the Snake River upstream to Shoshone Falls, and the Kootenai River upstream to Kootenai Falls. Currently in Washington State, the white sturgeon is found in the Columbia River, Snake River, Grays Harbor, Willapa Bay, Puget Sound and Lake Washington (Wydoski and Whitney 2003). In the Columbia River system, five separate stocks of white sturgeon exist: the lower Columbia stock, the mid Columbia stock, the Lake Roosevelt stock, the Snake River stock, and the Kootenai River stock (Wydoski and Whitney 2003). The populations within the Columbia River Basin are considered the largest and most studied in the state.

Essential Habitat Components

Habitat use of white sturgeon varies according to life-history stage and location. Adult white sturgeon seems to prefer large deep pools and eddies in the main channels of the Columbia and Snake Rivers (Wydoski and Whitney 2003). They generally prefer water deeper than 15 meters with low velocities where they rest on the bottom to feed on drifting items (Wydoski and Whitney 2003). In California, adults spend most of their lives in estuaries of large rivers only moving into upper reaches to spawn (Moyle 2002). White sturgeon adults in the Fraser River, British Columbia, prefer deep, near-shore areas adjacent to fast flowing sections with sand and gravel substrates (Ptolemy and Vennesland 2003).

Juveniles and sub-adults tend to occupy sloughs off the main channel during the summer months (Wydoski and Whitney 2003). Young-of-the-year are often found over hard clay, mud, silt, sand, grave and cobble at depths of 12 to 27 meters, with water velocities around 1.4 meters/second (Wydoski and Whitney 2003). Juveniles in the lower reaches of tributaries of the Fraser River, British Columbia, utilized large backwaters, side channels and sloughs, and were often found at depths greater than 5 meters, in low velocities and variable current direction, and preferred high turbidity and relatively warm water. Juveniles were also seen moving from sloughs and backwaters to mainstem areas as summer progressed (Ptolemy and Vennesland 2003).

Generally water temperature, depth, velocity and substrate types are the main factors in determining spawning and rearing habitat by white sturgeon adults. Spawning substrates selected by adult white sturgeon in the lower Columbia River below the tailraces of dams were generally composed of cobble, boulder and bedrock (Parsley et al. 1993). Spawning and subsequently egg incubation occurred in the swiftest water available (mean water column velocity, 0.8 to 2.8 meters/second) (Parsley et al. 1993). In the Fraser River, which is unregulated and largely unaltered, white sturgeon spawning areas were mainly in shallow side channels as opposed to mainstem reaches (Perrin et al. 2003).

Reproductive Ecology

Most studies on the reproductive ecology of white sturgeon have been done on the Columbia and Snake Rivers (Wydoski and Whitney 2003; Parsley et al. 1993; Parsley and Beckman 1994), the Fraser River in British Columbia (Perrin et al. 2003) and the Sacramento River in California (Moyle 2002). A recent study by Perrin et al. (2003) indicates that spawning habitat may vary between natural systems, like the Fraser River, and those that are impounded such as the Columbia and Snake Rivers. In regulated flow systems, sturgeon utilize fast, turbulent mainstem water over clean, large rocky substrate, whereas in unregulated systems, sturgeon selected side-channel habitats to spawn (Perrin et al. 1993; Ptolemy and Vennesland 2003). In the Fraser River, Perrin et al. (2003) found evidence that spawning occurred only in side-channels, rather than within mainstem reaches, with substrates comprised of gravel, cobble and sand, and flows that were mainly laminar with near-bed velocities averaging 1.7 meters/second.

When ready to spawn, white sturgeons migrate upstream. Males in the lower Columbia River mature at 1.2 meters in length and females at 1.8 meters (Wydoski and Whitney 2003). In some areas males mature at 9 years of age and females mature between 13 and 16 years of age (Wydoski and Whitney 2003). Sturgeon tend to spawn in alternating years, with only a small percentage of adults spawning in any one giver year. Sometimes there can be spawning intervals of 3 to 11 years (Wydoski and Whitney 2003). Spawning in the lower Columbia River starts in April and goes through July in water temperatures from 10° to 18°C (Parsley et al. 1993). Males and females spawn in the swiftest water possible (0.8 to 2.8 meters/second at 4 to 20 meters in depth) in mainstem reaches below the dams, over cobble, boulder and bedrock substrate (Wydoski and Whitney 2003). Water released from the dams during this time becomes extremely important to the success of spawning sturgeon. Parsley and Beckman (1994) found that lowering spring and summer discharges reduces the availability of spawning habitats. Survival to hatch is also expected to be greatest under these conditions, as high velocities in egg deposition areas may exclude some predators and provide high turbidity, improving juvenile survival (Gadomski et al. 2001b). Based on limited data, spawning intensity is greatest when discharges are high and steady (Ptolemy and Vennesland 2003).

Mature females in the lower Columbia can produce 98,000 to 700,000, 3-millimeter diameter eggs (Wydoski and Whitney 2003). A 43.3 kg female contained 1.7 million eggs and larger fish may produce as many as 3 million eggs (Wydoski and Whitney 2003). White sturgeon are broadcast spawners with adhesive eggs. Eggs hatch in about 7 days at 15°C (Wydoski and Whitney 2003). The hatched sac-fry are then transported by the river currents from spawning areas into deeper areas with lower water velocities and finer substrates, where they begin to feed (Parsley et al. 1993).

Movements and Habitat Use

Movements and habitat use of white sturgeon vary according to location and life history state. Sturgeons have been known to make relatively small movements and also extensive migrations of many hundreds to over 1,000 kilometers (Wydoski and Whitney 2003; Moyle 2002). With the construction of the dams on the Columbia and Snake Rivers in the last century, sturgeon populations have generally become isolated from historic migratory routes. The dams have formed migratory barriers that have limited the movement of migratory populations and confined them to relatively short sections of river, often with little essential habitat.

In the lower Columbia River, movements associated with spawning typically occur during the fall months, when adults begin to move upstream to spawning areas. They move back down in late winter and spring after spawning (Wydoski and Whitney 2003). Anadromous adults begin to move into larger rivers such as the Columbia and Fraser Rivers in early spring (Scott and Crossman 1973).

The population of white sturgeon below Bonneville Dam is one of the healthiest in the Columbia River, in part because of its ability to move into the marine environment to feed and overwinter. Little is known about the movements of white sturgeon in the marine environment. Tagged individuals have been captured at sea as far as 1,062 kilometers from the tagging site (Scott and Crossman 1973). An adult sturgeon tagged in San Francisco Bay was captured in the lower Columbia River (Moyle 2002). Other populations in the Columbia and Snake Rivers remain entirely in fresh water throughout their lives in part due to the system of dams and natural barriers. Non-anadromous individuals may travel long distances over short periods of time within an impounded reach (Haynes et al. 1978). One tagged adult was captured more than 1,000 kilometers up the Columbia River after navigating the system of dams (Moyle 2002).

Adults and juveniles move into overwintering habitats in the fall where they remain until water temperatures increase. During this time they are relatively inactive, remaining close to or lying on the bottom of deep pools. In the Hanford Reach, Haynes et al. (1978), found that movement of tagged sturgeon ceased in mid-October when water temperatures were about 15°C, not exceeding 0.2 kilometers from November through May, a period which seemed to be a dormant season.

Sturgeon are also known to make movements to feeding areas. These movements depend on food availability and are not well understood. In San Francisco Bay, sturgeon moved to intertidal areas to feed at high tides (Moyle 2002). Sturgeon in the Fraser River, British Columbia, have been reported traveling more than 30 kilometers to overwintering and feeding areas (Ptolemy and Vennesland 2003). In the upper Columbia River, white sturgeon moved to shallow foraging areas during the spring and summer (Ptolemy and Vennesland 2003).

Threats to Survival

White sturgeon in the Columbia River have declined due to dams, altered streamflows, altered temperature regimes, and overharvest (Wydoski and Whitney 2003). Information suggests that white sturgeon populations are less productive than they were before 1885 (Rieman and Beamesderfer 1990).

This is primarily due to two main factors: overfishing; and habitat loss/alterations due to the constructions of dams in the Columbia and Snake Rivers.

White sturgeon are long lived, slow growing, mature later in life than most fish, and spawn every 2 to 11 years. These life history traits make them susceptible to over exploitation (Miller et al. 1996). In the Columbia River, commercial fisheries for white sturgeon began in the 1880's, peaking in 1892 with a harvest of 2.5 million kg. By 1899 the population of white sturgeon in the Columbia River had been severely depleted and populations remained very low until the late 1940's, when the population appeared to recover enough to expand the fisheries. Restrictions were enacted, which have been subsequently modified over the years, and currently the harvest of white sturgeon has reached on average 42,000 individuals per year for the last ten years (DeVore et al. 1999). Currently, the abundance of white sturgeon below the Bonneville Dam is considered the greatest in the Columbia River system, mainly due to access to the marine environment, abundant food resources, and favorable hydrologic conditions during spawning. Although this population is abundant, it could collapse if not properly managed (Rieman and Beamesderfer 1990).

The construction of dams throughout the Columbia and Snake Rivers has created wide ranging effects on the white sturgeon. First constructed in the 1930's, the dams restricted and eliminated migratory paths, altered seasonal fluctuation of water flows and temperatures, fragmented populations, and eliminated some habitats all together. White sturgeons trapped behind the dams were unable to move into lower river habitats and the ocean. Population fragmentation represents a critical threat to the survival of the white sturgeon.

Altered daily and seasonal river flows and water temperatures from dam operations may also limit migration, habitat availability, and affect timing, location and success of reproduction. Dams have altered the magnitude and timing of discharge, as well as depths, turbidities and channel substrates. Dams have been found to negatively affect spawning habitat and some populations of white sturgeon have shown reduced production potential as a result of dam construction (Perrin 2003).

The construction of dams has also been shown to have an effect on water quality and pollution. Feist et al. (In Press) found that fish residing in the reservoir behind the oldest dam in the study (Bonneville) had the highest contaminant loads, incidence of gonadal abnormalities, and the lowest gonad size. Chemicals are most likely accumulating behind dams over time, and exposure to these contaminants may be affecting both growth and reproductive physiology of sturgeon in some areas of the Columbia River (Feist et al. 2005). Dissolved gases created by dams have also been shown to negatively affect larval sturgeon. One to two day old yolk-sac larvae exposed to gas supersaturation exhibited bubble trauma, where bubbles accumulated in the buccal cavity and forced the larvae to the surface of the water (Counihan et al. 1998).

8.5.24.2 ENVIRONMENTAL BASELINE (within the FPHCP Action Area)

White sturgeon are found in marine and freshwaters. In Washington, they occur in the Columbia River, Snake River, Grays Harbor, Willapa Harbor, Puget Sound, and Lake Washington (Wydoski and Whitney 2003). The largest population of white sturgeon occurs in the Columbia River between the mouth upstream to the Bonneville Dam. The average annual abundance was estimated to be 895,000 fish 21.3" or longer (Wydoski and Whitney 2003). In the Dalles pool, 73,382 white sturgeon were estimated in 1997. In 1994 in Lake Roosevelt, 5,702 white sturgeon were estimated from Grand Coulee dam upstream to the Canada border.

Role of FPHCP Action Area in Conservation of species:

The role of the FPHCP Action Area for the white sturgeon is minor. Due to the habitats the species occupies relative to the threats to it, the FPHCP will only have a minimal influence on the long-term survival of the white sturgeon.

8.5.24.3 EFFECTS OF THE ACTION

Effects resulting from permit issuance have been summarized above for the River System Guild and Nearshore Habitat Association. The FPHCP is expected to have minimal influence on the long-term survival of the white sturgeon.

Summary of sediment effects to white sturgeon

Sediment may be delivered to white sturgeon habitat from road surface erosion as a result of the FPHCP. Certain watershed features and road use may contribute sediment to fish-bearing streams that are above natural background rates. Culvert projects may increase siltation over short durations, especially until vegetation has recovered to reduce harmful sediment.

Summary of adverse effects to white sturgeon

It is not anticipated that there will be effects to large wood or temperature that would affect sturgeon habitat. Any effects from increased sediment to white sturgeon habitat as a result of the FPHCP are expected to be negligible and are not expected to affect the distribution, abundance or survival of the species.

Summary of beneficial effects

The long-term benefits of the FPHCP are expected to outweigh the short-term, negative affects to white sturgeon. Maturation of riparian areas, restoring fish passage, adaptive management, and improved road management practices are all expected from implementation of the FPHCP. These management prescriptions are expected to contribute to increasing the likelihood of long-term survival for white sturgeon in the FPHCP Action Area.

8.5.24.4 CUMULATIVE EFFECTS

Cumulative effects were addressed in the **Comprehensive Cumulative Effects**, with respect to the aquatic and riparian environment in Washington State. Additional information regarding cumulative effects for the covered fish species was presented in the section **River System Guild: Cumulative Effects.**

No additional information is available with respect to cumulative effects for this particular species above those cumulative effects already discussed earlier in this document.