Table 9. Aggregate Results of All Suitable Habitat (acres) Affected by Section 7 Consultation for the Murrelet; Summary of Effects by Conservation Zone and Habitat Type from October 1st, 2003 to January 31, 2013.

Conservation Zone[1]	Authorized Habitat Effects In Acres[2]		Reported Habitat Effects in Acres[2]	
	Stands[3]	Remnants[4]	Stands[3]	Remnants[4]
Puget Sound	-69	0	-1	0
Western Washington	-43	0	-12	0
Outside CZ Area in WA	0	0	0	0
Oregon Coast Range	-702	-150	-137	0
Siskiyou Coast Range	-1,765	0	-137	0
Outside CZ Area in OR	-2	0	0	0
Mendocino	0	0	0	0
Santa Cruz Mountains	0	0	0	0
Outside CZ Area in CA	0	0	0	0
Total	**-2,581**	**-150**	**-287**	

Notes:

1. Conservation Zones (CZ) six zones were established by the 1997 Recovery Plan to guide terrestrial and marine management planning and monitoring for the Murrelet. *Marbled Murrelet Recovery Plan, September, 1997*
2. Habitat includes all known occupied sites, as well as other suitable habitat, though it is not necessarily occupied. Importantly, there is no single definition of suitable habitat, though the Murrelet Effectiveness Monitoring Module is in the process. Some useable working definitions include the Primary Constituent Elements as defined in the Critical Habitat Final Rule, or the criteria used for Washington State by Raphael et al. (2002).
3. Stand: A patch of older forest in an area with potential platform trees.
4. Remnants: A residual/remnant stand is an area with scattered potential platform trees within a younger forest that lacks, overall, the structures for murrelet nesting.

viii. Landscape Characteristics

Studies have determined the characteristics of murrelet nesting habitat at a landscape-scale using a variety of methods, including predictive models, radio telemetry, audio-visual surveys, and radar. McShane et al. (2004, pg. 4-103) reported, “At the landscape level, areas with evidence of occupancy tended to have higher proportions of large, old-growth forest, larger stands and greater habitat complexity, but distance to the ocean (up to about 37 miles [60 km]) did not seem important.” Elevation had a negative association in some studies with murrelet habitat occupancy (Burger 2002). Hamer and Nelson (1995b) sampled 45 nest trees in British Columbia, Washington, Oregon, and California and found the mean elevation to be 1,089 feet (332 m).

Multiple radar studies (e.g., Burger 2001, Cullen 2002, Raphael et al. 2002, Steventon and Holmes 2002) in British Columbia and Washington have shown that radar counts of murrelets are positively associated with total watershed area, increasing amounts of late-seral forests, and with increasing age and height class of associated forests. Murrelet radar counts are also negatively associated with increasing forest edge and areas of logged and immature forests (McShane et al. 2004). Several studies have concluded that murrelets do not pack into higher densities within remaining habitat when nesting habitat is removed (Burger 2001, Manley et al. 2001, Cullen 2002).

There is a relationship between proximity of human-modified habitat and increased avian predator abundance. However, increased numbers of avian predators does not always result in increased predation on murrelet nests. For example, Luginbuhl et al. (2001, pg. 565) report, in a study using simulated murrelet nests, that “Corvid numbers were poorly correlated with the rate of predation within each forested plot”. Luginbuhl et al. (2001, pg. 569), conclude, “that using measurements of corvid abundance to assess nest predation risk is not possible at the typical scale of homogenous plots (0.5-1.0 km^2 in our study). Rather this approach should be considered useful only at a broader, landscape scale on the order of 5-50 km^2 (based on the scale of our fragmentation and human-use measures).”

Artificial murrelet nest depredation rates were highest in western conifer forests where stand edges were close to human development (Luginbuhl et al. 2001), and Bradley (2002) found increased corvid densities within three miles of an urban interface, probably due to supplemental feeding opportunities from anthropogenic activities. Golightly et al. (2002) found extremely low reproductive success for murrelets nesting in large old-growth blocks of redwoods in the California Redwoods National and State Parks. Artificially high corvid densities from adjacent urbanization and park campgrounds are suspected to be a direct cause of the high nesting failure rates for murrelets in the redwoods parks.

If the surrounding landscape has been permanently modified to change the predators’ numbers or densities through, for example, agriculture, urbanization, or recreation, and predators are causing unnaturally high nest failures, murrelet reproductive success may remain depressed. Because corvids account for the majority of depredations on murrelet nests and corvid density can increase with human development, corvid predation on murrelet habitat is a primary impact consideration. The threat of predation on murrelet populations (both nests and adults) appears to be greater than previously anticipated (McShane et al. 2004).

4.3.3 Population Status

i. *Historical status and distribution*

Murrelet abundance during the early 1990s in Washington, Oregon, and California was estimated at 18,550 to 32,000 birds (Ralph et al. 1995).

The historical breeding range of the murrelet extends from Bristol Bay, Alaska, south to the Aleutian Archipelago, northeast to Cook Inlet, Kodiak Island, Kenai Peninsula and Prince William Sound, south coastally throughout the Alexander Archipelago of Alaska, and through British Columbia, Washington, Oregon, to northern Monterey Bay in central California. Birds winter throughout the breeding range and also occur in small numbers off southern California.

At the time of listing, the distribution of active nests in nesting habitat was described as non-continuous (USFWS 1997, p. 14). The at-sea extent of the species currently encompasses an area similar in size to the species' historic distribution, but with the extremely low density of murrelets in Conservation Zone 5, and the small population in Conservation Zone 6, the southern end of the murrelet distribution is sparsely populated compared to Conservation Zones 1-4 (Table 10).

ii. *Current status and distribution of the listed species in rangewide (summary)*

Based primarily on the results from the NWFP Effectiveness Monitoring (EM) Program, the 2010 murrelet population for the listed range (Table 21) is estimated at 16,691 birds (95 percent confidence interval [CI]: 13,075 – 20,307;Table 21). Based on the 2010 estimates, Conservation Zones 3 and 4 support approximately 65 percent of the murrelet population within the U.S., and consistently have the highest – at-sea densities during the nesting season (Falxa et al. 2011). As with the historic status, murrelets continue to occur in the lowest abundance in Conservation Zones 5 and 6.

Table 10. Estimates of murrelet density and population size (95% CI) in Conservation Zones 1 through 5 during the 2010 breeding season (Falxa et al. 2011), and in Conservation Zone 6 during the 2009 breeding season (Perry and Henry 2010).

Conservation Zone	**Density** (birds/km^2)	**Coefficient of Variation** (% Density)	**Population Size Estimates with 95% CI**			**Survey Area** (km^2)
			Number of Birds	Lower	Upper	
1	1.26	20.4	4393	2,689	6,367	3,497
2	0.18	25.7	1,286	650	1946	1,650
3	4.53	16.9	7,223	4,605	9,520	1,595
4	3.16	27.3	3,668	2,196	6,140	1,159
5	0.14	-	121	-	242	883
6	-	-	631	449	885	-
Zones 1-6	-	-	17,322	13,524	21,192	-

The at-sea distribution also exhibits discontinuity within Conservation Zones 1, 2, 5, and 6, where five areas of discontinuity are noted: a segment of the border region between British Columbia, Canada and Washington, southern Puget Sound, WA, Destruction Island, WA to Tillamook Head, OR, Humboldt County, CA to Half Moon Bay, CA, and the entire southern end of the breeding range in the vicinity of Santa Cruz and Monterey Counties, CA (McShane et al. 2004, p. 3-70).

The current breeding range of the murrelet is the same as the historic breeding range. Birds winter throughout the breeding range and also occur in small numbers off southern California.

iii. *Trend*

There are two general approaches that researchers use to assess murrelet population trend: at-sea surveys and population modeling based on demographic data. In general, the FWS assigns greater weight to population trend and status information derived from at-sea surveys than estimates derived from population models because survey information generally provides more reliable estimates of trend and abundance.

iv. *Marine Surveys*

Researchers from the EM Program detected a statistically significant decline ($p < 0.001$) in the abundance of the population in Conservation Zones 1 through 5 combined, for the 2001-2010 sample period (Falxa et al. 2011). The estimated average annual rate of decline for this period was 3.7 percent (95 percent CI: -4.8 to -2.7 percent). This rate of annual decline suggests a total population decline of about 29 percent between 2001 and 2010 (Miller et al. 2012).

At the scale of individual conservation zones, the murrelet population declined at an estimated average rate of 7.4 percent per year (95 percent CI: -11.2 to -3.5) in Conservation Zone 1 (Falxa et al. 2011, Miller et al. 2012). In that same analysis, statistically significant trends were not detected elsewhere at the single-zone scale, but evidence of a declining trend was strong in Zone 2 (6.5% rate of decline, $P = 0.06$). For Washington State (Conservation Zones 1 and 2 combined) there was a 7.31 percent (standard error = 1.31 percent) annual rate of decline in murrelet density for the 2001-2010 period (Pearson et al. 2011, p. 10), which equates to a loss of approximately 47 percent of the murrelet population since 2001.

In Conservation Zone 6, the 2008 population estimate for Conservation Zone 6 suggested a decline of about 55 percent from the 2007 estimate and a 75 percent decline from the 2003 estimate (Peery et al. 2008). However, in the most recent population estimate available, the 2009 estimate was similar to estimates from 1999-2003 (Peery and Henry 2010). Peery and Henry (2010) speculated that their 2009 results may have indicated murrelets in central California moved out of the survey area in 2007 and 2008, and then returned in 2009, or the higher estimate in 2009 may have been due to immigration from larger populations to the north. Results from 2010 and 2011 surveys from Zone 6 are currently not available.

v. *Population Models*

Prior to the use of survey data to estimate trend, demographic models were more heavily relied upon to generate predictions of trends and extinction probabilities for the murrelet population (Beissinger 1995; Cam et al. 2003; McShane et al. 2004; USFWS 1997). However, murrelet population models remain useful because they provide insights into the demographic parameters and environmental factors that govern population stability and future extinction risk, including stochastic factors that may alter survival, reproductive, and immigration/emigration rates.

In a report developed for the 5-year Status Review of the Murrelet in Washington, Oregon, and California (McShane et al. 2004, p. 3-27 to 3-60), computer models were used to forecast 40-year murrelet population trends. A series of female-only, multi-aged, discrete-time stochastic Leslie Matrix population models were developed for each conservation zone to forecast decadal population trends over a 40-year period and extinction probabilities beyond 40 years (to 2100). The authors incorporated available demographic parameters (Table 11) for each conservation zone to describe population trends and evaluate extinction probabilities (McShane et al. 2004, p. 3-49).

Table 11. Rangewide murrelet demographic parameter values based on four studies all using Leslie Matrix models.

Demographic Parameter	Beissinger 1995	Beissinger and Nur 1997*	Beissinger and Peery (2007)	McShane et al. 2004
Juvenile Ratio (Ŕ)	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	-
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 %

*In USFWS (1997).

McShane et al. (2004) used mark-recapture studies conducted in British Columbia by Cam et al. (2003) and Bradley et al. (2004) to estimate annual adult survival and telemetry studies or at-sea survey data to estimate fecundity. Model outputs predicted 3.1 to 4.6 percent mean annual rates of population decline per decade the first 20 years of model simulations in murrelet Conservation Zones 1 through 5

(McShane et al. 2004, p. 3-52). Simulations for all zone populations predicted declines during the 20 to 40-year forecast, with mean annual rates of 2.1 to 6.2 percent decline per decade (McShane et al. 2004, p. 3-52). These reported rates of decline are similar to the estimates of 4 to 7 percent per year decline reported in the Recovery Plan (USFWS 1997, p. 5).

McShane et al. (2004, pp. 3-54 to 3-60) modeled population extinction probabilities beyond 40 years under different scenarios for immigration and mortality risk from oil spills and gill nets. Modeled results forecast different times and probabilities for local extirpations, with an extinction risk[28] of 16 percent and mean population size of 45 individuals in 100 years in the listed range of the species (McShane et al. 2004, pp. 3-58).

4.3.4 Threats; including reasons for listing, current rangewide threats

When the murrelet was listed under the Endangered Species Act (57 FR 45333-45336 [October 1, 1992]) and threats summarized in the Recovery Plan (USFWS 1997, pp. 43-76), several anthropogenic threats were identified as having caused the dramatic decline in the species.

- habitat destruction and modification in the terrestrial environment from timber harvest and human development caused a severe reduction in the amount of nesting habitat
- unnaturally high levels of predation resulting from forest “edge effects” ;
- the existing regulatory mechanisms, such as land management plans (in 1992), were considered inadequate to ensure protection of the remaining nesting habitat and reestablishment of future nesting habitat; and
- manmade factors such as mortality from oil spills and entanglement in fishing nets used in gill-net fisheries.

There have been changes in the levels of these threats since the 1992 listing (USFWS 2004e, pp. 11-12; USFWS 2009d, pp. 27-67). The regulatory mechanisms implemented since 1992 that affect land management in Washington, Oregon, and California (for example, the NWFP) and new gill-netting regulations in northern California and Washington have reduced the threats to murrelets (USFWS 2004e, pp. 11-12). The levels for the other threats identified in 1992 listing (57 FR 45333-45336 [October 1, 1992]) including the loss of nesting habitat, predation rates, and mortality risks from oil spills and gill net fisheries (despite the regulatory changes) remained

[28] Extinction was defined by McShane et al. (2004, p. 3-58) as any murrelet conservation zone containing less than 30 birds.

unchanged following the FWS's 2004, 5-year, range-wide status review for the murrelet (USFWS 2004e, pp. 11-12).

However, new threats were identified in the FWS's 2009, 5-year review for the murrelet (USFWS 2009d, pp. 27-67). These new stressors are due to several environmental factors affecting murrelets in the marine environment. These new stressors include:

- Habitat destruction, modification, or curtailment of the marine environmental conditions necessary to support murrelets due to:
    - elevated levels of polychlorinated biphenyls in murrelet prey species;
    - changes in prey abundance and availability;
    - changes in prey quality;
    - harmful algal blooms that produce biotoxins leading to domoic acid and paralytic shellfish poisoning that have caused murrelet mortality; and
    - climate change in the Pacific Northwest.

- Manmade factors that affect the continued existence of the species include:
    - derelict fishing gear leading to mortality from entanglement;
    - energy development projects (wave, tidal, and on-shore wind energy projects) leading to mortality; and
    - disturbance in the marine environment (from exposures to lethal and sub-lethal levels of high underwater sound pressures caused by pile-driving, underwater detonations, and potential disturbance from high vessel traffic; particularly a factor in Washington state).

The Service also believes climate change is likely to further exacerbate some existing threats such as the projected potential for increased habitat loss from drought-related fire, mortality, insects and disease, and increases in extreme flooding, landslides and windthrow events in the short-term (10 to 30 years). However, while it appears likely that the murrelet will be adversely affected, we lack adequate information to quantify the magnitude of effects to the species from the climate change projections described above (USFWS 2009d, page 34).

Several threats to murrelets, present in both the marine and terrestrial environments, have been identified. These threats collectively comprise a suite of environmental stressors that, individually or through interaction, have significantly disrupted or impaired behaviors which are essential to the reproduction or survival of individuals. When combined with the species naturally low reproductive rate, these stressors have led to declines in murrelet abundance, distribution, and reproduction at the population scale within the listed range.

Detailed discussions of the above-mentioned threats, life-history, biology, and status of the murrelet are presented in the Federal Register, listing the murrelet as a threatened species (57 FR 45328 [October 1, 1992]); the Recovery Plan, Ecology and Conservation of the Murrelet (Ralph et al. 1995); the final rule designating murrelet critical habitat (61 FR 26256 [May 24, 1996]); the Evaluation Report in the 5-Year Status Review of the Murrelet in Washington, Oregon, and California (McShane et al. 2004); the 2004 and 2009, 5-year Reviews for the Murrelet (USFWS 2004e; USFWS 2009d), and the final rule revising critical habitat for the murrelet (76 FR 61599 [October 5, 2011]).

4.3.5 Conservation

i. *Needs*

Reestablishing an abundant supply of high quality murrelet nesting habitat is a vital conservation need given the extensive habitat removal during the 20th century. However, there are other conservation imperatives. Foremost among the conservation needs are those in the marine and terrestrial environments to increase murrelet fecundity by increasing the number of breeding adults, improving murrelet nest success (due to low nestling survival and low fledging rates), and reducing anthropogenic stressors that reduce individual fitness[29] or lead to mortality.

The overall reproductive success (fecundity) of murrelets is directly influenced by nest predation rates (reducing nestling survival rates) in the terrestrial environment and an abundant supply of high quality prey in the marine environment during the breeding season (improving potential nestling survival and fledging rates). Anthropogenic stressors affecting murrelet fitness and survival in the marine environment are associated with commercial and tribal gillnets, derelict fishing gear, oil spills, and high underwater sound pressure (energy) levels generated by pile-driving and underwater detonations (that can be lethal or reduce individual fitness).

General criteria for murrelet recovery (delisting) were established at the inception of the Plan and they have not been met. More specific delisting criteria are expected in the future to address population, demographic, and habitat based recovery criteria (USFWS 1997, p. 114-115). The general criteria include:

- documenting stable or increasing population trends in population size, density, and productivity in four of the six Conservation Zones for a 10-year period and
- implementing management and monitoring strategies in the marine and terrestrial environments to ensure protection of murrelets for at least 50 years.

Thus, increasing murrelet reproductive success and reducing the frequency, magnitude, or duration of any anthropogenic stressor that directly or indirectly

[29] Fitness is measure of the relative capability of individuals within a species to reproduce and pass its’ genotype to the next generation.

affects murrelet fitness or survival in the marine and terrestrial environments are the priority conservation needs of the species. The FWS estimates recovery of the murrelet will require at least 50 years (USFWS 1997).

ii. *Current Actions*

On Federal lands under the NWFP surveys are required for all timber sales that remove murrelet habitat. If habitat outside of mapped Late-Successional Reserves (LSRs) is found to be used by murrelets, then the habitat and recruitment habitat (trees at least 0.5 site potential tree height) within a 0.5-mile radius of the occupied behavior is designated as a new LSR. Timber harvest within LSRs is designed to benefit the development of late-successional conditions, which should improve future conditions of murrelet nesting habitat. Designated LSRs not only protect habitat currently suitable to murrelets (whether occupied or not), but will also develop future suitable habitat in large blocks.

4.3.6 Status of Murrelet Critical Habitat

Critical habitat consists of geographic areas essential to the conservation of a listed species. Under the Act, conservation means to use and the use of all methods and procedures which are necessary to bring an endangered species or threatened species to the point at which the measures provided pursuant to the Act are no longer necessary.

Critical habitat is provided protection under section 7 of the Act by ensuring that activities funded, authorized, or carried out by Federal agencies do not adversely modify such habitat to the point that it no longer remains functional (or retains its current ability for primary constituent elements to be functionally established) to serve the intended conservation role for the species.

On May 24, 1996, the USFWS designated critical habitat for the murrelet within 104 critical habitat Units (CHUs) encompassing approximately 3.9 million acres across Washington (1.6 million), Oregon (1.5 million), and California (0.7 million). The final rule became effective June 24, 1996. The final rule intended the scope of the section 7(a)(2) analysis to evaluate impacts of an action on critical habitat at the conservation zone(s) or even a major part of a conservation zone (USFWS 1996, page 26271).

On October 5, 2011, the final rule revising critical habitat for the murrelet was published (76 FR 61599). The Service reduced critical habitat in Northern California and Oregon. New information indicates that these areas do not meet the definition of critical habitat and 189,671 acres were removed from the network (USFWS 2011e, page 61599).

4.3.7 Primary Constituent Elements

The PCEs are physical and biological features the USFWS determines are essential to a species' conservation (i.e., recovery) and require special management considerations. The PCEs for the murrelet are: (1) individual trees with potential nesting platforms; and (2) forested lands of at least one half site potential tree height regardless of contiguity within 0.8 kilometers (0.5 miles) of individual trees with potential nesting platforms, and that are used or potentially used by murrelets for nesting or roosting (USFWS 1996, page 26264). The site-potential tree height is the average maximum height for trees given the local growing conditions, and is based on species-specific site index tables. These primary constituent elements are intended to support terrestrial habitat for successful reproduction, roosting and other normal behaviors.

4.3.8 Conservation Strategy and Objectives

The Service's primary objective in designating critical habitat was to identify existing terrestrial murrelet habitat that supports nesting, roosting, and other normal behaviors that require special management considerations and to highlight specific areas where management should be given highest priority. The Service designated critical habitat to protect murrelets and their habitat in a well-distributed manner throughout the three states. Critical habitat is primarily based on the LSRs identified in the NWFP (approximately 3 million acres of critical habitat are located within the 3.9 million acre LSR boundary designation). These LSRs were designed to respond to the problems of fragmentation of suitable murrelet habitat, potential increases in predation due to fragmentation, and reduced reproductive success of murrelets in fragmented habitat. The LSR system identifies large, contiguous blocks of late-successional forest that are to be managed for the conservation and development of the older forest features required by the murrelet, and as such, serve as an ideal basis for murrelet critical habitat. Where Federal lands were not sufficient to provide habitat considered crucial to retain distribution of the species, other lands were identified, including state, county, city and private lands (USFWS 1996, page 26265).

4.3.9 Current Condition

The majority (77 percent) of designated critical habitat occurs on Federal lands in LSRs as identified in the Northwest Forest Plan. Because of this high degree of overlap with LSRs and LSR management guidelines, the condition of most of the range-wide network of murrelet critical habitat has experienced little modification of habitat since designation. Consultation data, from October 1, 2003 – January 31, 2013 (Table 12), indicates 261 acres of PCE 1 and 462 acres of PCE 2 were planned for removal in CH, of which 137 acres of PCE 1 and 234 acres of PCE 2 removal was associated with Tribal activities in the Siskiyou Coast Range Zone. All other impacts are associated with Federal activities.

Table 12. Aggregate Results of All Critical Habitat (acres) Affected by Section 7 Consultation for the Murrelet; Baseline and Summary Effects by Conservation Zone and Habitat Type from October 1, 2003 to Janauary 31, 2013.

	Designated Acres[2]	Authorized Habitat Effects in Acres[3]			Reported Habitat Effects in Acres[3]		
Conservation Zone[1]	**Total CHU Acres**	**Stands[4]**	**Remnants[5]**	**PCE 2[6]**	**Stands[4]**	**Remnants[5]**	**PCE 2[6]**
Puget Sound	1,271,782	-16	0	-21	0	-1	0
Western Washington	414,050	0	0	0	0	0	0
Outside CZ Area in WA	0	0	0	0	0	0	0
Oregon Coast Range	1,024,122	-5	0	-208	0	0	0
Siskiyou Coast Range	1,055,788	-240	0	-234	0	-97	0
Outside CZ Area in OR	0	0	0	0	0	0	0
Mendocino	122,882	0	0	0	0	0	0
Santa Cruz Mountains	47,993	0	0	0	0	0	0
Outside CZ Area in CA	0	0	0	0	0	0	0
Total	**3,936,617**	**-261**	**0**	**-463**	**0**	**-98**	**0**

Notes:

1. Conservation Zones (CZ) six zones were established by the 1997 Recovery Plan to guide terrestrial and marine management planning and monitoring for the Murrelet (USFWS 1997).
2. Critical Habitat Unit acres within each Conservation zones, as presented in the Marbled Murrelet Recovery Plan Figure 8, page 114.
3. Habitat includes all known occupied sites, as well as other suitable habitat, though it is not necessarily occupied. Importantly, there is no single definition of suitable habitat, though the Murrelet Effectiveness Monitoring Module is in the process. Some useable working definitions include the Primary Constituent Elements as defined in the Critical Habitat Final Rule, or the criteria used for Washington State by Raphael et al. (2002).
4. Stand: A patch of older forest in an area with potential platform trees.
5. Remnants: A residual/remnant stand is an area with scattered potential platform trees within a younger forest that lacks, overall, the structures for murrelet nesting.
6. PCE 2: trees with a ½ site-potential tree height within .5 mile of a potential nest tree.

4.3.10 Analytical Framework for analyzing impacts to critical habitat

A "may affect, likely to adversely affect" determination for critical habitat that triggers the need for completing an adverse modification analysis under formal consultation is warranted in cases where a proposed Federal action will cause: (1) Removal or degradation of individual trees with potential nesting platforms, or removal or degrade the nest platforms themselves, as this results in a significant decrease in the value of the trees for future nesting use. Moss may be an important component of nesting platforms in some areas; (2) Removal or degradation of trees adjacent to trees with potential nesting platforms that provide habitat elements essential to the suitability of the potential nest tree or platform, such as trees providing cover from weather or predators; (3) Removal or degradation of forested areas with a canopy height of at least one half the site-potential tree height and regardless of contiguity, within 0.5 mile of individual trees containing potential nest platforms. This includes removal or degradation of trees currently unsuitable for nesting that contribute to the structure/integrity of the potential nest area (i.e., trees that contribute to the canopy of the forested area). These trees provide the canopy and stand conditions important for murrelet nesting (USFWS 1996, page 26271).

A "may affect, not likely to adversely affect" determination for murrelet critical habitat is warranted in cases where a proposed Federal action will include, but are not limited to: (1) certain recreational use and personal-use commodity production (e.g., mushroom picking, Christmas tree cutting, rock collecting, recreational fishing along inland rivers) and certain commercial commodity production (e.g., mushroom picking, brush picking); (2) Actions that affect forest stands not within 0.5 miles of individual trees with potential nesting platforms; (3) Activities that do not affect the primary constituent elements. However, even though an action may not adversely affect critical habitat, it may still affect murrelets (e.g. through disturbance) and may, therefore, still be subject to consultation under section 7 of the Act. Activities conducted according to the standards and guidelines for Late Successional Reserves, as described in the ROD for the Northwest Forest Plan would be unlikely to result in the destruction or adverse modification of murrelet critical habitat. Activities in these areas would be limited to manipulation of young forest stands that are not currently murrelet nesting habitat. These forest management activities would be conducted in a manner that would not be likely to slow the development of these areas into future nesting habitat, and should speed the development of some characteristics of older forest (USFWS 1996, pages 26271-26272).

5.0 Environmental Baseline

The "environmental baseline" includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section

7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02).

5.1 Columbia River Basin

The action area for this consultation is located within the Columbia River Basin and Oregon coastal river basins. The Columbia River Basin occupies approximately 220,000 square miles in seven states: Washington, Oregon, Idaho, Montana, Wyoming, Utah, and Nevada. The river and its tributaries are the primary hydrologic features in the Pacific and inland Northwest. The Columbia River runs for more than 1,200 miles from its origin at Columbia Lake in British Columbia to its estuary on the Oregon-Washington coast. The largest major tributary of the Columbia is the Snake River, which is 1,036 miles long. Average annual runoff at the mouth of the Columbia River is approximately 198 million acre-feet.

The entire Columbia River basin is too large and variable to describe its baseline conditions as a whole. However, the factors influencing the baseline conditions in the varied provinces and subbasins of the Columbia River basin are similar throughout the basin and can be discussed for the basin as a whole. Within the action area, many stream, estuarine and riparian areas have been degraded by the effects of land and water use, including road construction, forest management, agriculture, mining, urbanization, and water development. Each of these economic activities has contributed to a myriad of interrelated factors for the decline of ESA-listed fish. Among the most important of these are changes in stream channel morphology, degradation of spawning substrates, reduced instream roughness and cover, loss and degradation of estuarine rearing habitats, loss of wetlands, loss and degradation of riparian areas, water quality (*e.g.*, temperature, sediment, dissolved oxygen, contaminants) degradation, blocked fish passage, direct take, and loss of habitat refugia.

Columbia River Estuary

The Columbia River estuary, through which all the basin's anadromous species must pass, has also been changed by human activities. Historically, the downstream half of the estuary was a dynamic environment of multiple channels, extensive wetlands, sandbars, and shallow areas. Historically, the mouth of the Columbia River was about four miles wide; today it is two miles wide. Previously, winter and spring floods, low flows in late summer, large woody debris floating downstream, and a shallow bar at the mouth of the Columbia River kept the environment dynamic. Today, navigation channels have been dredged, deepened, and maintained; jetties and pile-dike fields have been constructed to stabilize and concentrate flow in navigation channels; marsh and riparian habitats have been filled and diked; and causeways have been constructed across waterways. These actions have decreased the width of the mouth of the Columbia River to two miles and increased the depth of the Columbia River channel at the bar from less than 20 to more than 55 feet.

More than 50% of the original marshes and spruce swamps in the estuary have been converted to industrial, transportation, recreational, agricultural, or urban uses. More than 3,000 acres of intertidal marsh and spruce swamps have been converted by human use since 1948 (LCREP 1999). Many wetlands along the shore in the upper reaches of the estuary have been converted to industrial and agricultural lands after levees and dikes were constructed. Furthermore, water storage and release patterns from reservoirs upstream of the estuary have changed the seasonal pattern and volume of discharge. The peaks of spring/summer floods have been reduced and the amount of water discharged during winter has increased.

Land Use Practices

Land ownership has also played its part in the region's habitat and land-use changes. Federal lands, which compose 50% of the basin, are generally forested and situated in upstream portions of the watersheds. While there is substantial habitat degradation across all land ownerships, in general, habitat in many headwater stream sections is in better condition than in the largely non-Federal lower portions of tributaries (Doppelt et al. 1993, Frissell 1993, Henjum et al. 1994, Quigley and Arbelbide 1997). In the past, valley bottoms were among the most productive fish habitats in the basin (Stanford and Ward 1992, Spence et al. 1996, ISG 1996). Today, agricultural and urban land development and water withdrawals have significantly altered the habitat for fish and wildlife in these valley bottoms. Streams in these areas typically have high water temperatures, sedimentation problems, low flows, simplified stream channels, and reduced riparian vegetation.

At the same time some habitats were being destroyed by water withdrawals in the Columbia basin, water *impoundments* in other areas dramatically reduced habitat by inundating large amounts of spawning and rearing habitat and reducing migration corridors, for the most part, to a single channel. Floodplains have been reduced in size, off-channel habitat features have been lost or disconnected from the main channel, and the amount of large woody debris (large snags/log structures) in rivers has been reduced. Most of the remaining habitats are affected by flow fluctuations associated with reservoir management.

Hydropower

Since the 1880s, numerous dams—both federal and private—have been built for flood control, hydropower, fish and wildlife, navigation, recreation, irrigation, and municipal and industrial water supply and quality. As the region's population increased, the Federal government developed storage projects to capture water from rain and snowmelt for flood control, as well as for power generation, irrigation, and other purposes. Storage dams have eliminated spawning and rearing habitat (loss of spawning gravels and access to spawning and rearing areas) while altering the natural hydrograph of the Snake and Columbia Rivers (decreasing spring and summer flows and increasing fall and winter flows).

The mainstem lower Columbia and Snake River projects were designed to enable navigation from the mouth of the Columbia to the Port of Lewiston in Idaho, as well as for hydropower generation and other purposes. These run-of-river projects have minimal storage capacity, and are not considered flood storage projects. These dams have converted the once-swift river into a series of slow-moving reservoirs—slowing the smolts' journey to the estuary and ocean and creating habitat for predators. Because most of the ESA-listed salmonids must navigate at least one, and up to nine major hydroelectric projects during their up- and downstream migrations (and experience the effects of other dam operations occurring upstream from their ESU boundary), they experience the influence of all the impacts listed above.

However, ongoing consultations between NMFS and the BPA, the USACE, USFWS, and the Bureau of Reclamation (Reclamation) have brought about numerous beneficial changes in the operation and configuration of the Columbia River hydropower system. BOs outlining a number of proposed operations and structural configuration changes to FCRPS dams were issued in 1993, 1994, 1995, 1998, 2000, 2004, 2008, and 2010. As a result of these operations and configuration improvements, juvenile and adult survival through the FCRPS migration corridor has improved significantly since the early 1990s. For example, increased spill at the dams allows smolts to avoid both turbine intakes and bypass systems; increased flow in the mainstem Snake and Columbia Rivers provides better in-river conditions for smolts; and better smolt transportation (through the addition of new barges and by modifying existing barges) helps young salmonids make their way down to the ocean.

Within the habitat currently accessible by ESA-listed salmonids the quality and quantity of fresh water habitat in much of the Columbia River basin have declined dramatically in the last 150 years. Forestry, farming, grazing, road construction, hydropower system development, mining, and urban development have radically changed the historical habitat conditions of the basin. Consumptive water losses resulting from agricultural, industrial, or municipal purposes have changed water temperature (including generally warmer minimum winter temperatures and cooler maximum summer temperatures), altered water velocity (reduced spring flows and increased crosssectional areas of the river channel), affected food resources (alteration of food webs, including the type and availability of prey species), and reduced safe passage (increased mortality rates of migrating juveniles) (Williams *et al*. 2005; Ferguson *et al*. 2005).

Water Quality

More than 2,500 streams, river segments, and lakes in the Northwest do not meet Federally-approved, state, and/or tribal water quality standards and are now listed as water-quality-limited under Section 303(d) of the Clean Water Act. Both point (industrial and municipal waste) and nonpoint sources (agriculture, forestry, urban activities, etc.) contribute to poor water quality when sediment and contaminants from the tributaries settle in mainstem reaches and the estuary. The types and amounts of compounds found in runoff are often correlated with land use patterns: fertilizers and pesticides are found frequently in agricultural and urban settings, and nutrients are found in areas with human and animal waste. People contribute to chemical pollution in the basin, but natural and seasonal factors also influence pollution levels in various ways. Nutrient and pesticide concentrations vary considerably from season to season, as well as among regions with different geographic and hydrological conditions. Natural features (such as geology and soils) and land-management practices (such as storm water drains, tile drainage and irrigation) can influence the movement of chemicals over both land and water.

Most of the water bodies in Oregon, Washington, and Idaho on the 303(d) list do not meet water quality standards for temperature. Bull trout and salmon require different stream temperatures depending on the life stages and life form. Bull trout are in stream all year round as are juvenile Chinook and steelhead and generally require colder temperatures for incubation, rearing, and spawning. High water temperatures adversely affect salmonid metabolism, growth rate, and disease resistance, as well as the timing of adult migrations, fry emergence, and smoltification. Many factors can cause high stream temperatures, but they are primarily related to land-use practices rather than point-source discharges. Some common actions that cause high stream temperatures are the removal of trees or shrubs that directly shade streams, water withdrawals for irrigation or other purposes, and warm irrigation return flows. Loss of wetlands and increases in groundwater withdrawals contribute to lower base-stream flows that, in turn, contribute to temperature increases.

Water Quantity

Water quantity problems are also a significant cause of habitat degradation and reduced fish production. Millions of acres in the Columbia River basin are irrigated. Although some of the water withdrawn from streams eventually returns as agricultural runoff or groundwater recharge, crops consume a large proportion of it. Withdrawals affect seasonal flow patterns by removing water from streams in the summer (mostly May through September) and restoring it to surface streams and groundwater in ways that are difficult to measure. Withdrawing water for irrigation, urban consumption, and other uses increases temperatures, smolt travel time, and sedimentation. Return water from irrigated fields can introduce nutrients and pesticides into streams and rivers. Deficiencies in water quantity have been a problem in the major production subbasins for some ESUs that have seen major agricultural development over the last century. Water withdrawals (primarily for irrigation) have lowered summer flows in nearly every stream in the basin and thereby profoundly decreased the amount and quality of rearing habitat. In fact, in 1993, fish and wildlife agency, tribal, and conservation group experts estimated that 80% of 153 Oregon tributaries had low-flow problems, two-thirds of which were caused (at least in part) by irrigation withdrawals (OWRD 1993). The Northwest Power Planning Council (NWPPC 1992) found similar problems in many Idaho, Oregon, and Washington tributaries.

On the landscape scale, human activities have affected the timing and amount of peak water runoff from rain and snowmelt. Forest and range management practices have changed vegetation types and density that, in turn, affect runoff timing and duration. Many riparian areas, flood plains, and wetlands that once stored water during periods of high runoff have been destroyed by development that paves over or compacts soil—thus increasing runoff and altering natural hydrograph patterns.

Recovery and Restoration Programs

Federal, state, tribal, and private entities have—singly and in partnership—begun recovery efforts to help slow and, eventually, reverse the decline of federally listed fish populations. Notable efforts within the range of the 13 listed salmon and steelhead ESUs are the NWPPC's Fish and Wildlife Program, Basinwide Salmon Recovery Strategy (both of which the activities proposed in this HIP III consultation are based on), the Northwest Forest Plan, PACFISH, the Washington Wild Stock Restoration Initiative, the Washington Wild Salmonid Policy, and the Oregon Plan for Salmon and Watersheds. (These are all large programs; for details on these efforts please see the websites for ODFW, WDFW, the USFS, and the BPA). Full discussions of these efforts can be found on the referenced websites and in the Federal Columbia River Power System biological opinions (NMFS 2000e, NOAA Fisheries 2004a). Despite these efforts, however, much remains to be done to recover listed fish populations in the Columbia River basin.

The environmental baseline also includes the anticipated impacts of all Federal projects in the action area that have already undergone formal consultation. From 2003 to 2006, the BPA covered 218 projects under the HIP I consultation. Most projects involved use of multiple HIP I activity categories with improvement of fish passage and treatment of non-native plants with herbicides as the most common actions. During the same time period, BPA completed 28 individual formal consultations on habitat improvement actions that were not covered by the HIP I consultation. Channel reconstruction, complex fish passage improvement projects, and streambank stabilization were the most common activity types.

Other Federal Projects that have undergone consultation in the action area include various transportation, natural resource management, and water management projects. The USACE and Federal Highway Administration have consulted on numerous transportation projects, primarily bridge and culvert replacement projects. These actions typically improve fish passage at road-stream crossings and reduce the hydraulic effects of culverts and bridges by replacing them with larger structures. The USACE has consulted on projects permitted under the section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act. These actions include installation or improvement of docks and bulkheads, streambank stabilization, and improvements to other navigational and transportation infrastructure. Some stream restoration projects are also permitted under these authorities.

The USDA Forest Service and USDI Bureau of Land Management have consulted on restoration and natural resource management projects throughout Oregon, Washington, Idaho and Montana. These projects include stream restoration actions, commercial timber harvest, authorization of livestock grazing, and issuance of special use permits. These actions, as implemented in conjunction with these agencies' aquatic conservation strategies, are designed to avoid or minimize effects on ESA-listed salmonids and their habitat. The restoration actions are designed to restore natural stream habitat forming processes.

The Bureau of Reclamation has completed consultation on a few large tributary water management projects such as the Umatilla Project and Deschutes Project. These projects are operated in manner consistent with the recovery of ESA-listed salmonids. As more information on the recovery needs of ESA-listed salmonids becomes available, operation of these projects can be adjusted accordingly.

It is very likely that a small number of action areas for some of these previously consulted upon actions will overlap with action areas for restoration projects covered under this HIP III consultation. Impacts to the environmental baseline from these previous projects vary from short-term adverse effects to long-term beneficial effects. When considered as whole, these actions are likely to have a small beneficial effect on the environmental baseline over time.

Under the current environmental baseline, the biological needs of ESA-listed fish are generally not being met on lands in Oregon, Washington, Idaho and western Montana where the BPA would fund projects covered by this consultation. The purpose of the actions proposed in this consultation is to improve degraded habitat conditions. In areas with high quality habitat, the BPA proposes to protect this habitat through land acquisition or lease and conservation easements. Because the HIP III program is intended to correct or ameliorate existing habitat problems, rather than enhancing habitats that are not impaired, program activities would generally occur in areas where the environmental baseline is degraded to the extent that the biological needs are not met.

5.2 Environmental Baseline of Species in the Action Area

Oregon Chub

The species range of Oregon chub is completely within the action area of this programmatic consultation thus the status of the species previously discussed also adequately represents the environmental baseline of the species. As such there will be no discussion of Oregon chub in this Environmental Baseline section.

Bull Trout

The preamble to the implementing regulations for section 7 (51 FR 19932; third paragraph, left column) contemplates that the evaluation of "…the present environment in which the species or critical habitat exists, as well as the environment that will exist when the action is completed, in terms of the totality of factors affecting the species or critical habitat…will serve as the baseline for determining the effects of the action on the species or critical habitat." The regulations at 50 CFR 402.02 define the environmental baseline to include "the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process." The analyses presented in this section supplement the above *Status of the Species* and *Status of Critical Habitat* evaluations by focusing on the current condition of the bull trout and its critical habitat in the action area, the factors responsible for that condition (inclusive of the factors cited above in the regulatory definition of environmental baseline), and the role the action area plays in the survival and recovery of the bull trout and in the recovery support function of designated critical habitat. Relevant factors on lands surrounding the action area that are influencing the condition of the bull trout and its critical habitat were also considered in completing the status and baseline evaluations herein.

As previously noted, the action area of this programmatic consultation includes the Columbia River Basin in Oregon, Washington, Idaho and western Montana, as well as coastal watersheds in Oregon from the Columbia River confluence with the Pacific Ocean south to Cape Blanco in southwestern Oregon. Bull trout are not present in the coastal watersheds of Oregon thus their distribution within the action area is limited to the Columbia River Basin (Figure 4 and 5 below). As previously stated, the five draft interim recovery units (IRUs) for bull trout in the coterminous U.S. include: 1) Saint Mary Belly; 2) Klamath; 3) Jarbidge; 4) Columbia River; and 5) Coastal-Puget Sound. The action area of this programmatic consultation encompasses just one of the five IRUs - the Columbia River IRU. The Status of the Species section (above) provides a fairly comprehensive assessment of the environmental baseline of bull trout in the Columbia Basin.

Within the Columbia River IRU there are 23 management units and 97 core areas. The status of bull trout populations within affected core areas varies widely, and resident, adfluvial, and fluvial migratory populations can all be found within the action area. The only systematic analysis of status in recent years at the DPS or IRU scale is found in the Service's 5-year status review of bull trout that was completed in 2008 (USFWS 2008). The assessment concluded that the original threats to bull trout still existed for the most part in all core areas within the Columbia River IRU, but no substantial new and widespread threats were identified. This finding indicates the baseline conditions overall rangewide and within the Columbia River IRU had not changed substantially in the last 5 years and that the trend and magnitude of the rangewide population and Columbia River IRU had not worsened nor did it improve measurably.

Figure 4. Bull Trout Core Areas and Occupied Habitat in the Columbia River Basin and Columbia River Interim Recovery Unit

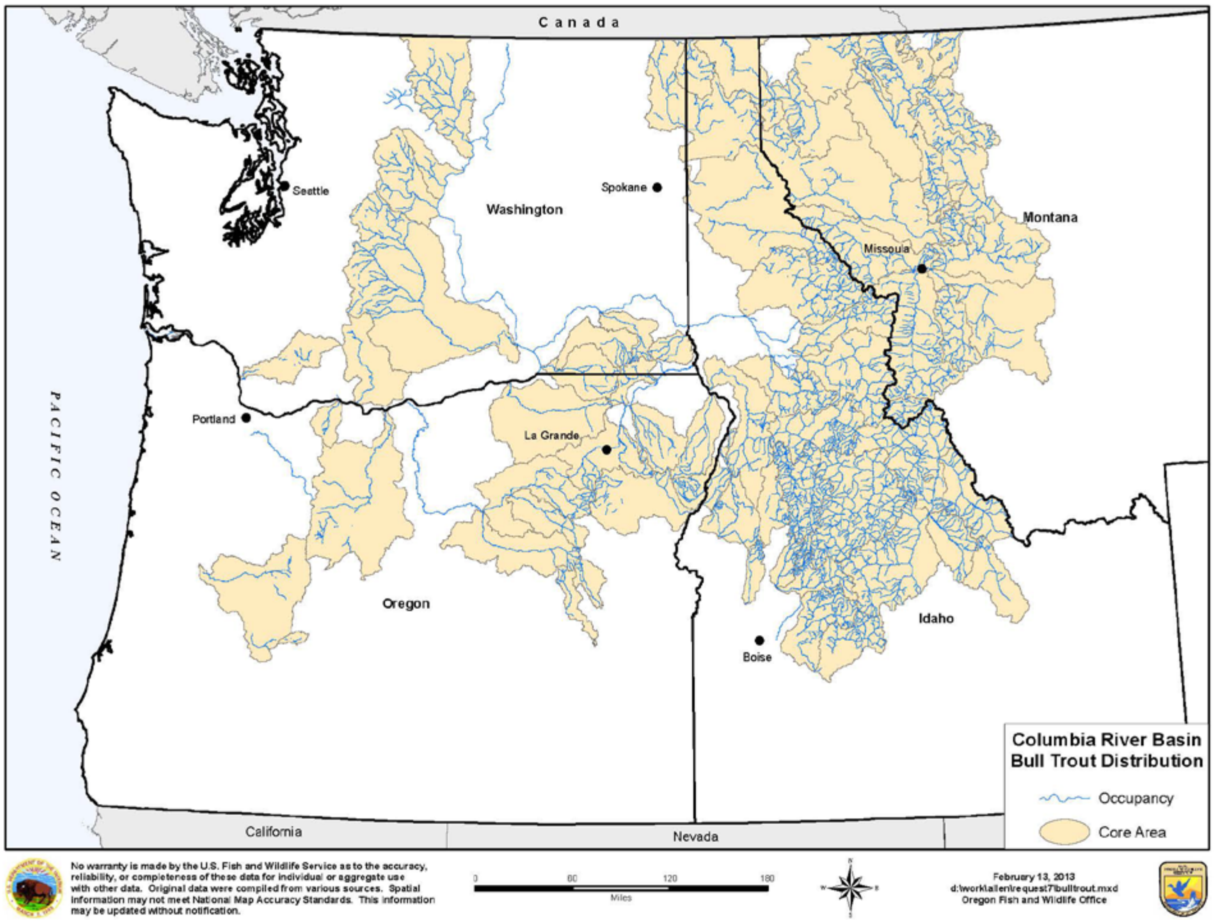
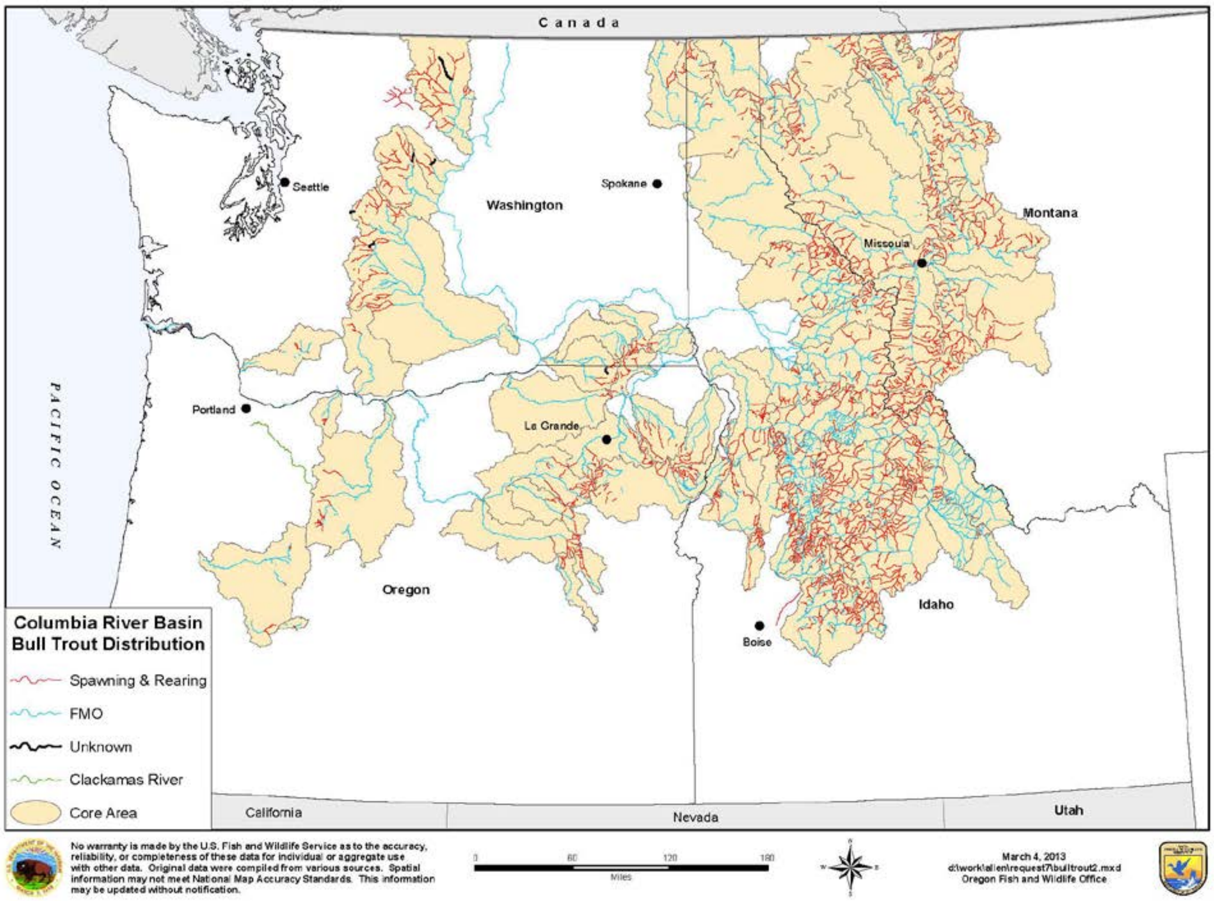


Figure 5. Spawning and Rearing (SR) and Foraging, Migration and Overwintering (FMO) Habitat in the Columbia River Interim Recovery Unit



The Service's 5-year review contains extensive analyses by core area of bull trout status, trends and threats range-wide in the coterminous U.S. These analyses were not rolled up into larger units for assessment, such as management units or interim recovery units that could easily be incorporated into this BO. For this reason we choose to incorporate this information by reference. The 5-year review can be found at the following link: http://www.fws.gov/pacific/bulltrout/5yrreview.html

Marbled Murrelet

The environmental baseline of marbled murrelets was adequatetly covered in the Status of the Species section.

6.0 Effects of the Action

'Effects of the action' means the direct and indirect effects of an action on the listed species and critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02).

The actions covered by this consultation have predictable effects. The FWS has conducted individual and programmatic consultations on activities similar to those in the proposed action throughout Oregon, Washington and Idaho over the past 15 years, and the information gained from monitoring and feedback has been applied by the FWS, NMFS and BPA to refine project design criteria and conservation measures for this consultation. Habitat improvement activities that are less predictable will either be reviewed by the RRT prior to approval, or will require an individual consultation.

The implementation of the proposed action is intended to increase the quality and quantity of restoration projects over the long term. In general, ephemeral effects are expected to last for hours or days, short-term effects are expected to last for weeks, and long-term effects are expected to last for months, years or decades. The activities covered by this program will have some ephemeral or minor, unavoidable, short-term adverse effects such as increased stream turbidity and riparian disturbance, in order to gain the more permanent habitat improvements associated with BPA's HIP program. The FWS and NMFS worked closely with BPA to incorporate conservation measures (general conservation measures, and activity specific conservation measures) into the proposed action to reduce these short-term effects. However, short-term adverse effects are reasonably certain to occur, and are generally associated with near and instream construction or the application of chemical herbicides. The direct physical and chemical effects of the construction of each project will vary depending on the type of action being performed, but will all be based on a common set of effects related to construction. The effects to habitat that are common to many of the activity categories are discussed first, followed by a discussion of habitat effects specific to each activity category and the resulting effects on listed fish.

6.1 Effects to Habitat

The habitat improvement actions will have long-term beneficial effects to the habitat of listed fish species at the project-site scale and the watershed scale. As stated above, many of the actions will include activities that result in short-term adverse effects to habitat. Some projects proposed for authorization under this BO require one or more actions related to pre-construction, construction, operation and maintenance, and site restoration. The direct chemical and physical effects of these activities typically begin with pre-construction activity, such as surveying, minor vegetation clearing, placement of stakes and flagging guides, and minor movements of machines and personnel within the action area. The next stage, site preparation, typically requires development of access roads, construction staging areas, and materials storage areas that affect more of the project area, and clear vegetation that will allow rainfall to strike the bare earth surface. Additional earthwork follows to clear, excavate, fill and shape the site for its eventual use, frequently with activity in the active channel, and reshaping banks as necessary for successful revegetation.

The effects associated with construction, operation or maintenance depend on the purpose and location of each activity category, and will be analyzed in subsequent sections. The final stage for actions that involve construction is site restoration; this stage involves the restoration of ecological function and habitat-forming processes to maintain or promote the site along a trajectory toward conditions that support functional aquatic habitats.

Pre-construction. Pre-construction activity includes planning, design, permit acquisition, and surveying. Vegetation and fluvial geomorphic processes at a project site provide for natural creation and maintenance of habitat function. Pre-construction activities that result in removal of vegetation will reduce or eliminate those habitat values (Darnell 1976, Spence *et al*. 1996). Denuded areas lose organic matter and dissolved minerals, such as nitrates and phosphates. The microclimate becomes drier and warmer with a corresponding increase in soil and water temperatures. Loose soil can temporarily accumulate in the construction areas and, in dry weather, this soil can be dispersed as dust. In wet weather, loose soil is transported to stream by erosion and runoff, particularly in steep areas. Erosion and runoff increase the supply of soil to lowland areas, and eventually to aquatic habitats where they increase turbidity and sedimentation. This effect is amplified during high frequency and high duration flow events.

Loss of vegetation on the project site will increase the rate of transport of water to streams during rain events, which can lead to higher peak flows. Higher stream flows increase stream energy that scours stream bottoms and transport greater sediment loads farther downstream than would otherwise occur. Sediments in the water column reduce light penetration, increase water temperature, and modify water chemistry. Once deposited, sediments can alter the distribution and abundance of important instream habitats, such as pool and riffle areas. During dry weather, the physical effects of increased runoff appear as reduced ground water storage, lowered stream flows, and lowered wetland water levels.

The combination of erosion and mineral loss can reduce soil quality and site fertility in upland and riparian areas. Concurrent in-water work can compact or dislodge channel sediments, thus increasing turbidity and allowing currents to transport sediment downstream where it is eventually redeposited. Continued operations when the construction site is inundated can significantly increase the likelihood of severe erosion and contamination.

Implementation of conservation measures can reduce, but not eliminate, the risk of soil erosion and increased sediment inputs to streams, thus reducing the likelihood of impacts to stream habitats. At watershed scale, this risk is not expected to be significant because of the localized nature of the impacts and the dispersed location of project sites in multiple watersheds across the landscape.

Construction, Operation and Maintenance Activities. The effects of construction, operation, and maintenance activities are similar to those described above for pre-construction, but involve significantly greater use of heavy equipment for vegetation removal and earthwork. New impervious surfaces allow for faster and more delivery of soil and contaminants in stormwater runoff, causing impaired water quality. It is also likely that in-water work will be required to complete some activities (fish passage restoration, river, stream restoration, etc); isolation of the work area may result in the injury or death of fish due to handling.

Heavy equipment. Additional heavy equipment use compacts soil, thus reducing soil permeability and infiltration of stormwater. Use of heavy equipment also creates a risk that accidental spills of fuel, lubricants, and hydraulic fluid and similar contaminants may occur. Discharge of construction water used for vehicle washing, concrete washout, pumping for work area isolation, and other purposes can carry sediments and a variety of contaminants to the riparian area and stream.

Pilings**.** Piles are removed using a vibratory hammer, direct pull, clam shell grab, or cutting/breaking the pile below the mudline. Vibratory pile removal causes sediments to slough off at the mudline, resulting in some suspension of sediments and, possibly, contaminants. Old and brittle piles may break under the vibrations and require use of another method. The direct pull method involves placing a choker around the pile and pulling upward with a crane or other equipment. When the piling is pulled from the substrate, sediments clinging to the piling slough off as it is raised through the water column, producing a plume of turbidity, contaminants, or both. The use of a clamshell may suspend additional sediment if it penetrates the substrate while grabbing the piling. If a piling breaks, the stub is often removed with a clam shell and crane. Sometimes, pilings are cut, broken, or driven below the mudline, and the buried section left in place. This may suspend small amounts of sediment, providing the stub is left in place and little digging is required to reach the pile. Direct pull or use of a clamshell to remove broken piles is likely to suspend more sediment and contaminants.

In-water work**.** Although the most lethal biological effects of the proposed action on individual listed species will likely be caused by the isolation of in-water areas, lethal and sublethal effects would be greater than without isolation. In-water work area isolation is itself a conservation measure intended to reduce the adverse effects of erosion and runoff on the population. Any individual fish present in the work isolation area will be captured and released.

Post-construction Site Restoration. The direct physical and chemical effects of post-construction site restoration included as part of the proposed activities are essentially the reverse of the construction activities that go before it. Bare earth is protected by seeding, planting woody shrubs and trees, and mulching. This quickly dissipates erosive energy associated with precipitation and increases soil infiltration. It also accelerates vegetative succession necessary to restore the delivery of large wood to the riparian area and stream, root strength necessary for slope and bank stability, leaf and other particulate organic matter input, sediment filtering and nutrient absorption from runoff, and shade. Microclimate will become cooler and moister, and wind speed will decrease.

Besides revegetation, site restoration may include restoring or repairs to streambanks. Streambank restoration activities require bioengineered solutions that include vegetation and large wood as the major structural elements to increase bank strength and resistance to erosion stabilization (Mitsch 1996, WDFW *et al.* 2003). The intent of these activities is to restore riparian function and allow habitat to develop, and allow the banks to respond more favorably to hydraulic disturbance than conventional hard alternatives.

Fish Passage Restoration Effects (Category 1). BPA has divided this activity category into two sections: transportation infrastructure and profile discontinuities. Under transportation infrastructure, BPA has proposed activities to improve fish passage, prevent bank erosion, and facilitate natural sediment and wood movement. Included activities are bridge and culvert removal or replacement, bridge and culvert maintenance, and the installation of fords. The effects related to general pre-construction and construction described above apply.

In addition, the periodic maintenance of culverts and ditches will ensure fish passage and floodplain connectivity; allow for dynamic flow conditions; and maintain access to spawning, rearing and resting habitats for fish. The installation of properly designed culverts and bridges will increase the fluvial transport of sediment that is needed to form diverse habitats. The culverts will enable additional recruitment of wood to downstream reaches compared to current conditions. The new culverts will reduce the probability of catastrophic damage to aquatic habitats that is often associated with undersized culverts during extreme high flows and large movement of wood. The installation of new culverts should also increase the stability of the streambed.

Fish passage restoration activities that address profile discontinuities include: removal of a dam, water control, or legacy structures; consolidation or replacement of existing irrigation diversions; headcut and grade stabilization; removal of trash, artificial debris dams, sediment bars or terraces that block or delay fish passage; low flow consolidation; and providing fish passage at an existing facility. These activities involve significant in-water work, and general pre-construction and construction effects to habitat are discussed above. However, increases in irrigation system efficiencies will result in increased consumptive use (Upendram and Peterson 2007; Samani and Skaggs 2008; Ward and Pulido-Velazquez 2008) which will reduce flow in downstream reaches, which will impair the quality and availability of habitat.

In addition, these activities will benefit habitat by removing impediments to passage for flow, sediment, wood, and fish. Removing barriers allows access to unoccupied spawning and rearing habitat, or allows occupancy during more flow conditions. Removing or consolidating large instream structures will facilitate the release of bedload materials as the structures are notched or removed; this will cause immediate increases in suspended sediment and turbidity, and may degrade downstream habitat for a short period of time. Long-term effects include increased access to spawning, rearing and migration habitat above the site, increased gravel recruitment for spawning downstream of the diversion site, and increased floodplain connectivity and channel migration capacity.

River, Stream, Floodplain, and Wetland Restoration (Category 2). BPA proposes to fund improvements to secondary channels and wetland habitats; set back or remove existing berms, dike, and levees; protect streambanks using bioengineering methods; install habitat-forming instream structures using native materials; plant riparian vegetation; and reconstruct channels. These activities will aid in the re-establishment of hydrologic regimes, increase the area available for rearing habitat, improve access to rearing habitat, increase the hydrologic capacity of side channels, increase channel diversity and complexity, provide resting areas for fish at various levels of inundation, provide flood water attenuation, nutrient and sediment storage, and establish and augment native plant communities. General construction-related effects are described above, and will be short-term.

The long-term effects of this activity category will be improved habitat conditions, and habitat-forming processes. Increased vegetation and habitat complexity will improve thermal regulation, hydrologic and nutrient cycling, channel formation and sediment storage, floodplain development and energy dissipation. Streambank stabilization will use large wood and vegetation to improve bank strength and resistance to erosion (Mitsch 1996, WDFW *et al*. 2000). Bioengineered bank treatments develop root systems that are flexible and regenerative, and respond more favorably to hydraulic disturbance than conventional hard alternatives. This type of bank treatment and the installation on instream wood structures promote channel complexity, through pool formation, gravel and organic material retention, velocity disruption, and cover (Carlson *et al*. 1990, Bilby and Ward 1989, Beechie and Sibley 1997). Instream structures dissipate stream energy, thus reducing the erosive force of the stream on vulnerable banks, and provide areas for pools and gravel bars to form.

Excavating new channels or reconnecting historic stream channels risk failure during high flows; they could be filled with sediment, or supporting structures washed downstream. The risk of channel avulsion will be greatest during the first year after channel construction, and will decrease as riparian vegetation becomes established and floodplain roughness increases. These projects will be reviewed by the RRT to ensure strong designs to achieve restoration goals and to minimize the risk of failure. Also, all projects that involve streambank excavation resulting in bare earth exposure must include erosion controls, revegetation plans, and riparian fencing if appropriate. All in-water construction will occur during the site-specific, in-water work windows to minimize effects to spawning and migration. Despite implementation of minimization measures, these projects will likely cause minor pulses of suspending sediment which could result in localized areas of fine sediment deposition.

Invasive and Non-native Plant Control (Category 3). BPA proposes to fund activities to control or eliminate non-native, invasive plant species that compete with or displace native plant communities. The goal of this activity category is to maximize habitat processes and functions through diverse communities of native plants. This was the most common activity category funded under HIP II; 35 percent of all project activities funded and implemented were vegetation management projects. Under the HIP II consultation between BPA and NMFS, a total of 23,887 acres were treated with herbicides (primarily eastern Oregon, eastern Washington, and Idaho), and of these, 3,186 acres were within riparian areas. The herbicides and adjuvants that are proposed for use under the HIP III proposed action are provided in Table 2.1 in BPA's BA.

BPA's proposed use of chemicals to control non-native plants is designed to minimize the risk of adverse effects on aquatic habitat. Chemical (including fuel) transport, storage, and emergency spill plans will be implemented to reduce the risk of an accidental spill of fuel or chemicals. A catastrophic spill would have the potential for significant adverse effects to water quality. No spills occurred during the implementation of the HIP I or HIP II consultation between BPA and NMFS and thus we consider the risk of an accidental spill to be low as long as conservation measures included in the proposed action and reiterated in this BO are followed strictly.

In Appendix B of the BA, BPA provided an environmental fate and transport analysis to evaluate the risk of effects to water quality from this vegetation management program. In addition, NMFS has recently analyzed the effects of these activities using the similar active ingredients and conservation measures for proposed Forest Service and BLM invasive plant control programs (NMFS 2010, NMFS 2012). The types of plant control actions analyzed here are a conservative (*i.e.*, less aggressive) subset of the types of actions considered in those analyses, and the effects presented here are summarized from those analyses. Each type of treatment is likely to affect fish and aquatic macrophytes through a combination of pathways, including disturbance, chemical toxicity, dissolved oxygen and nutrients, water temperature, sediment, instream habitat structure, forage, and riparian and emergent vegetation (Table 8 below).

Table 13. Potentail Pathways of Effects of Invasive and Non-Native Plant Control

	Pathways of Effects							
Treatment Methods	**Disturbance***	**Chemical toxicity**	**Dissolved oxygen and nutrients**	**Water temperature**	**Fine sediment and turbidity**	**Instream habitat structure**	**Forage**	**Riparian and emergent vegetation**
Manual	X					X	X	X
Mechanical	X			X	X		X	X
Biological				X	X			
Herbicides		X	X	X	X	X	X	X

***Stepping on redds, displacing fish, interrupting fish feeding, or disturbing banks.

Mechanical and herbicidal treatments of invasive plant species in riparian areas are not likely to substantially decrease shading of streams. Significant shade loss is likely to be rare, occurring primarily from treating streamside knotweed and blackberry monocultures, and possibly from cutting streamside woody species (tree of heaven, scotch broom, etc.). Most invasive plants are understory species of streamside vegetation that do not provide the majority of streamside shade and furthermore and will be replaced by planted native vegetation or vegetation. The loss of shade would persist until native vegetation reaches and surpasses the height of the invasive plants that were removed. Shade recovery may take one to several years, depending on the success of invasive plant treatment, stream size and location, topography, growing conditions for the replacement plants, and the density and height of the invasive plants when treated. However, short-term shade reduction is likely to occur due to removal of riparian weeds, which could slightly affect stream temperatures or dissolved oxygen levels. Effects pathways are described in detail below.

Manual and mechanical treatments are likely to result in mild restoration construction effects (discussed above). Hand pulling of emergent vegetation is likely to result in localized turbidity and mobilization of fine sediments. Treatment of knotweed and other streamside invasive species with herbicides (by stem injection or spot spray) or heavy machinery is likely to result in short-term increases in fine sediment deposition or turbidity when treatment of locally extensive streamside monocultures occurs. Thus, these treatments are likely to affect a definite, broad area, and to produce at least minor damage to riparian soil and vegetation. In some cases, this will decrease stream shade, increase suspended sediment and temperature in the water column, reduce organic inputs (*e.g*., insects, leaves, woody material), and alter streambanks and the composition of stream substrates. However, these circumstances are likely to occur only in rare circumstances, such as treatment of an invasive plant monoculture that encompasses a small stream channel. This effect would vary depending on site aspect, elevation, and amount of topographic shading, but is likely to decrease over time at all sites as shade from native vegetation is reestablished.

Herbicide applications. In NMFS' HIP III BO they identified three scenarios for the analysis of herbicide application effects: (1) Runoff from riparian application; (2) application within perennial stream channels; and (3) runoff from intermittent stream channels and ditches. All three scenarios are relevant to Oregon chub and bull trout. Herbicides 2,4-D and triclopyr, which are proposed, as well as many other herbicides and pesticides are detected frequently in freshwater habitats within the four western states where listed fish are distributed (NMFS 2011).

Spray and vapor drift are important pathways for herbicide entry into aquatic habitats. Several factors influence herbicide drift, including spray droplet size, wind and air stability, humidity and temperature, physical properties of herbicides and their formulations, and method of application. For example, the amount of herbicide lost from the target area and the distance the herbicide moves both increase as wind velocity increases. Under inversion conditions, when cool air is near the surface under a layer of warm air, little vertical mixing of air occurs. Spray drift is most severe under these conditions, since small spray droplets will fall slowly and move to adjoining areas even with very little wind. Low relative humidity and high temperature cause more rapid evaporation of spray droplets between sprayer and target. This reduces droplet size, resulting in increased potential for spray drift. Vapor drift can occur when herbicide volatilizes. The formulation and volatility of the compound will determine its vapor drift potential. The potential for vapor drift is greatest under high air temperatures and low humidity and with ester formulations. For example, ester formulations of triclopyr are very susceptible to vapor drift, particularly at temperatures above 80°F. When temperatures go above 75˚F, 2,4-D ester chemicals evaporate and drift as vapor. Even a few days after spraying, ester-based phenoxytype herbicides still release vapor from the leaf surface of the sprayed weed (DiTomaso *et al.*2006).

When herbicides are applied with a sprayer, nozzle height controls the distance a droplet must fall before reaching the weeds or soil. Less distance means less travel time and less drift. Wind velocity is often greater as height above ground increases, so droplets from nozzles close to the ground would be exposed to lower wind speed. The higher that an application is made above the ground, the more likely it is to be above an inversion layer that will not allow herbicides to mix with lower air layers and will increase long distance drift. Several proposed conservation measures address these concerns by ensuring that herbicide treatments will be made using ground equipment or by hand, under calm conditions, preferably when humidity is high and temperatures are relatively low. Ground equipment reduces the risk of drift, and hand equipment nearly eliminates it.

Surface water contamination with herbicides can occur when herbicides are applied intentionally or accidentally into ditches, irrigation channels or other bodies of water, or when soil-applied herbicides are carried away in runoff to surface waters. Direct application into water sources is generally used for control of aquatic species. Accidental contamination of surface waters can occur when irrigation ditches are sprayed with herbicides or when buffer zones around water sources are not wide enough. In these situations, use of hand application methods will greatly reduce the risk of surface water contamination.

The contribution from runoff will vary depending on site and application variables, although the highest pollutant concentrations generally occur early in the storm runoff period when the greatest amount of herbicide is available for dissolution (Stenstrom and Kayhanian 2005, Wood 2001). Lower exposures are likely when herbicide is applied to smaller areas, when intermittent stream channel or ditches are not completely treated, or when rainfall occurs more than 24 hours after application. Under the proposed action, some formulas of herbicide can be applied within the bankfull elevation of streams, in some cases up to the water’s edge. Any juvenile fish in the margins of those streams are more likely to be exposed to herbicides as a result of overspray, inundation of treatment sites, percolation, surface runoff, or a combination of these factors. Overspray and inundation will be minimized through the use of dyes or colorants.

Groundwater contamination is another important pathway. Most herbicide groundwater contamination is caused by “point sources,” such as spills or leaks at storage and handling facilities, improperly discarded containers, and rinses of equipment in loading and handling areas, often into adjacent drainage ditches. Point sources are discrete, identifiable locations that discharge relatively high local concentrations. Proposed conservation measures minimize these concerns by ensuing proper calibration, mixing, and cleaning of equipment. Non-point source groundwater contamination of herbicides is relatively uncommon but can occur when a mobile herbicide is applied in areas with a shallow water table. Proposed conservation measures minimize this danger by restricting the formulas used, and the time, place and manner of their application to minimize offsite movement.

Piling Removal (Category 4). BPA proposes to fund projects that may include piling removal. Turbidity generated during piling removal will be temporary will only extend a few meters downstream (the distance will depend on flow and size fraction of streambed material). If sediment in the vicinity of a piling is contaminated, or if the piling had been treated with creosote, PAH will be released during removal, particularly if the piling breaks. To minimize the potential for adverse effects, BPA has imposed measures that will limit the extent of sediment plumes or surface debris and contaminant exposure. The potential long-term benefits of piling removal include reduced predation from piscivorous birds and fish; reduced ongoing contamination from treated pilings; and increased area for benthic production and juvenile salmon rearing.

Road and Trail Erosion Control, Maintenance, and Decommissioning (Category 5). BPA proposes to fund projects that include activities that maintain or decommission roads and trails with the goal of eliminating or reducing erosion and mass wasting of sediment. Roads and their drainage systems cause accelerated runoff of sediment. However, with proper maintenance and design, the amount of sediment that enters a stream from roads and trails can be small, infrequent, and of short duration.

Asphalt used during road resurfacing leach hydrocarbons, which can be toxic if it reaches a stream. Maintenance activities in this category would be patches to small road segments applied during dry conditions. Therefore, the potential for hydrocarbons impacting water quality is very low.

Likewise, dust abatement programs can affect water quality if not applied properly. The most common dust abatement compounds are calcium chloride, magnesium chloride and ligninsulfonates (oil-based products cannot be used in this program). Proper implementation of conservation measures (no application within 25 feet of a water body, or before or during rainfall) will minimize the risk of these chemicals reaching streams or negatively affecting riparian vegetation. Thus the risk of effects to water quality from dust abatement activities is insignificant.

Road maintenance activities are expected to benefit stream channels because these activities will minimize the risk of catastrophic road failure, and mass wasting of soil into stream channels, and will minimize the risk of more minor types of erosion and sediment delivery to channels. Road obliteration and decommissioning will also benefit streams because nearly all sediment delivery from road surfaces should be eliminated from those areas. Long-term benefits include reduced risk of washouts and landslides and improved fish passage by removing fish barriers caused by roads. Watershed conditions will be improved as road densities are reduced and riparian areas at old road crossings are revegetated. Floodplain connectivity may also be improved when the road had been built in the floodplain. Decommissioning a road reconnects natural habitat, and allows for the recolonization of native vegetation.

In-channel Nutrient Enhancement (Category 6). This category includes the addition of salmon carcasses, processed fish cakes or placement of inorganic fertilizers into stream channels.

In-channel nutrient supplementation may introduce piscine diseases into streams as well as the chemicals applied that are used to control those diseases, and may also introduce too many nutrients to stream channels causing algal blooms or other eutrophication problems downstream (Compton *et al*. 2006). Because of the lack of science associated with the ecosystems effects from nutrient enhancements, BPA-funded nutrients enhancements will follow measures to minimize the risk of adverse effects. For example, projects will not place carcasses in naturally oligotrophic systems where nutrient levels would be natural low, and they will not add nutrients to eutrophic systems where nutrient levels are anthropogenically elevated. The benefit of nutrient supplementation includes the delivery of marine nutrients into freshwater that will enhance primary and secondary production, thus enhancing the prey base for juvenile fish (Reeves *et al*. 1991, Ward *et al*. 2003).

Irrigation and Water Delivery/Management Actions (Category 7). BPA proposes to fund the following activities in this category: convert water delivery system to drip or sprinkler irrigation; convert water conveyance from an open ditch to a pipeline or line-leaking ditch/canal; convert from instream diversion to a groundwater well for primary water source; install or replace return flow cooling systems; install irrigation water siphon beneath the waterway; install livestock water facilities; and; maintain, upgrade, or install a new fish screen. The purpose of all these activities is to increase the amount of instream flow and to improve riparian function through irrigation efficiencies. Less water is needed to irrigate crops via drip or sprinkler irrigation than via flood irrigation because less water is lost through evaporation, and the application is more precise. The delivery of water can be controlled to meet the needs of plants with less waste. Drip irrigation technology can also incorporate agricultural wastewater and water from retention/detention basins, serving to further reduce the amount of water that must be withdrawn from streams (Trooien *et al*. 2000, Venhuizen 1998). Drip and sprinkler irrigation can also reduce the amount of soil erosion, and nutrient and pesticide runoff that is normally associated with furrow irrigation systems (Ebbert and Kim 1998).

However, converting from flood to drip or sprinkler irrigation may enable a water user to conduct more irrigation events with less water applied per event. This could increase the amount of water consumptively used per acre of irrigation (Upendram and Peterson 2007; Ward and Pulido-Velazquez 2008). Conversion from flood to drip irrigation could increase consumptive use by 22% to 29% (Ward and Pulido-Velazquez 2008) and conversion from flood to sprinkler irrigation could increase consumptive use by 24% to 39% (Upendram and Peterson 2007). Assuming a consumptive use of 1.45 acre feet per acre for flood irrigation (Lemhi Decree), an acre converted from flood irrigation to drip or sprinkler irrigation could reduce the amount of water flowing downstream to the ocean by 0.32 acre feet to 0.56 acre feet.

Irrigation water delivery via pipes or lined ditches/canals also uses less water, although the reduction in water loss is less than described above. The replacement of canals with pipelines will reduce the amount of herbicides and fertilizers entering streams, as these substances can easily drain to streams through open ditch networks in agricultural fields (Louchart *et al*. 2001). If these activities require instream construction the general effects of construction on stream and riparian habitat discussed above are applicable.

Fisheries, Hydrologic, and Geomorphologic Surveys (Category 8). BPA will fund activities that collect habitat information; collect data on fish presence, abundance, and habitat use; and conservation, protection and rehabilitation opportunities or effects. NMFS expects these activities could cause minor erosion and sedimentation, and minor compaction and disturbance to the streambed. Some riparian vegetation may be trampled, and excavated material from cultural resource excavation may contribute sediment to streams and increase turbidity. Implementation of conservation measures and the limited extent of this work will minimize the potential for effects to stream channels. The amount of soil disturbed will be negligible.

6.2 Effects to Bull Trout

Potential effects on bull trout may occur as the result of multiple activities described in the proposed action; these effects are described below by categories of activities.

Each project will be reviewed by BPA staff to determine whether the proposed work is covered under the HIP III consultation. This will include a review of whether the proposed work incorporates the appropriate general and species-specific conservation measures and project design standards that have been designed to reduce or avoid impacts to listed species. Projects which cannot meet these standards or that have the likelihood of causing effects beyond the scope of the analysis within this Biological Opinion will require a separate ESA Section 7 consultation.

The biological effects included as part of the proposed action are primarily the result of physical and chemical changes in the environment caused by activities funded under the HIP III program. These effects are complex, and vary in magnitude and severity between individuals, local populations, core areas, and DPSs. Our analysis of effects at the bull trout local population level is not considered in detail because projects are initiated at the discretion of non-federal applicants and site-specific locations and types of projects are not readily predictable.

We do not expect that all projects implemented under the HIP III programmatic within the range of bull trout will have adverse effects. There will be a range of effects depending on the size of the stream, the geology of the basin, soil types, condition of the riparian area, the type of project, the nature of bull trout that use the site, the ability of fish to escape to unaffected areas, the type of habitat at the project site, and other factors. In some cases the effects to bull trout will be insignificant because of their limited extent or discountable when fish are unlikely to be present. In other circumstances, such as projects that occur in spawning and rearing habitat, the short-term effects are likely to be adverse.

Preconstruction Activities. The primary habitat effect from preconstruction activities is a temporary and localized increased in turbidity and suspended sediment. Turbidity may have beneficial or detrimental effects on fish, depending on the intensity, duration, and frequency of exposure (Newcombe and MacDonald 1991). Salmonids have evolved in systems that periodically experience short-term pulses (days to weeks) of high suspended sediment loads, often associated with flood events, and are presumably adapted to high pulse exposures. Adults and larger juvenile salmonids may be little affected by high concentrations of suspended sediments that occur during storm and snowmelt runoff (Bjorn and Reiser 1991) although these events may produce behavioral effects, such as gill flaring and feeding changes (Berg and Northcote 1985).

Deposition of fine sediments reduces egg incubation success (Bell 1991), interferes with primary and secondary production (Spence *et al*. 1996), and degrades cover for juvenile salmonids (Bjornn and Reiser 1991). Chronic, moderate turbidity can harm new-emerged salmonid fry, juveniles, and even adults by causing physiological stress that reduces feeding and growth, and increases basal metabolic requirements (Redding *et al*. 1987, Lloyd 1987, Bjornn and Reiser 1991, Servizi and Martens 1991, Spence *et al*. 1996). Juveniles avoid chronically turbid streams, such as glacial streams or those disturbed by human activities, unless those streams must be traversed along a migration route (Lloyd *et al*. 1987). Older salmonids typically move laterally and downstream to avoid turbidity plumes (McLeay et al. 1984, 1987, Sigler *et al*. 1984, Lloyd 1987, Scannel 1988, Servizi and Martens 1991).

Fish exposed to moderately high turbidity levels in natural settings are able to feed, although at a lower rate and with increased energy expenditure due to a more active foraging strategy. Over a period of several days or more, reduced feeding resulting from increased turbidity can translate into reduced growth rates. Turbidity also limits fish vision which can interfere with social behavior (Berg and Northcote 1985), foraging (Gregory and Northcote 1993, Vogel and Beauchamp 1999) and predator avoidance (Miner and Stein 1996, Meager *et al*. 2006). This can have varying effects on fish growth and survival, depending on a range factors such as ambient light levels and depth; relative visual sensitivities of predators and prey; and non-visual sensory abilities. Conversely, salmon may benefit from increased turbidity; predation on salmonids may be reduced in water turbidity equivalent to 23 Nephalometric Turbidity Units (NTU) (Gregory 1993, Gregory and Levings 1998) which may improve survival.

Therefore, as a result of preconstruction activities, fish will be exposed to elevated turbidity and suspended sediment. Some juvenile bull trout may decrease feeding, experience increased stress, or may be unable to use the action area, depending on the severity of the increase in suspended sediments.

Construction, Operation and Maintenance Activities. All of the activity categories require some level of construction, operation, and/or maintenance adjacent to, or within, streams or rivers with listed fish. These activities can have direct biological effects on individual bull trout by altering development, bioenergetics, growth and behavior. Actions that increase flows can disturb gravel in bull trout redds and can also agitate or dislodge developing young, which can impair survival. Similarly, actions that result in water quality changes can result in altered behavior and death. Actions that reduce subsurface or surface flows, reduce shade, deposit silt in streams, or otherwise reduce the velocity, temperature, or oxygen concentration of surface water as it cycles through a redd can adversely affect the survival, timing and size of emerging fry (Warren 1971). Once bull trout arrive at a spawning area, their successful reproduction is dependent on the same environmental conditions that affect survival of embryos in the redd.

BPA has imposed conservation measures to minimize the risk of direct or indirect impact to redds. If any redds are impacted, scope of the impacted will be very limited in space and time, and is not expected to affect population viability.

Heavy Equipment. Heavy equipment used in spawning areas will disturb or compact gravel and other channel materials, making it harder for fish to excavate redds and decrease the oxygen concentration in existing redds. Heavy equipment used in streams in any occupied habitat may inhibit fish passage, or kill or injure individual fish; because of the scale of the program (HIP II had 114 construction projects with in-water work from 2008 through March of 2012 in the Columbia Basin) this effect is not expected to be significant at the population scale. Cederholm *et al*. (1997) recommend that heavy equipment work should be performed from the bank and that work within bedrock or boulder/cobble bedded channels should be viewed as a last resort. They also recommended using equipment such as spider harvesters and log loaders that are less disturbing to the streambed. BPA has incorporated similar measures into their proposed action. Bull trout generally spawn in high elevation headwaters of streams and based on the locations of projects previously funded through the BPA's HIP, we anticipate few HIP III funded actions will occur in spawning and rearing habitats. As suspended fine sediment settles out downstream from the construction areas, minor increases in stream substrate embeddedness occurs. Suttle *et al*. (2004) report that increases in fine sediments in stream substrates can decrease productivity and habitat quality for juvenile salmonids. Waters (1995) described how elevated fine sediment in streams impair both physical and biological processes; significant increases in fine sediment reduces interstitial spaces between substrate particles, leads to shifts in invertebrate community structure, fills pools, and can entomb redds. In such cases, eggs are smothered, and prey availability for juveniles is reduced.

When heavy equipment is operating within a stream or in a riparian area, there is always the potential for fuel or other contaminant spills. Operation of bulldozers, excavators, and other equipment requires the use of fuel and lubricants which, if spilled, can injure or kill aquatic organisms. Petroleum-based contaminants such as fuel, oil and some hydraulic fluids contain PAHs, which can be acutely toxic to salmonids at high levels of exposure and can cause acute and chronic sublethal effects to aquatic organisms (Neff 1985). BPA will require an erosion and pollution control plan for all projects that require soil disturbance; this includes all projects using heavy equipment near streams and rivers. This measure will minimize the risk of a hazardous spill, and if a spill occurs, will minimize the risk of it reaching the water. BPA reports from the implementation of HIP I and HIP II demonstrate the effectiveness of the conservation measures; a spill has never been reported. Therefore, the risk of a spill during the implementation of HIP III is low, and no population level effects to bull trout or Oregon chub from hazardous spills are expected from the implementation of this program.

Pilings. Turbidity from piling removal is temporary and confined to the area close to the activity. Given the preferred habitat of bull trout, we anticipated few if any individuals would be adversely affected by this activity category. The proposed requirements for completing the work during the preferred in-water work window will further minimize the effects of turbidity on these two species.

In-water work. Adverse effects to listed fish from in-water work are generally avoided and minimized through use of: (1) In-water work isolation strategies that often involve capture and release of trapped fish, and (2) performing the work during work windows when the fewest individuals of a species are present.

Direct effects on fish from work area isolation and relocation include mechanical injury during capture, holding, or release, and potential horizontal transmission of disease and pathogens and stress-related phenomena. Stress approaching or exceeding the physiological tolerance limits of individual fish can impair reproductive success, growth, resistance to infectious diseases, and survival (Wedemeyer *et al*. 1990). If electrofishing is used to salvage fish, it will add to increased stress loads. Harmful effects of electrofishing are detailed by Snyder (2003) and include internal and external hemorrhage, fractured spines, and death. The primary contributing factors to stress and death from handling are differences in water temperatures (between the river and the holding tank), dissolved oxygen concentrations, the amount of time that fish are held out of the water, and physical trauma. Stress on salmonids increases rapidly from handling if the water temperature exceeds 18ºC or dissolved oxygen is below saturation. Fish that are transferred to holding tanks can experience trauma if care is not taken in the transfer process, and fish can experience stress and injury from overcrowding in traps if the traps are not emptied on a regular basis. Debris buildup at traps can also kill or injure fish if the traps are not monitored and cleared on a regular basis. Although some listed bull trout may die from electroshocking, fish will only be exposed to the stress caused by work area isolation once, and the fish relocation is only expected to last a few hours for each project. The risk of injury or death to individual fish would be greater if construction occurred without work area isolation.

It is unlikely that individual adult or embryonic bull trout will be adversely affected by the proposed action because all in-water construction will occur during in-water work periods before spawning season occurs and after fry have emerged from gravel. However, in some locations, adult bull trout may be present (either due to migration, or residency) during part of the in-water work, and fry may still be emerging from the gravel.

In contrast to migratory adult and embryonic fish that will likely be absent during implementation of projects, resident adults and juvenile bull trout may be present at some portion of the restoration sites, particularly those located in spawning and rearing habitat, and those located where bull trout exhibit the resident life form. At in- or-near-water construction projects (*i.e.*, stream crossing replacement projects, channel reconstruction/relocation, *etc.),* some direct effects of the proposed actions are likely to be caused by the isolation of in-water work areas, although other combined lethal and sublethal effects would be greater without the isolation. An effort will be made to capture all bull trout (all life stages) present within the work isolation area and to release them at a safe location, although some juveniles will likely evade capture and later die when the area is dewatered. Fish that are captured and transferred to holding tanks can experience trauma if care is not taken in the transfer process. Fish can also experience stress and injury from overcrowding in traps, if the traps are not emptied on a regular basis. The primary contributing factors to stress and death from handling are: (1) water temperatures difference between the river and holding buckets; (2) dissolved oxygen conditions; (3) the amount of time that fish are held out of the water; and (4) physical trauma. Stress from handling increases rapidly if water temperature exceeds 18ºC (64ºF), or if dissolved oxygen is below saturation. Debris buildup at traps can also kill or injure fish if the traps are not monitored and cleared on a regular basis. PDC related to the capture and release of fish during work area isolation will avoid most of these consequences, and ensure that most of the resulting stress is short-lived (Portz 2007).

Juvenile fish compensate for, or adapt to, some of these disturbances so that they continue to perform necessary physiological and behavioral functions, although in a diminished capacity. However, fish that are subject to prolonged, combined, or repeated stress by the effects of the actions, combined with poor environmental baseline conditions, will likely suffer metabolic costs that are sufficient to impair their rearing, migrating, feeding, and sheltering behaviors and thereby increase the likelihood of injury or death. Because juvenile fish in the project areas are already subject to stress as a result of degraded watershed conditions, it is likely that a small number of those individuals will die due to increased competition, disease, and predation, and reduced ability to obtain food necessary for growth and maintenance (Moberg 2000; Newcombe and Jensen 1996; Sprague and Drury 1969).

Because juvenile-to-adult survival rate for bull trout is thought to be quite low, the effects of a project would have to occur to a large proportion of juvenile fish in a single area or local population before those effects would be equivalent even to a single adult, and would have to kill many times more than that to affect the abundance or productivity of the entire local population over a full life cycle. Moreover, because the geographic area that will be affected by the proposed programmatic action is so large for bull trout, the small numbers of juvenile fish that are likely to be killed are spread out across many local populations. The adverse effects of each proposed individual action will be too infrequent, short-term, and limited to kill more than a very small number of juvenile bull trout at a particular site or even across the range of a single local population, much less when that number is even partly distributed among all local populations within the action area. Thus, the proposed action will simply kill too few fish, as a function of the size of the affected populations and the habitat carrying capacity after each action is completed, to meaningfully affect the primary attributes of abundance or population growth rate for any single local population of bull trout.

The remaining population attributes are within-population spatial structure, a characteristic that depends primarily on spawning group distribution and connectivity, and diversity, which is based on a combination of genetic and environmental factors (McElhany *et al.* 2000). Because the proposed actions are only likely to have short-term adverse effects to spawning sites, if any, and in the long-term will improve spawning habitat attributes, they are unlikely to adversely affect spawning group distributions or within-population spatial structure. Actions that restore fish passage will improve population spatial structure. Similarly, because the proposed action does not affect basic demographic processes through human selection, alter environmental processes by reducing environmental complexity, or otherwise limit a population's ability to respond to natural selection, the action will not adversely affect population diversity.

At the species level, biological effects are synonymous with those at the population level or, more likely, are the integrated demographic response of one or more subpopulations (McElhany *et al.* 2000). Because the likely adverse effects of any action funded or carried out under this opinion will not adversely affect the overall population characteristics of any ESA-listed fish population, the proposed actions also will not have any a measurable effect on species-level abundance, productivity, or ability to recover bull trout across its range.

NMFS' HIP III BO (NMFS 2013) assumed up to 150 projects per year may be funded or carried out under BPA's HIP III programmatic based on the BA and information from the HIP I and II consultations between BPA and NMFS. For the purposes of our analysis, and for consistency between our HIP III biological opinion and NMFS', we will assume the same. Based on information from the HIP I and II consultations, which included many of the same project activity categories as the HIP III proposed action, at most half of the predicted 150 annual projects under HIP III will involve near or in-water work (n=75).

The past pattern of project activities (HIP I and II) has been used to infer the expected level of activity under the HIP III proposed action. Given the general locations of projects implemented under BPA's HIP program from 2003 to 2012, we estimate that 50 of the estimated 75 near or in-stream projects implemented annually under HIP III could occur within the range of the bull trout (SR or FMO habitat). While we expect the majority of ESA-listed fish captured as part of these projects would be salmon and steelhead, a portion of these fish are likely to be bull trout.

In the absence of empirical data, and for programmatic assessments where there is uncertainty as to where projects will be implemented across the action area, we often rely on professional judgment to develop formulas that help predict the likelihood of a listed species occurrence and rate of occurrence within a project area. Given that bull trout are an apex predator and generally persist in much lower abundance than other sympatric salmonids such as salmon, steelhead and other species of trout, we believe bull trout would comprise a relatively low percentage of the overall catch of salmonids within a given project area; probably somewhere between three and four percent for migratory populations, although there will be wide variation between project locations. Areas where resident bull trout populations exist may comprise a slightly higher proportion of the overall number of salmonids, somewhere near ten percent or possibly higher in some cases. While the overall percentage of bull trout to other salmonids may increase in SR habitat during summer and fall, the converse is true for FMO habitats during this time period because of warmer water temperatures and generally poorer water quality. Because the ratio of bull trout to other salmonids varies considerably across their range, and to err conservatively, we estimate a ratio of bull trout to salmon and steelhead of .05 to 1 (i.e., bull trout are estimated to comprise on average five percent of all salmonids captured during isolation and capture efforts). Therefore based on NMFS' anticipated capture of 100 salmon and steelhead per in-stream project as described previously, we anticipate an average capture of five bull trout for each project within the range of bull trout where isolation and dewatering could be required.
We anticipate injury or mortality to five percent of the fish that are captured and released, with the remainder (95 percent) likely to survive with no long-term adverse effects (McMichael *et al*.

1998; Cannon 2012). Thus, we anticipate up to 250 individual bull trout will be captured on average per year (estimated 50 in-stream projects within the range of bull trout x 5 bull trout captured per project on average) of which an estimated 13 (rounded up from 12.5) individual bull trout (.05 percent x 250 fish) will be injured or killed per year as a result of fish capture necessary to isolate in-water construction areas.

Overall, the effects of work area isolation on the abundance of bull trout in the Columbia River IRU are likely to be small. Almost all of these fish are anticipated to be juveniles, but a small number of adults could possibly be captured. For utility of operation we will not distinguish between take of juveniles and take of adults but will assume that most (95-99%) of the capture would be juveniles.

Post-construction Site Restoration. Most direct and indirect effects of proposed streambank restoration activities are the same as those for general construction discussed above, and these activities will follow the conservation measures for general construction, as applicable.

Fish Passage Restoration (Category 1 Activities). Activities in this category will provide a net long-term beneficial effect to ESA-listed fish. Improved habitat conditions and fish passage will provide greater access to spawning and rearing habitat, less energy expenditure in movement, greater access to diverse habitats that fosters the development and maintenance of locally adapted populations. Negative effects listed fish are related to general construction activities. These effects will be short-term, and will not affect bull trout at the population scale.

River, Stream, Floodplain, and Wetland Restoration (Category 2 Activities). Activities in this category will improve access to off-channel and floodplain habitats, improve the ecological function of streambanks, improve hydrological regimes, improve channel diversity and complexity, and provide resting and rearing areas for fish at a variety of flows. Greater diversity of habitat, and the presence and abundance of large wood is positively related to growth, abundance, and survival of juvenile salmonids (Spalding *et al*. 1995, Fausch and Northcote 1992). Similarly, greater access to rearing habitat and improved rearing conditions through improved habitat complexity will contribute to increased distribution and abundance of juvenile salmonids (Beechie and Sibley 1997, Spalding *et al*. 1995). Instream complexity will provide overhead cover for both adults and rearing juveniles, reducing predation risk. Negative effects related to this activity are primarily related to construction and are discussed above. In addition, there is a potential for negative effects associated with the construction of new channels. Newly-constructed channels may fill during subsequent high flows, and the risk of channel failure, avulsion, or accelerated bank erosion is greatest the first year following construction. Sediment pulses from channel failures or increased erosion may affect migrating adults and rearing juveniles; however, the effect is likely minor and short term. Project design review and adherence to fish work windows will minimize the risk to vulnerable life stages.

The overall effect of this proposed activity category will be beneficial, with improvements expected to productivity, survival, spatial structure, and diversity at the population scale where projects are implemented.

Invasive and Non-native Plant Control (Category 3 Activities). Activities in this category are designed to control or eliminate non-native, invasive plant communities where a benefit to habitat processes and functions are possible. Methods of plant control include both physical control and the use of herbicides. Effects of plant management using physical controls may include effects similar to general construction. Conservation measures such as the restriction to ground-based application methods and spot treatment will minimize the risk of effects. If a catastrophic spill of fuels or chemicals reaches water with listed fish, the potential for mortality to those fish is high. No accidental spill of fuels or chemicals has occurred with HIP I or HIP II, and with continued vigilant implementation of proposed conservation measures, that trend is expected to continue under HIP III.

When used according to the EPA label and the proposed conservation measures, BPA concluded that because of the uncertainty associated with the effectiveness of the conservation measures, it is reasonably likely that chemicals will reach streams with listed fish. BPA asserts that there may be some sub-lethal effects to listed fish as a result of herbicide and adjuvant exposure. It is reasonable to expect that effects will include direct and indirect mortality, an increase or decrease in growth, changes in reproductive behavior, reduction in number of eggs produced, fertilized or hatched, developmental abnormalities, reduction in ability to osmoregulate or adapt to salinity gradients, reduced ability to respond to stressors, increase in susceptibility to disease and predation, and changes in migratory behavior. The consequence of these effects is reasonably likely to result in reduced survival, reproductive success and/or migration.

BPA proposes to fund projects that use 2,4-D and triclopyr as well as many other herbicides that are detected frequently in freshwater habitats within the four western states where listed salmonids are distributed (NMFS 2011b). Stream margins often provide shallow, low-flow conditions, have a slow mixing rate with mainstem waters, and are the site at which subsurface runoff is introduced. Juvenile bull trout use low-flow areas along stream margins. As juveniles grow, they migrate away from stream margins and occupy habitats with progressively higher flow velocities. Nonetheless, stream margins continue to be used by older salmonids for a variety of reasons, including nocturnal resting, summer and winter thermal refuge, predator avoidance, and flow refuge. It is these stream margin habitats that the potential for exposure of the herbicides to fish is the greatest.

Lower exposures are likely when herbicide is applied to smaller areas, when intermittent stream channel or ditches are not completely treated, or when rainfall occurs more than 24 hours after application. Under the proposed action, some formulas of herbicide can be applied within the bankfull elevation of streams, in some cases up to the water’s edge. Any juvenile fish in the margins of those streams are reasonably likely to be exposed to herbicides as a result of overspray, inundation of treatment sites, percolation, surface runoff, or a combination of these factors. Overspray and inundation will be minimized through the use of dyes or colorants.

Herbicide toxicity. Herbicides included in this activity were selected due to their low to moderate aquatic toxicity to listed salmonids. The risk of adverse effects from the toxicity of herbicides and other compounds present in formulations to listed aquatic species is mitigated by reducing stream delivery potential by restricting application methods. Only aquatic labeled herbicides are to be applied within wet stream channels. Aquatic glyphosate and aquatic imazapyr can be applied up to the waterline using spot spray or hand selective application methods in both perennial and intermittent channels. Triclopyr TEA and 2,4-D amine can be applied up to the waterline, but only using hand selective techniques. The associated application methods were selected for their low risk of contaminating soils and subsequently introducing herbicides to streams. However, direct and indirect exposure and toxicity risks are inherent in some application scenarios.

Generally, herbicide active ingredients have been tested on only a limited number of species and mostly under laboratory conditions. While laboratory experiments can be used to determine acute toxicity and effects to reproduction, cancer rates, birth defect rates, and other effects to fish and wildlife, laboratory experiments do not typically account for species in their natural environments and little data is available from studies focused specifically on the listed species in this opinion. This leads to uncertainty in risk assessment analyses. Environmental stressors increase the adverse effects of contaminants, but the degree to which these effects are likely to occur for various herbicides is largely unknown.

NMFS (NMFS 2010, NMFS 2012) analyzed the effects of herbicide applications to various representative groups of species for each proposed herbicide. The effects of herbicide applications using spot spray, hand/select, and broadcast spray methods were evaluated under several exposure scenarios: (1) runoff from riparian (above HWM) application along streams, lakes and ponds, (2) runoff from treated ditches and dry intermittent streams, and (3) application within perennial streams (dry areas within channel and emergent plants). The potential for herbicide movement from broadcast drift was also evaluated. Herbicide delivery to surface water is likely to result in mortality to fish during incubation, or lead to altered development of embryos. Stehr *et al*. (2009) found that the low levels of herbicide delivered to surface waters are unlikely to be toxic to the embryos of ESA-listed salmon, steelhead and trout. However, mortality or sub-lethal effects to juveniles are likely to occur; these effects include reduced growth and development, decreased predator avoidance, or other modified behaviors. Herbicides are likely to also negatively impact the food base for listed salmonids and other fish, which includes terrestrial organisms of riparian origin, aquatic macroinvertebrates and forage fish.

Adverse effect threshold values for each species group were defined as either 1/20th of the LC50 value for listed salmonids, 1/10th of the LC50 value for non-listed aquatic species, or the lowest acute or chronic "no observable effect concentration," whichever was lower, found in Syracuse Environmental Research Associates, Inc. risk assessments that were completed for the USFS. Generally, effect threshold values for listed salmonids were lower than values for other fish species groups. In the case of sulfometuron-methyl, threshold values for fathead minnow were lower than salmonid values, so threshold values for minnow were used to evaluate effects to listed fish.

Data on toxicity to wild fish under natural conditions are limited and most studies are conducted on lab specimens. Adverse effects could be observed in stressed populations of fish, and it is less likely that effects would be noted in otherwise healthy populations of fish. Chronic studies or even long-term studies on fish egg-and-fry are seldom conducted. Risk characterizations for both terrestrial and aquatic species are limited by the relatively few animal and plant species on which data are available, compared to the large number of species that could potentially be exposed. This limitation and consequent uncertainty is common to most if not all ecological risk assessments. Additionally, in laboratory studies, test animals are exposed to only a single chemical. In the environment, humans and wildlife may be exposed to multiple toxicants simultaneously, which can lead to additive or synergistic effects.

Given their long residency period and use of freshwater, estuarine, and nearshore areas, juveniles and migrating adults have a high probability of exposure to herbicides that are applied near their habitats. The risk of exposure from herbicides applied under HIP III is low; however, in both HIP I and HIP II, this is the most commonly implemented activity category, and over 23,000 acres were treated with herbicides in the Columbia Basin under HIP II. Therefore, there is a risk of exposure to herbicides as a consequence of HIP III, and negative effects to listed salmonids (including bull trout) would be a consequence of that exposure. Because of the large size of the action area relative to the area treated with herbicides, it is unlikely that the effects would be measureable at the population or DPS scale.

Summary. The proposed conservation measures, including limitations on the herbicides, adjuvants, carriers, handling procedures, application methods, drift minimization measures, and riparian buffers, will greatly reduce the likelihood that significant amounts of herbicide will be transported to aquatic habitats, although some herbicides are still likely to enter streams through aerial drift, in association with eroded sediment in runoff, and dissolved in runoff, including runoff from intermittent streams and ditches. Some individual fish are likely to be negatively impacted as a consequence of that exposure. The indirect effects or long-term consequences of invasive, non-native plant control will depend on the long-term progression of climatic factors and the success of follow-up management actions to exclude undesirable species from the action area, provide early detection and rapid response before such species establish a secure position in the plant community, eradicate incipient populations, and control existing populations.

Piling Removal (Category 4 Activities). Piling removal will re-suspend sediment, and if the piling had been treated creosote or if the adjacent sediments had been contaminated, then there is a reasonable likelihood for exposure to those contaminants. This effect would be short term, and extend for a few days during construction. The long term effect of piling removal is a net beneficial effect for listed fish because it will reduce the number of resting sites for piscivorous birds. It will also reduce cover for aquatic predators such as large and smallmouth bass. It may also reduce the amount of creosote exposure by removing treated pilings.

Road and Trail Erosion Control, Maintenance, and Decommissioning (Category 5 Activities). Effects associated with general construction are discussed above. Individual fish may be exposed to hydrocarbons during small resurfacing activities using asphalt. However, implementation of conservation measures (conducting this activity during dry weather, and limiting the scope to minor repairs) will limit the opportunity for exposure, and this activity will be a net benefit for listed salmonid populations in watersheds that implement these activities.

In-channel Nutrient Enhancement (Category 6 Activities). The goal of this activity is to enhance primary and secondary production in streams, thus enhancing the prey base of listed fish. If successful, the consequence will be increased growth and survival, which contribute to increase productivity for listed fish populations. Potential negative effects include the introduction of piscine diseases into streams as well as the chemicals applied that are used to control those diseases. In-channel nutrient enhancement may also introduce too many nutrients to stream channels causing algal blooms or other eutrophication problems downstream (Compton *et al*. 2006). These adverse effects are not reasonably likely to occur because of the conservation measures that will be implemented with this activity, and the remote likelihood of this activity category being implemented under HIP III.

Irrigation and Water (Category 7 Activities). These activities will maintain or increase the amount of instream flow for fish, and improve riparian complexity and processes. Improved flow, particularly in late summer when flows are typically the lowest, will improve juvenile survival thus enhancing productivity at the reach scale. However, unless conservation measures are adequate to ensure no increase in consumptive use of water, these activities could result in decreases in streamflow downstream of the project site. Construction work will cause minor disturbances to individual fish over the short term, or a short exposure to a sediment pulse.

Fisheries, Hydrologic, and Geomorphologic Surveys (Category 8 Activities). These activities will be implemented to support aquatic restoration, but over the short term, could cause minor disturbances to individual fish, or a short exposure to a sediment pulse. ESA-listed fish would be observed in-water (*e.g*., by snorkel surveys or from the banks). Direct observation is the least disruptive method for determining a species' presence/absence and estimating their relative numbers. Its effects are also generally the shortest-lived and least harmful of the monitoring activities discussed in this section because a cautious observer can effectively obtain data while only slightly disrupting the fishes' behavior. Fry and juveniles frightened by the turbulence and sound created by observers are likely to seek temporary refuge in deeper water or behind or under rocks or vegetation. In extreme cases, some individuals may leave a particular pool or habitat type and then return when observers leave the area. Harassment is the primary effect associated with these observation activities, and few if any injuries (and no deaths) are expected to occur—particularly in cases where monitoring is observed from the stream banks rather than in the water.

Summary of Effects to Bull Trout. The purpose of the proposed action is to fund activities that improve fish and wildlife habitat. These activities will have negative, short-term construction-related effects, but will provide a net benefit to bull trout and other native fishes in the long term. Many environmental conditions can cause incremental differences in feeding, growth, movements, and survival of bull trout during the juvenile life stage. Construction actions that reduce the input of particulate organic matter to streams, add fine sediment to channels, or disturb shallow-water habitats, can adversely affect the ability of fish to obtain food necessary for growth and maintenance. Bull trout are generally able to avoid the adverse conditions created by construction if those conditions are limited to areas that are small or local compared to the total habitat area, and if the system can recover before the next disturbance. This means juvenile and adult bull trout will, to the maximum extent possible, readily move out of a construction area to obtain a more favorable position within their range of tolerance along a complex gradient of temperature, turbidity, flow, noise, contaminants, and other environmental features. The degree and effectiveness of the avoidance response varies with life stage, season, the frequency and duration of exposure to the unfavorable condition, and the ability of the individual to balance other behavioral needs for feeding, growth, migration, and territory.

Chronic or unavoidable exposure heightens physiological stress thus increasing maintenance energy demands (Redding *et al.* 1987, Servizi and Martens 1991). This reduces the feeding and growth rates of juveniles and can interfere with juvenile migrations and growth to maturity. Other threats to bull trout include exposure to herbicides and loss of habitat because of increased consumptive use of water because of irrigation efficiency activities. However, given the full range of mandatory conservation measures in the HIP III program outlined above, the threat is low that the environmental changes caused by events at any single site associated with the proposed action, or even any combination of such sites, could cause chronic or unavoidable exposure over a large habitat area sufficient to cause more than transitory direct affects to individual bull trout.

At the population level, the effects of the environment are understood to be the integrated response of individual organisms to environmental change. Thus, instantaneous measures of population characteristics, such as population abundance, population spatial structure and population diversity, are the sum of individual characteristics within a particular area, while measures of population change, such as population growth rate, are measured as the productivity of individuals over the entire life cycle (McElhany *et al.* 2000). We anticipate on average non-lethal take of five or less bull trout per project (250 total per year) and lethal take of less than 13 bull trout in aggregate annually for all projects implemented under the proposed action. That is too few to influence population abundance at the local population or core area scale. Similarly, small to intermediate reductions in juvenile population density in the action area caused by individuals moving out of project areas to avoid injury or death as a result of exposure to short-term physical and chemical effects of construction are expected to be transitory and are not expected to alter juvenile survival rates. Over the long term, the sum of the HIP III activities may result in measurable improvements to population characteristics, particularly if a project is of large enough scale (provides access to many miles of habitat), or if enough projects are implemented within the Columbia River IRU.

Because adult bull trout are larger and more mobile than juveniles, it is unlikely that any will be killed during work area isolation although adults may move laterally or stop briefly during migration to avoid noise or other construction disturbances. Given the full range of mandatory conservation measures in the HIP III program, it is unlikely that physical and chemical changes caused by construction events at any single site associated with the proposed action, or even any combination of such sites, will cause delays severe enough to reduce spawning success, alter population growth rate, or cause straying that might alter the spatial structure or genetic diversity of populations. Thus, it is unlikely that the biological effects of implementing the activities within the HIP III program will negatively affect the characteristics of local populations or core areas of bull trout. We anticipate the proposed action will have long-term beneficial effects on population abundance, productivity, and spatial structure.

6.2.1 Effects to Bull Trout Critical Habitat

Construction projects have the greatest potential to affect critical habitat. Most projects that alter stream channel, or provide fish passage will adversely affect PCEs 1, 2, 3, 6, 7 and 8 by contributing sediment to the system and increasing cobble embeddedness during the short term. Depending on the category and specific design of the project these effects could last from a few days or weeks to several months (possibly years or decades where stream channels are reconstructed). While these PCEs will be adversely affected for some period of time by these projects, all of the projects described in this BO will eventually contribute to the improvement of fish habitat with long-term benefits resulting from passage enhancement. Thus they will result in benefits over time to these PCEs of critical habitat.

Instream projects will result in insignificant negative effects to PCEs 2, 3 and 6. These are ephemeral effects of low intensity and short duration.

Vegetation management activities will have adverse effects on PCEs 1, 2, 3, 4, 6, 7 and 8. These effects are likely to be a combination of short-term (weeks to months) and long-term (one to 20 years depending on the individual project) effects that will contribute increased sediment to the system. These effects should diminish and eventually halt as native vegetation becomes reestablished. These projects will ultimately result in improved infiltration rates, reduced overland flows and sediment yields and a more natural hydrograph.

A more detailed description of how the proposed action will affect individual PCEs of bull trout critical habitat follows:

PCE 1. Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia.

Channel Condition, dynamics and floodplain connectivity will be greatly affected by construction projects. Inwater or near-water construction will cause short-term adverse effects to stream channels at the site specific scale. Changes in flow resulting from many construction projects will also cause short-term adverse effects to the dynamics of the stream system. In most cases these effects will be short-term (weeks to months), but could be long term, lasting years. Ultimately these projects are designed to improve conditions (passage, channel dynamics, correct anthropogenic conditions), and therefore will benefit the ability of critical habitat to provide high quality water and connectivity. Because short-term impacts will reduce the ability of critical habitat to supply these functions for weeks, months, or even years in some cases, these projects will adversely affect PCE 1.

Instream projects such as the placement of gravel, or LW may have slight negative effects to PCE 1 by contributing to turbidity and donation of some amounts of sediment to the system thus affecting water quality. Channel conditions will show some effects from many of these projects. These effects will be of low intensity, short duration (more likely hours than days), and are considered insignificant to PCE 1.

Flow and Hydrology (change in peak/base flows) will be affected by construction projects. Flow will be interrupted, and redirected in some cases. Most of the adverse effects resulting from these types of projects would be short-term (weeks or months). However, larger projects such as stream reconstruction could have adverse effects on flow for many years before beneficial effects to the system are recognized. In general, construction projects described within this BO will adversely affect PCE 1.

Vegetation management projects will have short-term adverse effects on PCE 1 through this indicator. The use of herbicides to treat invasive plants could add chemicals to the system that may affect aquatic flora and thus aquatic fauna as well. Any adverse effect to this PCE will be short-term and would be expected to lesson and then terminate once native vegetation becomes reestablished on the project sites. Restoration activities that improve conditions for streamside and upland vegetation will ultimately benefit the aquatic system in the long-term (1-20 years) through the reduction of sediment delivery over time, improved infiltration rates, and a more natural hydrograph over time.

PCE 2. Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers.

Habitat Access (barriers) may be disrupted during implementation of some construction projects. In many cases this disruption may only be ephemeral, but in other cases short-term adverse effects will occur to PCE 2. With long-term benefits resulting from passage enhancement. Thus they will result in benefits over time to PCE 2 of critical habitat eventually.

Instream projects such as the addition of LW, or the placement of gravel or boulders will have a neutral effect on this indicator. Also vegetation projects will have a neutral effect to this PCE.

Water quality (chemical contaminants/nutrients) will be adversely affected by instream and near stream construction projects. These projects will contribute sediment to the system and increase cobble embeddedness during the short term. Depending on the category and specific design of the project these effects could last from a few days or weeks to several months (possibly years where stream channels are reconstructed). The presence of equipment instream adds some degree of risk of contamination from lubricants, antifreeze, and hydraulic fluids. These risks are greatly reduced by the general and specific conservation measures proposed by BPA. While PCE 2 will be adversely affected for some period of time by these projects, all of the projects described in the proposed action will eventually contribute to the improvement of fish habitat.

Instream projects will have a slightly negative effect on water quality. The addition of LW, or placement of gravel or boulders may contribute minor amounts of sediment to the system. These effects should be of short duration and low intensity and are considered insignificant.

Vegetation treatments considered within this BO will adversely affect water quality in the short-term. The use of herbicides to treat invasive plants could add chemicals to the system that may affect aquatic flora and thus aquatic fauna as well. Further, the removal of vegetation can change overland flows and infiltration rates. Increased run off from rainfall or snow melt will result in increased sediment delivery to the system. Any adverse effects to this PCE will be short-term and would be expected to lesson and then terminate once native vegetation becomes reestablished on the project sites. Restoration activities that improve conditions for streamside and upland vegetation will ultimately benefit the aquatic system in the long-term (1-20 years) through the reduction of sediment delivery over time, improved infiltration rates, and a more natural hydrograph.

Flow and Hydrology **(**change in peak/base flows) will be affected by construction projects. Flow will be interrupted, and redirected in some cases. Most of the adverse effects resulting from these types of projects would be short-term (weeks or months). However, larger projects such as stream reconstruction could have adverse effects on flow for many years before beneficial effects to the system are recognized. In general, construction projects described within this BO will adversely affect PCE 2.

Vegetation management projects will have short-term adverse effects on PCE 2 through this indicator. The use of herbicides to treat invasive plants could add chemicals to the system that may affect aquatic flora and thus aquatic fauna as well. Any adverse effect to this PCE will be short-term and would be expected to lesson and then terminate once native vegetation becomes reestablished on the project sites. Restoration activities that improve conditions for streamside and upland vegetation will ultimately benefit the aquatic system in the long-term (1-20 years) through the reduction of sediment delivery over time, improved infiltration rates, and a more natural hydrograph.

Instream projects such as the addition of LW, or the placement of gravel or boulders will have a neutral effect on this PCE.

PCE 3. An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.

Water quality, channel condition and dynamics, and habitat access will be adversely affected by construction projects. These effects will limit the availability of prey species within critical habitat in the short-term. Increased sediment and reduced water quality will reduce the ability of critical habitat to provide foraging opportunities to bull trout through reduced visibility, and reduced presence of prey fish.

Instream projects may have a slightly negative effect on this PCE. These projects may increase, or disturb fine sediment at a small, localized scale. These effects are likely to be ephemeral, of short duration and of low intensity. Thus, these effects are considered insignificant to PCE 3 through these pathways.

Vegetation management projects will adversely affect the ability of critical habitat to provide both aquatic and terrestrial prey species needed by bull trout during the short term. Increased donations of sediment with increase turbidity and reduce both the availability of prey and the ability of bull trout to pursue such prey. Changes to streamside vegetation will result in some reduction of terrestrial macroinvertebrates available in bull trout critical habitat. This condition should ease over-time as native vegetation becomes reestablished on the affected sites. Because of these factors, vegetation management projects will adversely affect PCE 3.

PCE 4. Complex river, stream, lake, reservoir, and marine shoreline aquatic environments, and processes that establish and maintain these aquatic environments, with features such as LW, side channels, pools, undercut banks and unembedded substrates, to provide a variety of depths, gradients, velocities, and structure.

Habitat Elements such as large wood, pool frequency and quality, large pools, off channel habitat, and refugia, will not be affected by construction projects when applied to PCE 4. Instream projects such as additions of large wood, or placement of gravel or boulders would have entirely beneficial effects. Vegetation management projects would generally have a neutral effect as applied to PCE 4, however they may well have a short-term (months) adverse effect on refugia. Therefore they must be considered as an adverse effect on PCE 4 through this pathway.

PCE 5. Water temperatures ranging from 36 °F to 59 °F (2 °C to 15 °C), with adequate thermal refugia available for temperatures that exceed the upper end of this range. Specific temperatures within this range will depend on bull trout life-history stage and form; geography; elevation; diurnal and seasonal variation; shading, such as that provided by riparian habitat; streamflow; and local groundwater influence.

Water quality (Temperature) will not be affected by construction projects. Vegetation projects will have a slightly negative effect on this PCE. The removal of vegetation could allow increased solar radiation which could affect temperatures to some degree. These effects will be extremely localized and of low intensity, and are considered insignificant to PCE 5.

PCE 6. In spawning and rearing areas, substrate of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount of fine sediment, generally ranging in size from silt to coarse sand, embedded in larger substrates, is characteristic of these conditions. The size and amounts of fine sediment suitable to bull trout will likely vary from system to system.
Water Quality (sediment*)* will be adversely affected by construction projects. These projects will contribute sediment to the system and increase cobble embeddedness during the short term.

Depending on the category and specific design of the project these effects could last from a few days or weeks to several months (possibly years where stream channels are reconstructed).

Instream projects such as the placement of gravel, or LW may have slight negative effects to PCEs 1 by contributing to turbidity and donation of some amounts sediment to the system thus affecting water quality. Channels conditions will show some effects from many of these projects. These effects will be of low intensity, short duration (more likely hours than days), and are considered insignificant to PCE 6

Vegetation treatments considered within this BO will adversely affect water quality in the short-term. The removal of vegetation can change overland flows and infiltration rates. Increased run off from rainfall or snow melt will result in increased sediment delivery to the system. Most adverse effects to PCE 6 will be relatively short-term and would be expected to lesson and then terminate once native vegetation becomes reestablished on the project sites. However larger scale projects may increase sediment loads for long periods (up to five years). Restoration activities that improve conditions for streamside and upland vegetation will ultimately benefit the aquatic system in the long-term (1-20 years depending on the exact project) through the reduction of sediment delivery over time, improved infiltration rates, and a more natural hydrograph over time.

Habitat Elements such as substrate embeddedness will be adversely affected by instream or near-stream construction projects. The addition of sediment described above will result in some portion of substrate embeddedness. While it is expected that most of this would subside the year following the project when high flows would purge the system of most of the residual sediment on the substrate, these projects will still result in short-term adverse effects for most projects. Obviously in larger scale projects such as stream reconstruction these adverse conditions could persist longer, possibly up to years in time.

Instream projects such as the placement of gravel, or LW may have slight negative effects to PCE 6 by contributing to turbidity and donation of some amounts sediment to the system thus affecting water quality. These effects will be of low intensity, short duration (more likely hours than days), and are considered insignificant to this indicator.

Vegetation management projects will have an adverse effect on substrate embeddedness because they will result in increased sediment donations to the system short-term. If projects are located within bull trout spawning and rearing habitat this could adversely affect the ability of critical habitat to provide high quality substrates needed for spawning. As mentioned above most of these effects would not last more than one season, but are considered an adverse effect on PCE 6.

PCE 7. A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, minimal flow departure from a natural hydrograph.

Flow and Hydrology (change in peak/base flows) will be adversely affected by construction projects. Flow will be interrupted, and redirected in some cases. Most of the adverse effects resulting from these types of projects would be short-term (weeks or months). However, larger projects such as stream reconstruction could have adverse effects on flow for many years before beneficial effects to the system are recognized. In general, construction projects described within this BO will adversely affect PCE 7 during the short-term, but will ultimately benefit critical habitat over the long term (1-20 years) by aiding in the restoration of a more natural hydrograph.

Vegetation management projects will have short-term adverse effects on PCE 7 through this indicator. The removal of vegetation can change overland flows and infiltration rates. Increased run off from rainfall or snow melt will result in increased water delivery to the system. Any adverse effect to this PCE will be short-term and would be expected to lesson and then terminate once native vegetation becomes reestablished on the project sites. Restoration activities that improve conditions for streamside and upland vegetation will ultimately benefit the aquatic system in the long-term (1-20 years) through improved infiltration rates, and a more natural hydrograph over time.

PCE 8. Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.

Water quality (chemical contaminants/nutrients) will be adversely affected by instream and near stream construction projects. These projects will contribute sediment to the system and increase cobble embeddedness during the short term. Depending on the category and specific design of the project these effects could last from a few days or weeks to several months (possibly years where stream channels are reconstructed). The presence of equipment instream or near lakeshore adds some degree of risk of contamination from lubricants, antifreeze, and hydraulic fluids. These risks are greatly reduced by general and specific conservation measures proposed by BPA. While PCE 2 will be adversely affected for some period of time by these projects, all of the projects described in this BO will eventually contribute to the improvement of fish habitat.

Instream projects will have a slightly negative effect on water quality. The addition of LW, or placement of gravel or boulders may contribute minor amounts of sediment to the system. These effects should be of short duration and low intensity and are considered insignificant to this PCE.

Vegetation treatments considered within this BO will adversely affect water quality in the short-term. The use of herbicides to treat invasive plants could add chemicals to the system that may affect aquatic flora and thus aquatic fauna as well. Further, the removal of vegetation can change overland flows and infiltration rates. Increased run off from rainfall or snow melt will result in increased sediment delivery to the system. Any adverse effects to this PCE will be short-term and would be expected to lesson and then terminate once native vegetation becomes reestablished on the project sites. Restoration activities that improve conditions for streamside and upland vegetation will ultimately benefit the aquatic system in the long-term (1-20 years) through the reduction of sediment delivery over time, improved infiltration rates, and a more natural hydrograph over time.

PCE 9. Sufficiently low levels of occurrence of non-native predatory (e.g., lake trout, walleye, northern pike, smallmouth bass); interbreeding (e.g., brook trout); or competing (e.g., brown trout) species that, if present, are adequately temporally and spatially isolated from bull trout.

Subpopulation characteristics such as life history diversity and isolation, persistence and genetic integrity*)* will be benefitted by construction projects that improve fish passage. Providing improved passage, or reconnecting isolated local populations where safe to do so, will improve genetic diversity.

Summary of effects to bull trout CHUs, Columbia River IRU and critical habitat at the rangewide scale

While the proposed action will have adverse effects to bull trout critical habitat at the local, site specific scale, these adverse effects will not be significant when evaluated at larger scales. The projects involved are too small and too distant and too infrequent to adversely affect the PCEs across an entire CHU. Because of this the effects of these projects cannot rise to a level to adversely affect the Columbia River IRU.

6.3 Effects to Oregon Chub

Potential effects on Oregon chub may occur as the result of multiple activities described in the proposed action; these effects are described below by categories of activities.

Each project will be reviewed by BPA staff to determine whether the proposed work is covered under the HIP III consultation. This will include a review of whether the proposed work incorporates the appropriate general and species-specific conservation measures and project design standards that have been designed to reduce or avoid impacts to listed species. Projects which cannot meet these standards or that have the likelihood of causing effects beyond the scope of the analysis within this Biological Opinion will require a separate ESA Section 7 consultation.

Effects from Construction-Related Activities

The following effects to Oregon chub may occur as a result of construction-related activities proposed in the action, which include:

1. Fish Passage Restoration
2. River, Stream, Floodplain, and Wetland Restoration
3. Piling Removal
4. Road and Trail Erosion Control, Maintenance and Decommissioning

Effects on Water Quality

Turbidity

Construction-related activities may temporarily increase suspended sediment and turbidity during in-water work for minutes to hours following cessation of construction activities at each location. Although turbidity has been linked to a number of behavioral and physiological stress responses in salmonids, available data documenting the effects of turbidity on Oregon chub are limited. Localized turbidity increases are likely to cause some juveniles and adults to seek alternative habitat, which could contain suboptimal cover and forage and cause increases in behavioral stress (*e.g.,* avoidance and displacement), and sub-lethal responses (*e.g.,* increased respiration, reduced feeding success, and reduced growth rates). Turbidity and sediment can also reduce embryo survival and juvenile rearing densities. Excessive sediment can clog the gills of juvenile fish, reduce prey availability, and reduce juvenile success in catching prey. Similar responses, to a lesser magnitude, are expected in chub. Effects of turbidity on fish are influenced by several factors: the duration of turbidity (the quantity of suspended materials, size of sediment particles, and current velocities), and the proximity of fish to the turbid area (Bisson and Bilby 1982).

The effects of turbidity on Oregon chub will be minimized by the limited, temporary nature of disturbance, by conducting fish salvage, by installing turbidity controls (turbidity curtains), and by monitoring turbidity levels downstream during in-water work (BA p. 2-17). Additionally, work will be conducted only during approved in-water work periods prescribed by ODFW when Oregon chub are least vulnerable (i.e., not spawning). Temporary erosion controls will be installed down slope of restoration activities within the riparian buffer to prevent soil movement into aquatic habitats.

The use of access roads may cause erosion resulting in sediments entering chub habitats. However, the proposed action includes several conservation measures to prevent effects to Oregon chub from use of access roads (BA, p. 2-16). Existing access roads will be used whenever possible and temporary access roads will not be built on slopes greater than 30% or where soil erosion is likely to occur as a result. The implementation of these and other conservation measures described in the proposed action will reduce the likelihood of effects to Oregon chub from the use of access roads.

Chemical Contamination

Chemical contamination is possible when activities involving hazardous materials occur in areas having direct or indirect hydrologic connections to these drainages. These activities are primarily limited to fluid leaks from construction equipment and vehicles during project construction. The proposed action includes conservation measures designed to prevent equipment leaks into aquatic habitats (BA, p. 2-16).

Accidental spills of construction materials or petroleum products could result in adverse effects to water quality. The timing of such an effect would be instantaneous and unpredictable. The duration of effects from a spill would depend on the severity of the spill and whether the spill occurred inside an isolation/containment area or resulted in releases away from in-water work areas (e.g., a hydraulic fluid leak under pressure). The worst-case scenario could entail the failure of a large piece of equipment and the release of several gallons of petroleum product near or into a waterway. This could result in the death of local aquatic organisms such as fish, waterfowl, macroinvertebrates, and vegetation. There were no documented accidental spills of hazardous materials under HIP I and II; thus, we anticipate a very low likelihood of spills under HIP III.

Emergency spill control materials will be provided on-site at all times and ready for immediate deployment in the event of an accident. Development of pollution control plans that include preventive and containment measures for construction-related chemical hazards will significantly reduce the likelihood for chemical releases in the project area, as well as the severity and spatial extent of contamination, should they occur.

Effects on Habitat Function

Changes in flows, temperature, and habitat connectivity

In-water restoration activities under the categories of 1) Fish Passage Restoration, and 2) River, Stream, Floodplain, and Wetland Restoration may alter the physical features that make downstream habitat suitable for Oregon chub, including flow rates, connectivity, and temperatures. Although restoration activities under this category are intended to restore natural floodplain functions, they may also have the unintended consequence of affecting Oregon chub downstream. Construction projects may also cause long-term changes in sediment deposition patterns downstream. Sedimentation could affect Oregon chub habitat downstream of restoration projects by blocking the entrance to off-channel habitat and causing site isolation from the main channel. This isolation would eliminate the potential for dispersal between habitats and could lead to a reduction in genetic diversity in the affected population. Sedimentation could also reduce the area of affected habitat or the amount of emergent vegetation available for spawning. This reduction in habitat could cause a decline in survival, growth, or reproductive success in an affected population. For instance, removal of dikes could alter flow patterns downstream (e.g. shifting flows to secondary channels) and result in reductions in the volume of water reaching downstream off-channel habitat occupied by Oregon chub. Decreased water volumes and the resulting increased water temperatures could result in physiological stress and injury or death of individual chub due to decreased dissolved oxygen. Additionally, reproductive losses may occur as vegetated areas where spawning occurs are desiccated. Reduced flows could also reduce habitat connectivity that allows for chub dispersal and reduce genetic diversity due to isolation.

Projects could also result in increased flows into Oregon chub habitat reducing the habitat suitability for Oregon chub. For instance, flows may be redirected as a result of restoration projects into historic secondary channels that are now off-channel habitat with no or low velocity. Increased flows could significantly change the habitat conditions, including temperature, vegetation, and substrate deposition which are key elements in Oregon chub habitat.

Effects on Riparian Vegetation

Riparian reserves directly influence Oregon chub habitat structure and function, as well as indirectly affect a multitude of hydrologic and biochemical processes. Intact riparian areas are responsible for water quality treatment, stormwater infiltration, groundwater storage, and other biochemical and hydrologic processes vital to properly functioning habitat. Riparian vegetation influences shading, organic inputs, stream bank stabilization, channel complexity, and soil properties. Removal of riparian vegetation and trees may result in a reduction of these benefits to Oregon chub. Reduced shade over streams and off-channel habitats due to construction activities or after weeds are removed and before native vegetation becomes established could slightly increase water temperatures over the short-term. Consequently, it is possible that the optimal temperature range for Oregon chub could be exceeded or result in reduced oxygen levels that could cause stress to Oregon chub or their prey in the short-term. However, shade loss that significantly affects water temperature is likely to be rare, occurring primarily from treating large-scale streamside monocultures (e.g., knotweed and blackberry), and possibly from cutting streamside woody species (e.g., tree of heaven, scotch broom, etc.).

Effects from Work-Site Isolation

Fish removed from the isolated work area may be caught in nets, electrofished, and handled, resulting in an elevated risk of harm and harassment, and possible mortality. Oregon chub may also be injured or killed during containment system construction. However, work area isolation and fish salvage will be conducted by experienced biologists using methods approved by the ODFW and NMFS to minimize the potential for these effects.

Containment measures will minimize the potential for direct harm to fish from project construction activities. Work area isolation at each location will result in a minor localized habitat modification in the short term (until containment/isolation measures are removed) that could impair or disrupt behavioral patterns of fish, including feeding and sheltering. However, accomplishing the proposed work within the isolation/containment areas will reduce potential adverse effects to downstream habitat and reduce the probability of direct adverse effects to fish in the project area.

Fish Screens

Fish screens must be used on pump intakes to avoid juvenile fish entrainment; screens must meet NOAA Fisheries' fish screen criteria, be self-cleaning or regularly maintained (by removing debris buildup), and a responsible party must be designated to ensure proper operation (*i.e.*, regular inspection and as-needed maintenance to ensure pumps and screens are properly functioning).

The larvae of the Oregon chub are assumed to be more susceptible to entrainment due to their small size and differences in swimming performance compared to salmonids. While some entrainment or impingement of Oregon chub is possible, the screens will greatly reduce the risk of potential losses. Adults will be large enough to be kept out by the screens. The larval stage is the primary stage that will be vulnerable because larvae are small enough that they could potentially move through the screens. However, conservation measures that were designed to avoid work in areas occupied by Oregon chub will minimize the potential for these effects to occur.

Effects from Irrigation Improvements

Irrigation improvements will reduce the number of diversions on streams, conserve water, and improve habitat for fish. Projects with a medium to high risk (i.e. the removal of irrigation diversion structures greater than 3 feet in height) will be reviewed by the RRT prior to approval and will be designed to minimize or avoid any downstream effects to Oregon chub. Adverse effects of both low and medium to high risk activities in this category may include turbidity and reduced flows to existing Oregon chub habitats. See the above discussion for effects on Oregon chub from turbidity. Decreased water volumes and increased water temperatures could result in physiological stress and injury or death of individual chub due to decreased dissolved oxygen. Additionally, reproductive losses may occur as vegetated areas where spawning occurs are desiccated. Reduced flows could also reduce habitat connectivity that allows for chub dispersal and reduce genetic diversity due to isolation. However, given that only 9 projects in this category were funded under HIP II, we anticipate few of these projects are likely to occur within the range of Oregon chub.

Effects from Invasive and Nonnative Plant Control

Manual and Mechanical Control

Manual and mechanical control of invasive and nonnative plant control activities will follow conservation measures designed to prevent erosion of sediments into aquatic habitats. However, these activities may still result in small amounts of sediment entering the water. Any effects to Oregon chub from the resulting turbidity are likely to be short-term as sediment is expected to settle into the substrate or quickly diffuse in areas with higher flows.

Herbicide Applications

Herbicide delivery to surface water can result in mortality to fish during incubation, or lead to altered development of embryos. Mortality or sub-lethal effects such as reduced growth and development, decreased predator avoidance, or modified behavior could occur. Herbicides can also impact the food base for Oregon chub and other fish, which includes aquatic macroinvertebrates. Data are not available on the direct or indirect effects of herbicides to Oregon chub. However, in general, effects of chemical applications can be considered detrimental to aquatic ecosystems if the physical, chemical, or biological processes that support those ecosystems are adversely impacted (Preston 2002).

The risk of herbicides directly entering the water would be relatively low, as herbicides will be applied according to the guidelines in the BA. These guidelines include buffers, weather restrictions, application techniques, and quantity. The risks of Oregon chub being directly exposed to herbicides, and the risks of significant loss of submergent and emergent aquatic vegetation, are therefore minimized.

Herbicide use is limited to chemicals and measures that are expected to result in exposures that are below threshold risk levels (HQ values less than 1 or NOAC levels) for fish as well as aquatic invertebrates, algae and aquatic macrophytes. The conservation measures as proposed in the BA limit the specific herbicides, application rates, and distances from aquatic resources to only those that were found in the analyses to be below the threshold risk levels for all evaluated species groups. Therefore, as proposed with the conservation measures for herbicide use, the risk of adverse effects from herbicide use on BPA HIP projects has been greatly reduced and potentially avoided for Oregon chub.

Effects from Fisheries, Hydrologic, and Geomorphologic Surveys

Survey activities could result in accidental injury or mortality to a small percentage of Oregon chub as a result of capture stress or handling during trapping and species verification. Chub captured during surveys will be identified as quickly as possible and returned to the water immediately. Traps will be set for short duration (1 to 8 hours) to minimize impacts. The timing of surveys will occur outside the spawning window in order to avoid adverse impacts to chub reproduction. Oregon chub may spawn from April to August, with the bulk of spawning activity occurring May-late July. Surveys will be conducted outside this time frame. Additionally, BPA or their project proponent will consult the most recent location data available for Oregon chub and will avoid surveys in those habitats. This data is currently available from ODFW's Corvallis Research Lab, (541)757-4263 ext. 224.

Effects from Irrigation and Water Delivery/Management Actions

Restoration projects under this category are unlikely to occur in areas where Oregon chub are known to occur; therefore, we anticipate no effects to Oregon chub from irrigation and water delivery/management actions.

Benefits of Proposed Action

BPA HIP projects will benefit Oregon chub over the long-term. It is anticipated that floodplains will become more complex and natural function will be restored. If projects affect stream hydrographs, they are likely to more closely resemble natural conditions due to improved wetland, riparian and floodplain functions. Wetland restoration such as breaking tile drainage lines and restoring native plant communities increases water storage in wetlands and floodplains, creating additional fish habitat and enhancing subsurface flow into streams during the summer.

Establishment of native trees, shrubs, grasses and forbs along streams will increase shade, increase dissolved oxygen levels, and promote instream habitat complexity. Increased riparian vegetation and instream cover should increase aquatic insect populations, enhancing food availability for fish.

Summary of Effects to Oregon Chub

In summary, adverse effects may result from increases in turbidity and fine-sediment deposition; disturbance of individuals during instream work; changes in flows, temperature, and habitat connectivity; exposure to herbicides; and adverse effects to algae, aquatic macrophytes and aquatic macroinvertebrates from herbicides and sedimentation. Most of these adverse impacts will be of short duration, and over the long term we expect habitat conditions and status of Oregon chub populations to improve.

6.3.1 Effects to Oregon Chub Critical Habitat

Although projects will not occur in habitats that have been designated as critical habitat for Oregon chub, effects to critical habitat located downstream of restoration projects may occur. A variety of restoration activities are included in the proposed action. Only those activities likely to have adverse effects on Oregon chub critical habitat are analyzed below; the remaining activities are not likely to have adverse effects.

The primary constituent elements (PCEs) for Oregon chub critical habitat are:

1. Off-channel water bodies such as beaver ponds, oxbows, side-channels, stable backwater sloughs, low-gradient tributaries, and flooded marshes, including at least 500 continuous square meters (0.12 ac) of aquatic surface area at depths between approximately 0.5 and 2.0 m (1.6 and 6.6 ft).

2. Aquatic vegetation covering a minimum of 250 square meters (0.06 ac) (or between approximately 25 and 100 percent) of the total surface area of the habitat. This vegetation is primarily submergent for purposes of spawning, but also includes emergent and floating vegetation and algae, which are important for cover throughout the year. Areas with sufficient vegetation are likely to also have the following characteristics:

   • Gradient less than 2.5 percent;
   • No or very low water velocity in late spring and summer;
   • Silty, organic substrate; and
   • Abundant minute organisms such as rotifers, copepods, cladocerans, and chironomid larvae.

3. Late spring and summer subsurface water temperatures between 15 and 25 °C (59 and 78 °F), with natural diurnal and seasonal variation.
4. No or negligible levels of nonnative aquatic predatory or competitive species. Negligible is defined for the purpose of this rule as a minimal level of nonnative species that will still allow the Oregon chub to continue to survive and recover.

Effects from Construction-Related Activities

The following effects to Oregon chub critical habitat may occur as a result of construction-related activities proposed in the action, which include:

1. Fish Passage Restoration
2. River, Stream, Floodplain, and Wetland Restoration
3. Piling Removal

Effects on Water Quality

Chemical Contamination

Accidental spills of construction materials or petroleum products could result in adverse effects to water quality. The worst-case scenario could entail the failure of a large piece of equipment and the release of several gallons of petroleum product near or into a waterway. This could result in the death of local aquatic organisms such as macroinvertebrates and vegetation, both components of PCE 2. However, there were no documented accidental spills of hazardous materials under HIP I and II; thus, we anticipate a very low likelihood of spills under HIP III.

Effects on Critical Habitat Function

Changes in flows, temperature, habitat area, and vegetation

In-water restoration activities under the categories of 1) Fish Passage Restoration, and 2) River, Stream, Floodplain, and Wetland Restoration may alter the physical features of Oregon chub critical habitat, including flow rates (PCE 2) and temperatures (PCE 3). Construction projects may also cause long-term changes in sediment deposition patterns downstream. Sedimentation could reduce the area of affected habitat (PCE1) or the amount of emergent vegetation (PCE2) available for spawning. Projects could also result in increased flows into Oregon chub critical habitat. For instance, flows may be redirected as a result of restoration projects into historic secondary channels that are now off-channel habitat with no or low velocity (PCE 3). Increased flows could significantly change the habitat conditions, including temperature, vegetation, and substrate deposition (PCE 2) which are key elements in Oregon chub critical habitat.

Effects from Irrigation Improvements

Irrigation improvements will reduce the number of diversions on streams, conserve water, and improve habitat for fish. Projects with a medium to high risk (i.e. the removal of irrigation diversion structures greater than 3 feet in height) will be reviewed by the RRT prior to approval and will be designed to minimize or avoid any downstream effects to Oregon chub. An adverse effect of both low and medium to high risk activities in this category may include reduced flows to existing Oregon chub habitats. Decreased water volumes would affect the area of critical habitat (PCE 1) and may result in increased water temperatures (PCE 3) and decreased dissolved oxygen. Additionally, reproductive losses may occur as vegetated areas where spawning occurs are desiccated. Reduced flows could also reduce habitat connectivity that allows for chub dispersal and reduce genetic diversity due to isolation. However, given that only 9 projects in this category were funded under HIP II, we anticipate few of these projects are likely to occur within the range of Oregon chub.

Effects from Invasive and NonNative Plant Constrol

Herbicide Applications

Herbicides can impact the food base for Oregon chub, which includes aquatic macroinvertebrates (PCE 2). However, herbicide use is limited to chemicals and measures that are expected to result in exposures that are below threshold risk levels (HQ values less than 1 or NOAC levels) for fish as well as aquatic invertebrates, algae and aquatic macrophytes. The conservation measures as proposed in the BA limit the specific herbicides, application rates, and distances from aquatic resources to only those that were found in the analyses to be below the threshold risk levels for all evaluated species groups. Therefore, as proposed with the conservation measures for herbicide use, the risk of adverse effects from herbicide use on BPA HIP projects has been greatly reduced and potentially avoided for Oregon chub critical habitat.

Summary of Effects to Oregon Chub Critical Habitat

In summary, adverse effects to Oregon chub critical habitat include sediment deposition; changes in flows, temperature, and habitat area; reduced water quality due to chemical contamination and herbicides; and adverse effects to aquatic macroinvertebrates from herbicides and sedimentation. However, most of these adverse impacts will be of short duration and over the long term we expect habitat conditions for Oregon chub to improve under the HIP III Program.

6.4 Effects to Marbled Murrelet

The USFWS analyzed whether effects related to habitat changes (i.e., habitat effects) and effects related to increased noise (i.e., disturbance/disruption effects) are likely to cause murrelet injury or mortality. The primary focus is disturbance effects, since this consultation does not cover projects that may adversely affect murrelets via habitat changes, or that adversely affect their critical habitat.

a. Habitat Effects

We describe below how habitat modifications may negatively impact murrelets and why actions covered under this consultation are not likely to adversely affect murrelets through habitat changes. Considerable evidence links the declining numbers of murrelets to the removal and degradation of available suitable nesting habitat (Ralph et al. 1995). The removal of habitat can potentially adversely affect the murrelet population in several ways including the following: 1) immediate displacement of birds from traditional nesting areas; 2) concentration of displaced birds into smaller, fragmented areas of suitable nesting habitat that may already be occupied; 3) increased competition for suitable nest sites; 4) decreased potential for survival of remaining murrelets and offspring due to increased predation; 5) diminished reproductive success for nesting pairs; 6) diminished population due to declines in productivity and recruitment; and 7) reduction of future nesting opportunities.

For the purposes of this programmatic consultation, we assume suitable habitat is likely to be occupied by murrelets. As part of the proposed action, activities that remove or reduce the capability of suitable, potential, or critical murrelet habitat will not be covered under this consultation. This includes suitable habitat and potential nest structures, which are defined in Appendix D of this document. Also, for actions to avoid adverse effects to murrelet critical habitat, BPA must ensure that site-specific actions would not remove or eliminate the availability of primary constituent elements. In other words, adverse effects to primary constituent elements [i.e., “individual trees with potential nesting platforms and forested areas within 0.8 km (0.5 miles) of individual trees with nesting platforms, and with a canopy height of at least one-half the site-potential tree height (USFWS 1996).”] will not be covered by this programmatic BO.

Therefore activities will not harm (i.e., significantly change habitat such that it results in death or injury) murrelets by habitat loss.

b. Disturbance/Disruption Effects

There is an increased likelihood of injury to murrelet young from disturbance/disruption effects related to the proposed action. This likelihood is created because some projects will occur within disruption distances of occupied or suitable-unsurveyed murrelet areas during the murrelet breeding season. BPA has proposed to implement restoration projects within disruption distances during their breeding season. While most projects will avoid disturbing murrelets, we assume for the purposes of this effects analysis that some projects will occur near nesting murrelets that can only be implemented during the murrelet breeding period.

Likelihood of injury is greatly reduced because only a limited number of actions will adversely affect murrelets via disturbance/disruption effects. Restoration projects may disturb or disrupt murrelets only after the following steps have been taken to attempt to fully avoid or minimize adverse effects to murrelets: 1) a wildlife biologist has determined murrelets may occur in the project area; 2) a site survey by wildlife biologist indicates an active nest is within the species-specific disturbance distance of the project (or if protocol survey (Evans et al. 2003) is not completed then BPA will assume suitable habitat is occupied); and 3) the action cannot be scheduled outside of the murrelet nesting period, or moved to a location outside of the murrelet disturbance/disruption distance.

When the potential for injury exists, the USFWS needs to determine if the projects and nesting murrelets will occur within proximity (disruption distances) of each other (both spatially and temporally), but the actual project locations and nest locations are unknown for these proposed actions. Even when a murrelet survey is completed, the amount of site-specific adverse effects are not necessarily easier to quantify (i.e., since active nests are difficult to locate). Also, some projects may occur in suitable, unsurveyed murrelet habitat, which further complicates quantification of adverse effects.

Since murrelets can be very difficult to locate, we have developed a method to analyze expected adverse effects in unsurveyed, suitable habitat. This requires some site-specific or estimated knowledge of the likelihood of encountering a nest (i.e., density or home range size) within the project area. The size and shape of action areas is not specified for all actions, and it is possible for some projects to overlap into more than one potential active nest location. Consequently, we quantified the amount of action area (including disturbance buffers) where we might reasonably expect to locate one murrelet nest in unsurveyed, suitable habitat.

Our methodology is to be used as a guide, to help determine a project size where we anticipate finding one nest in continuous suitable murrelet habitat. This does not replace site-specific analysis, but is a tool to determine the probable extent of effects. A wildlife biologist during project design will determine whether there is suitable murrelet habitat or potential nest trees within the project area, which is part of the nest analysis required for pre-project planning (Appendix D – Specific Conservation Measures for Birds). This type of information would be provided by BPA to the Service via a Project Notification/Completion form. The USFWS assumes that project areas containing suitable habitat are likely to have a nesting murrelet, until an effects analysis from BPA or their project proponents (based on nest analysis and/or protocol survey) determine otherwise.

c. Methodology to predict effects in unsurveyed and occupied, suitable habitat

In cases of uncertainty such as unsurveyed habitat, it is USFWS policy to give the benefit of the doubt to the listed species. On that basis, the USFWS considers occupied and unsurveyed stands with murrelet nesting structure to be occupied. The USFWS determined the number of acres of occupied or unsurveyed habitat where we would anticipate finding a pair of nesting murrelets. A nest density study for the Washington and Oregon does not exist. Accordingly, we are unable to estimate the actual number of murrelets that would be exposed to noise and visual disturbance during the proposed action. Instead, our analysis uses an estimation of individuals exposed based on acres and stands disturbed as a surrogate for the actual number of individual murrelets disturbed.

The latest estimate comparing the murrelet population to the amount of inland suitable habitat results in an average of 186 acres of habitat per murrelet (Huff et al. 2006, page 141). The sex ratio is believed to be equal for murrelets in all Recovery Zones and juvenile murrelets are estimated to be eight percent of the population (McShane et al. 2004, p 3-45). Efforts to determine the proportion of adults breeding have resulted in estimates of 31 to 95 percent, potentially varying based on food availability (McShane et al. 2004, pp. 3-39 and 40). Therefore, the assumption that murrelets occur inland at a density of 372 acres (2 x 186) per pair would be a conservative assessment for the species as this number does not factor out the non-breeding murrelets. It also must be noted that although the USFWS is estimating the potential for murrelets, they are not territorial nor are they documented as colonial (seeking out nest sites based on the location of others nest site – an attracting factor[30]). Therefore, the USFWS estimates that one to zero murrelet pair is nesting at each site/stand smaller than 372 acres of habitat.

Therefore, one project in up to 372 acres of potential, unsurveyed murrelet habitat is expected to impact one young from one murrelet nest. Because the probability of encountering one nest differs between one continuous area of habitat compared to multiple fragments of habitat distributed across the landscape (since actual murrelet densities vary throughout the landscape), two spatially separated projects in unsurveyed suitable habitat (even if their total acreage amounts to 372 acres) is expected to affect two young from two separate nests. Project length impacts the likelihood of encountering multiple nests (i.e., 15 miles of channel work versus 5 miles of channel and associated riparian to upland area). Multiplying number of nests likely to be disturbed by acres of potential habitat where we expect to find one nest (i.e., 372), we can expect to find one nest in 0.01-372 acres, two nests in 373-744 acres, three in 745-1,116 acres, four in 1,117-1,488 acres, and five in 1,489-1,860 acres of unsurveyed potential habitat. Results are displayed in Table 14 below.

To quantify the project length for linear restoration projects in which we would expect to encounter a murrelet nest, we considered or assume the following: 1) for simplicity we assume a linear project area (e.g., linear stream); 2) the range-wide density estimate of one

[30] It is to be noted that Nelson and Wilson (2002, page 107) calculated murrelet nesting densities of 0.1 to 3.0 nests per hectare (or 1 nest per 24.21 to 0.83 acres). Murrelets in the study were nesting in patches of suitable habitat, and the density of nests at the stand scale is likely lower (Nelson and Wilson 2002, page 107). In general nests are spaced far apart (Nelson and Wilson 2002, page 107).

nest per 372 acres; 3) murrelets occur at range-wide density levels within a project area; 4) murrelets are relatively evenly distributed across the range in suitable habitat (since we do not have site-specific information and cannot predict distribution at the local-level/within a stand); and 5) a project area will generally occur within 300 feet of the stream on either side of the bank. The USFWS also uses the buffer for noise and smoke, 0.25 miles, in our estimates since this is the maximum level of potential effect.

Based on these assumptions, a project's zone of influence (with noise buffers) may extend 0.25 miles + 300 feet from a stream. The USFWS multiplies this by two (to account for work along both sides of the stream bank), and divide this into 372 acres to obtain project length. This length is the maximum project length, for projects that do not exceed 372 acres, where we anticipate disturbance to only one murrelet young. However, the projected project length where we expect to encounter one nest is 0.95 miles in marbled murrelet habitat (i.e., for every 0.95 miles of linear project ~ 600 feet wide the USFWS expects to encounter one marbled murrelet nest). Multiplying this by number of nests, we generally anticipate projects will encounter one nest within 0.01-0.95 miles, two in 0.96-1.92 miles, three in 1.93-2.85 miles, four in 2.86-3.81miles, and five in 3.82-4.77 miles of stream within suitable, unsurveyed habitat. Results are displayed in Table 14.

Table 14. Acreage and project length of action areas where activities are likely to encounter active marbled murrelet nests in unsurveyed, suitable murrelet habitat.

Estimated number of active murrelet nests	Project Area (acres)	Maximum Project Length (in miles)
1	0.01-372	0.01-0.95
2	373-744	0.96-1.92
3	745-1,116	1.93-2.85
4	1,117-1,488	2.86-3.81
5	1,489-1,860	3.82-4.77

Determining the number of likely projects with potential annual disruption impacts to MAMU under BPA's HIP III proposed action is difficult for several reasons: 1) BPA's previous proposed action under HIP II was limited to the Columbia Basin proper, thus only a small portion of the total action area occurred within the range of MAMU (Coast range of NW Oregon and SW Oregon along the lower Columbia River). As a result, few projects occurred in this portion of the action area; and, 2) the expanded HIP III action area now includes, in addition to the Columbia Basin, Oregon coastal basins from the Columbia River south to Cape Blanco. This expanded area is fully encompassed by three of the six MAMU recovery zones. Because this is a new area for BPA's HIP program, there's not a baseline established that would help predict the frequency of future BPA funded restoration projects in this area.

As discussed in Section 4.3.2 above, there are six MAMU recovery zones in the U.S. These recovery zones are the functional equivalent of recovery units as defined by FWS policy

(USFWS 1997, p. 115). BPA's HIP III action area overlaps with three of the six recovery zones: a small portion of Zone 2 in SW Washington; the entire Zone 3 along the Oregon coast; and a small portion of Zone 4 along the southern Oregon coast. Given the small amount of overlap between the action area and Recovery Zones 2 and 4, we expect no more than 2 BPA funded projects under HIP III will occur in each of these zones on an annual basis within disruption distances of marbled murrelets during the marble murrelet critical breeding season. Given the large area of overlap between the HIP III action area and Zone 3, we anticipate up to 5 projects per year may be implemented within disruption distances of marbled murrelets during the marble murrelet critical breeding season. To allow for flexibility in funding levels and variation in high priority restoration projects, project impacts will be averaged over a five-year period such that Recovery Zones 2 and 4 cannot exceed disruption to 10 nest in each zone, and 25 nest in Zone 3, during any five-year period.

Based on our above quantification, we anticipate that in total, BPA could fund and implement 45 restoration projects within the disruption distances of murrelets during their breeding season during any five-year period. This assumes that project size (area and length) in unsurveyed, suitable habitat does not exceed values listed in Table 14, or, if they do, that the project notification/completion form provided to the Service includes information on the site-specific analysis that documents otherwise.

d. Description of anticipated effects

The remainder of our effects analysis relates to disturbance/disruption effects that may occur to the murrelets in recovery zones 2, 3 and 4 on an annual basis.

Noise and human intrusion are one of many threats to this species (McShane et al. 2004). Effects to murrelets from noise and human intrusion are not well known, but effects (e.g., energetic expenditure, stress levels, and susceptibility to predation) have been documented in other species (Knight and Gutzwiller 1995). While studies have not directly linked murrelet nest failure, abandonment, or chick mortality to disturbance, they have documented flushes from the nest and missed or delayed feedings at the nest (Singer et al. 1995, Hamer and Nelson 1998, Golightly et al. 2002). Murrelet breeding biology may preclude easy detection of sub-lethal disturbance effects (i.e., flushes from the nest and missed feedings) at the population level. Therefore, potential effects of disturbance on murrelet fitness and reproductive success should not be completely discounted (McShane et al. 2004).

Based on available information for the murrelets (Nelson and Hamer 1995, Long and Ralph 1998, Hamer and Nelson 1998, Nelson and Wilson 2002) and other bird species (Kitaysky et al. 2001, Delaney et al. 1999a), the USFWS has concluded that significant noise, helicopter rotor wash and human presence in the canopy may significantly disrupt murrelet breeding, feeding, or sheltering behavior such that it creates the potential of injury to the species (i.e., adverse effects in the form of harassment; USFWS 2003e). Additionally, groups of people are known to attract corvids, which temporarily increase the likelihood of young or eggs being preyed on by corvids in the action area.

An effect to murrelet behavior may occur when activities covered under this BO occur within the disturbance/disruption distance of active murrelet nests. The disturbance and disruption distances were developed utilizing the best available scientific information (Table 15 below). Loud noises at distances greater than identified in Table 15 are expected to either have no or negligible effects on murrelet behavior. In Washington the Service considers the murrelet nesting season to span from April 1 – September 23, while in Oregon the Service considers the murrelet nesting season to span from April 1 – September 15. The differences in applied nesting seasons are due to internal evaluations of murrelet biology and nesting season data, which are on-going.

Although the USFWS has assumed disruption distances based on interpretation of the best available information, distances are likely conservative because they consider the reasonable worst-case scenario for murrelets. While the most severe impacts of noise likely occur within a narrower zone, the exact distance where disturbances disrupt murrelets is difficult to predict and can be influenced by a multitude of factors. Site-specific information (e.g., topographic features, project length or frequency of disturbance to an area) could influence effects. Activities that are short duration (i.e., 1-3 days) that do not cause physical injury to marbled murrelets, and include both daily timing restrictions and garbage pick-up may have limited exposure to nesting murrelets to an extent that renders the effects insignificant or discountable. The potential for noise or human intrusion-producing activities to create the likelihood of injury to murrelets also depends on background (baseline) environmental levels. In areas that are continually exposed to higher ambient noise or human presence levels (e.g., areas near well- traveled roads, camp grounds), murrelets are probably less susceptible to small increases in disturbances because they are accustomed to such activities. Murrelets do occur in areas near human activities and may habituate to certain levels of noise.

Human presence (including increase in corvids) or excessive noise levels within close proximity to individuals may cause nesting adults to flush and leave their eggs exposed to predation or increase the risk of predation to a chick. These disturbances can also cause delayed feeding attempts by adults which may reduce the fitness of the young. They may also cause premature juvenile fledging, potentially reducing their fitness due to having sub-optimal energy reserves before leaving the nest. A murrelet that may be disturbed when it flies into the stands for other reasons than nest exchange or feeding young is presumably capable of moving away from disturbance without a significant disruption of its own behavior. As stated in the Status of the Species section, murrelets feed at sea and only rely on forest habitat for nesting.

Table 15. Disturbance and disruption distance thresholds for marbled murrelet during the nesting season (April 1 - Sept 15 for OR; and, April 1 - Sept 23 for WA). Distances are to a known occupied murrelet nest tree or suitable nest trees in unsurveyed habitat.

Action	Action Not Likely Detected Above Ambient Levels	Disturbance Distances	Disruption Distances	Increased Risk of Physical Injury and/or Mortality
Light maintenance (e.g., road brushing and grading), and heavily-used roads	> 0.25 mile	≤ 0.25 mile	NA[1]	NA
Log hauling on heavily-used roads (FS maintenance levels 3, 4, 5)	>0.25 mile	≤ 0.25 mile	NA[1]	NA
Chainsaws (includes felling hazard/danger trees)	>0.25 mile	111 yards to 0.25 mile	≤ 110 yards[2]	Potential for mortality if trees felled contain platforms
Heavy equipment for road construction, road repairs, bridge construction, culvert replacements, piling removal, etc.	>0.25 mile	111 yards to 0.25 mile	≤ 110 yards[2]	NA
Helicopter: Chinook 47d	>0.5 mile	266 yards to 0.5 mile	≤ 265 yards[5]	100 yards[6] (injury/mortality)
Helicopter: Boeing Vertol 107, Sikorsky S-64 (SkyCrane)	>0.25 mile	151 yards to 0.25 mile	≤ 150 yards[7]	50 yards[6] (injury/mortality)
Helicopters: K-MAX, Bell 206 L4, Hughes 500	>0.25 mile	111 yards to 0.25 mile	≤ 110 yards[8]	50 yards[6] (injury/mortality)

1. NA = not applicable. We anticipate that marbled murrelets that select nest sites in close proximity to heavily used roads are either undisturbed by or habituate to the sounds and activities associated with these roads (Hamer and Nelson 1998, p. 21).
2. Based on recommendations from murrelet researchers that advised buffers of greater than 100 meters to reduce potential noise and visual disturbance to murrelets (Hamer and Nelson 1998, p. 13, USFWS 2012c, pp. 6-9).
3. Based on an estimated 92 dBA sound-contour (approximately 265 yards) for the Chinook 47d (Newman et al. 1984, Table D.1).
4. Because murrelet chicks are present at the nest until they fledge, they are vulnerable to direct injury or mortality from flying debris caused by intense rotor wash directly under a hovering helicopter. Hovering distance is based on a 300-ft radius rotor-wash zone for large helicopters hovering at < 500 above ground level (from WCB 2005, p. 2 – logging safety guidelines). We reduced the hovering helicopter rotor-wash zone to a 50-yard radius for all other helicopters based on the smaller rotor-span for all other ships.
5. Based on an estimated 92 dBA sound contour from sound data for the Boeing Vertol 107 the presented in the San Dimas Helicopter Logging Noise Report (USFS 2008, chapters 5, 6).
6. The estimated 92 dBA sound contours for these helicopters is less than 110 yards (e.g., K-MAX (100 feet) (USFS 2008, chapters 5, 6), and Bell 206 (85-89 dbA at 100 m)(Grubb et al. 2010, p. 1277).

Disturbance from proposed actions that are conducted: 1) outside of the breeding period (between September 24 and March 31 for WA and between September 16 and March 31 for Oregon); 2) greater than 0.25 mile from occupied or unsurveyed suitable habitat during the breeding season; or 3) within 0.25 mile of surveyed unoccupied habitat during any time of the year, *is not expected to affect* murrelets because these activities are not likely to result in any exposure to nesting murrelets. Murrelets that are not nesting are expected to be able to move away from disturbance with no increased risk of death or injury. Additionally, in these situations corvid attraction will not cause an increased risk of predation because we believe corvid predation is only likely to affect murrelet chicks and eggs, not adults.

Within the murrelet nesting period in Oregon, the USFWS considers two distinct periods: the critical nesting season between April 1 – August 5, and the late nesting season between August 6 and September 15. In Washington, the USFWS does not incorporate a late nesting period into its management evaluations. During the late nesting season in Oregon, activities other than helicopters are *not likely to adversely affect* murrelets *provided that they don't begin until two hours after sunrise and cease prior to two hours before sunset.*

In the late breeding period, we believe the likelihood that disturbance will cause injury declines because most murrelets are finished incubating and either have completed nesting (about half of the chicks have fledged) (Hamer et al. 2003) or adult murrelets are still tending the nest. Adults still tending their young in the late breeding period are heavily invested in chick-rearing making it unlikely adults will abandon their young due to noise from the proposed activities. In addition, the proposed action limits disturbance activities for the two hours after sunrise and two hours before sunset (between Aug 6-Sept 15) when most food deliveries to young are made. This restriction thus reduces the likelihood of nest abandonment or significant alteration of breeding success, therefore the likelihood of injury by annoying it to such an extent as to significantly disrupt normal behavior patterns, which includes but are not limited to, breeding feeding or sheltering has been minimized. However, some data indicate that murrelets are making more food deliveries during the day than previously assumed and that predation pressures on eggs and chicks is throughout the entire breeding period. Two-hour daily timing restrictions are still recommended minimization measures.

Due to disturbance, the proposed action could cause a chick to fall off a nest branch, prematurely fledge, or have an injury due to excessive noise. These activities may potentially cause the likelihood of injury to fledglings throughout the entire breeding period (April 1 – September 15 for Oregon and April 1-September 23 for Washington).

As the breeding season progresses there are fewer nesting murrelets as nests either fledge or fail. Therefore, projects that start during the end of the nesting season reach a point where the likelihood of a nearby nest site still being active is discountable. For Washington, after September 4th 97.72 percent of all nests are estimated to have fledged (B. Tuerler, *in litt.*). Therefore, in Washington, projects conducted September 5 – September 23 are not likely to adversely affect murrelets, as the likelihood of exposure to a nest site that is still active is considered discountable.

Table 16. Summary of disturbance effects from the proposed action when active marbled murrelet nests are within the disruption distances of actions within Washington State.

Disturbance Type	Time Period[1]	Effects	Rationale for Effect Determination
Noise other than helicopters (*i.e., all actions except surveys*)	Apr 1 - Sept 4	LAA	Effects vary and may cause from little to significant disruption depending on site- and activity-specific factors and the individual murrelet's noise tolerance. Worst-case scenario, adults move from noise, causing increased predation to young, missed feedings, or premature fledging. Based on anecdotal observations and limited studies, murrelets appear generally undisturbed by sharp or prolonged loud noise, and nesting attempts are not easily disrupted by human disturbance except when confronted very near the nest itself (Long and Ralph 1998, USFWS 2003). Most actions will not occur within 100 yards of active nests or likely occupied, unsurveyed habitat from Apr 1-Aug 5. For those that do, likelihood of injury to young will mostly occur through the potential increase of predation of abandoned young. However, predation likelihood is reduced by PDCs that are part of the proposed action (e.g., removal of project generated garbage to prevent attraction of corvids). Since this likelihood cannot be eliminated this type of disturbance is considered likely to adversely affect murrelets. Actions will seldom occur during crepuscular time periods, thereby significantly reducing the probability of missed feeding attempts.
	September 5 – Sept 23	NLAA	This is the tail end of the nesting season when approximately 98 percent of all nests are estimated to have fledged. Therefore in WA, projects conducted September 5 – September 23 are not likely to adversely affect murrelets as the likelihood of exposure to a nest site that is still active is considered discountable.
	Sept 24-March 31	NE	This time period is outside of the murrelet breeding season.

Disturbance Type	Time Period[1]	Effects	Rationale for Effect Determination
Noise and rotor wash associated with helicopters (*i.e., some culvert/bridge, nutrient enhancement, LW placement actions*).	Apr 1 - Sept 4	LAA	Noise effects vary and may cause little to significant disruption depending on site- and activity-specific factors and an individual's noise tolerance. Worst-case scenario, adults move from noise, causing increased predation to young, missed feedings, or premature fledging. Young, which are not capable of moving away from noise, may have injury form excessive noise levels. Most activities do not use helicopters, and most helicopter use will not occur within 0.25 miles of active nests or likely occupied, unsurveyed habitat from Apr 1-Sept 15. Helicopters will generally hover no closer than 300 feet from the ground and ferry logs at 500 feet altitude for safety purposes. Activities will seldom occur during crepuscular time periods, thereby significantly reducing the probability of delayed feeding attempts. Helicopter passes over nests are less likely to cause injury than hovering in close proximity to nests. There is some indication that murrelets do not respond to airplanes and helicopters flying overhead unless they pass over at low altitude (Long and Ralph 1998). Prior murrelet studies involved circling/hovering over 125 nests for 3-min intervals within 100-300 m (328-984 feet), which did not flush any of the incubating adults (USFWS 2003).
	September 5 – Sept 23	NLAA	This is the tail end of the nesting season when approximately 98 percent of all nests are estimated to have fledged. Therefore in WA, projects conducted September 5 – September 23 are not likely to adversely affect murrelets as the likelihood of exposure to a nest site that is still active is considered discountable.
	Sept 24-March 31	NE	This time period is outside of the murrelet breeding season.
	September 5 – Sept 23	NLAA	This is the tail end of the nesting season when approximately 98 percent of all nests are estimated to have fledged. Therefore in WA, projects conducted September 5 – September 23 are not likely to adversely affect murrelets as the likelihood of exposure to a nest site that is still active is considered discountable.
	Sept 24-March 31	NE	This time period is outside of the murrelets breeding season.
On-the-ground human	Apr 1 - Sept 4	LAA	Murrelets are susceptible to an increase in predation levels within an action area when groups of humans attract corvids.

Disturbance Type	Time Period[1]	Effects	Rationale for Effect Determination
presence (*i.e., all actions*)	September 5 – Sept 23	NLAA	This is the tail end of the nesting season when approximately 98 percent of all nests are estimated to have fledged. Therefore in WA, projects conducted September 5 – September 23 are not likely to adversely affect murrelets as the likelihood of exposure to a nest site that is still active is considered discountable.
	Sept 24-March 31	NLAA	This time period is outside of the murrelet breeding season.
In canopy human presence (*i.e., if needed to monitor adverse effects surveys*)	Apr 1 - Sept 4	LAA	Murrelets have been known to flush from a nest due to human presence in the tree canopy.
	September 5 – Sept 23	NLAA	This is the tail end of the nesting season when approximately 98 percent of all nests are estimated to have fledged. Therefore in WA, projects conducted September 5 – September 23 are not likely to adversely affect murrelets as the likelihood of exposure to a nest site that is still active is considered discountable.
	Sept 24-March 31	NE	This time period is outside of the murrelet breeding season.

[1] - All activities in the breeding season affecting murrelet habitat will have 2-hour timing restrictions applied.

Table 17. Summary of disturbance effects from the proposed action when active marbled murrelet nests are within the disruption distances of actions with the state of Oregon.

Disturbance Type	Time Period	Effects	Rationale for Effect Determination
Noise other than helicopters (*i.e., all actions except surveys*)	Apr 1 - Aug 5	LAA	Effects vary and may cause little to significant disruption depending on site- and activity-specific factors and the individual's noise tolerance. Worst-case scenario, adults move from noise, causing increased predation to young, missed feedings, or premature fledging. Most actions will not occur within 100 yards of active nests or likely occupied, unsurveyed habitat from Apr 1-Aug 5. For those that do, likelihood of injury to young will mostly occur through the potential increase of predation of abandoned young. However, predation likelihood is reduced by PDCs that are part of the proposed action (e.g., removal of project generated garbage to prevent attraction of corvids). Actions will seldom occur during crepuscular time periods, thereby significantly reducing the probability of missed feeding attempts. Based on anecdotal observations and limited studies, murrelets appear generally undisturbed by sharp or prolonged loud noise, and nesting attempts are not easily disrupted by human disturbance except when confronted very near the nest itself (Long and Ralph 1998, USFWS 2003e).
	Aug 6 – Sept 15	NLAA[1]	In this period nests have been established, most of incubation is complete and many young have fledged. Project design criteria in the proposed action require 2-hour timing restrictions, which will allow feedings of murrelet young to occur during crepuscular periods.
	Sept 16-March 31	NE	Based on nest fledging data this time period is past when most murrelets fledge.

Disturbance Type	Time Period	Effects	Rationale for Effect Determination
Noise and rotor wash associated with helicopters (*i.e., some culvert/bridge, nutrient enhancement, LW placement actions*).	Apr 1 – Aug 5	LAA	Noise effects vary and may cause little to significant disruption depending on site- and activity-specific factors and an individual's noise tolerance. Worst-case scenario, adults move from noise, causing increased predation to young, missed feedings, or premature fledging. Young, which are not capable of moving away from noise, may have injury form excessive noise levels. Most activities do not use helicopters, and most helicopter use will not occur within 0.25 miles of active nests or likely occupied, unsurveyed habitat from Apr 1-Sept 15. Helicopters will generally hover no closer than 300 feet from the ground and ferries logs at 500 feet for safety purposes. Also, helicopters will not hover within 500 feet of active nests. Activities will seldom occur during crepuscular time periods, thereby significantly reducing the probability of delayed feeding attempts. Helicopters passes over nests are less likely to cause injury than hovering in close proximity to nests. There is some indication that murrelets do not respond to airplanes and helicopters flying overhead unless they pass over at low altitude (Long and Ralph 1998). Prior murrelet studies involved circling/hovering over 125 nests for 3-min intervals within 100-300 m (328-984 feet), which did not flush any of the incubating adults (USFWS 2003e).
	Aug 6 – Sept 15	LAA	For young that have not fledged, the action could cause a chick to fall off a nest branch, prematurely fledge or may cause the chick injury form excessive noise levels or from being hit by flying debris.
	Sept 16- March 31	NE	Based on nest fledging data this time period is past when most murrelets fledge.
	Aug 6 – Sept 15	NLAA[1]	In this period nests have been established, most incubation is complete and many young have fledged. Project design criteria in the proposed action require 2-hour timing restrictions, which will allow feedings of murrelet young to occur during crepuscular periods.
	Sept 16- March 31	NE	Based on nest fledging data this time period is past when most murrelets fledge.
On-ground human	Apr 1– Aug5	LAA	Murrelets are susceptible to an increase in predation levels within an action area when groups of humans attract corvids.

Disturbance Type	Time Period	Effects	Rationale for Effect Determination
presence (*i.e., all actions*)	Aug 6-Sept 15	NLAA[1]	In this period nests have been established, most incubation is complete and many young have fledged. Project design criteria in the proposed action require 2-hour timing restrictions, which will allow feedings of murrelet young to occur during crepuscular periods.
	Sept 16-30	NLAA	Based on two hour daily timing restrictions, and that more marbled murrelets have finished nesting and have fledged as the season goes on, the risk of corvid predation is decreasing in this time period.
In canopy human presence (*i.e., if needed to monitor adverse effects surveys*)	Apr 1-Aug 5	LAA	Murrelets have been known to flush from a nest due to human presence in the tree canopy.
	Aug 6 – Sept 15	NLAA[1]	In this period nests have been established, most of incubation is completed and many young have fledged. Project design criteria in the proposed action require 2-hour timing restrictions, which will allow feedings of murrelet young to occur during crepuscular periods.
	Sept 16-March 31	NE	Based on nest fledging data this time period is past when most murrelets fledge.

NLAA[1] - The activity is NLAA because 2-hour timing restrictions will be applied.

The potential for large-scale disturbance is greatly reduced by the species specific conservation measures associated with the proposed action and as outlined in Appendix D of this document. The BPA and their project proponents will use disturbance and disruption guidelines listed in Tables 16 and 17 to determine whether projects are likely to adversely affect murrelets. Many activities will result in NE determinations for disturbance since agencies will implement most actions outside of nesting period windows and/or outside of disturbance distances from murrelet nests and unsurveyed suitable habitat. Additional activities will result in NLAA determinations for disturbance since BPA and their project proponents will implement some actions in the late nesting period with daily timing restrictions and outside of the disruption distance from murrelet nests and unsurveyed suitable habitat. The conservation measures for marbled murrelets proposed by BPA will ensure that most projects will not rise to the level of an LAA determination.

d. Effects at the Conservation Zone and Range-wide

It is likely that some nesting murrelets exposed to these disturbances will still nest successfully. We anticipate marbled murrelet nesting habitat in the action area will be subjected to noise and visual disturbance during implementation of the proposed action, and that all murrelets associated with occupied or unsurveyed nesting habitat would have a significant behavioral response to noise and visual disturbance that results in an increased likelihood of injury. Potential murrelet responses to disturbance include delay in or avoidance of nest establishment, flushing from a nest or branch within nesting habitat, aborted or delayed feeding of juveniles, or increased vigilance/alert behaviors at nest sites with implications for reduced individual fitness and reduced nesting success. These behavioral disruptions create a likelihood of injury by increasing the risk of predation, reduced fitness of nestlings as a result of missed feedings, and/or increased energetic costs to adults that must make additional foraging trips. We do not expect that noise and visual disturbance will result in actual nest failure, but acknowledge that disturbance creates a likelihood of injury that can indirectly result in nest failure due to predation or reduced fitness of some individuals. The proposed action incorporates a daily operating restriction that will avoid project activities during the murrelet’s daily peak activity periods during dawn and dusk hours. This daily restriction reduces but does not eliminate the potential for adverse disturbance effects or disrupted feeding attempts during mid-day hours.

We anticipate marbled murrelet nesting habitat in the action area (recovery zones 2, 3 and 4) will be subjected to the mechanical disruption from rotor wash (excessive wind) during implementation of the proposed action, and that all murrelets associated with occupied or unsurveyed nesting habitat subjected to rotor wash would have a significant behavioral response to these disturbances that results in an increased likelihood of injury. Potential murrelet responses to this disturbance includes being blown or shaken from the nest, which would result in death, or being injured from debris (i.e., a branch) being blown onto the chick at nest sites with implications for reduced individual fitness and reduced nesting success. Rotor wash has a small footprint and tree canopy cover may reduce actual impacts at a nest site. These behavioral disruptions create a likelihood of injury by increasing the risk of reduced fitness of nestlings as a result of physical injury from flying debris or being blown from the nest. We do expect that rotor wash disturbance will result in a likelihood of injury that can result in a reduced fitness of individuals.

The anticipated disruption of normal nesting behaviors will result in an increased likelihood of injury to murrelets nesting within those affected acres but is not reasonably certain to result in direct nest failures. The anticipated increased likelihood of injury is not anticipated to appreciably reduce murrelet numbers or reproduction at the scale of the action area or any larger scale because 1) most nests exposed to disturbance are not expected to fail given the variability of responses to noise, rotor wash and visual disturbance; and 2) no direct mortality of adult murrelets is anticipated, so there would be no reduction in the current population of breeding adults. Therefore, the Service believes the proposed project will not result in jeopardy for the marbled murrelet at the Conservation Zone or Range Wide scales.

6.4.1 Effects to Marbled Murrelet Critical Habitat

As the proposed projects are not likely to adversely affect marbled murrelet habitat or their critical habitat, the proposed projects will not affect the marbled murrelet critical habitat at the NWFP, Conservation Zones or range-wide scales.

7.0 Cumulative Effects

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

The contribution of non-Federal activities to the current condition of ESA-listed species and designated critical habitats within BPA's HIP III action area was described in the Status of the Species and sections, above. Among those activities were agriculture, forest management, mining, road construction, urbanization, water development, and river restoration. Those actions were driven by a combination of economic conditions that characterized traditional natural resource-based industries, general resource demands associated with settlement of local and regional population centers, and the efforts of social groups dedicated to the river restoration and use of natural amenities, such as cultural inspiration and recreational experiences.

Resource-based industries caused many long-lasting environmental changes that harmed ESA-listed species and their critical habitats, such as state-wide loss or degradation of stream channel morphology, spawning substrates, instream roughness and cover, estuarine rearing habitats, wetlands, riparian areas, water quality (*e.g.*, temperature, sediment, dissolved oxygen, contaminants), fish passage, and habitat refugia. Those changes reduced the ability of populations of ESA-listed species to sustain themselves in the natural environment by altering or interfering with their behavior in ways that reduce their survival throughout their life cycle. The environmental changes also reduced the quality and function of critical habitat PCEs. Without those features, species cannot successfully produce offspring. As noted above, however, the declining level of resource-based industrial activity and rapidly rising industry standards for resource protection are likely to reduce the intensity and severity of those impacts in the future.

The economic and environmental significance of natural resource-based economy is currently declining in absolute terms and relative to a newer economy based on mixed manufacturing and marketing with an emphasis on high technology (Brown 2011). Nonetheless, resource-based industries are likely to continue to have an influence on environmental conditions within the program-action area for the indefinite future. However, over time those industries have adopted management practices that avoid or reduce many of their most harmful impacts, as is evidenced by the extensive conservation measures included with the proposed action, but which were unknown or in uncommon use until even a few years ago.

While natural resource extraction within Oregon may be declining, general resource demands are increasing with growth in the size and standard of living of the local and regional human population. The percentage increase in population growth may provide the best estimate of general resource demands because as local human populations grow, so does the overall consumption of local and regional natural resources. Between April 2010 and July 2011, the population of Oregon and Idaho both grew by 1.1% and the population of Washington State grew by 1.6%.[31] The population is expected to continue to grow at a similar rate. We assume that private and state actions that have routinely occurred in the past will continue within the action area, increasing as population rises.

Similarly, demand for cultural and aesthetic amenities continues to grow with human population, and is reflected in decades of concentrated effort by Tribes, states, and local communities to restore an environment that supports flourishing wildlife populations, including populations of species that are now ESA-listed (CRITFC 1995; NWPCC 2012). Reduced economic dependence on traditional resource-based industries has been associated with growing public appreciation for the economic benefits of habitat restoration, and growing demand for the cultural amenities that restoration provides. Thus, many non-Federal actions have become responsive to the recovery needs of ESA-listed species. Those actions included efforts to ensure that resource-based industries adopt improved practices to avoid, minimize, or offset their adverse impacts. Similarly, many actions focused on completion of river restoration projects specifically designed to broadly reverse the major factors now limiting the survival of ESA-listed species at all stages of their life cycle. For aquatic species, those actions have improved the availability and quality of estuarine and nearshore habitats, floodplain connectivity, channel structure and complexity, riparian areas and large wood recruitment, stream substrates, stream flow, water quality, and fish passage. In this way, the goal of ESA-species recovery has become institutionalized as a common and accepted part of the State's economic and environmental culture. We expect this

[31] http://quickfacts.census.gov/qfd/states/16000.html, accessed December 18, 2012.

trend to continue into the future as awareness of environmental and at-risk species issues increases among the general public.

It is not possible to predict the future intensity of specific non-Federal actions related to resource-based industries at this program scale due to uncertainties about the economy, funding levels for restoration actions, and individual investment decisions. However, the adverse effects of resource-based industries in the action area are likely to continue in the future, although their net adverse effect is likely to decline slowly as beneficial effects spread from the adoption of industry-wide standards for more protective management practices. These effects, both negative and positive, will be expressed most strongly in rural areas where these industries occur, and therefore somewhat in contrast to human population density. The future effects of habitat restoration are also unpredictable for the same reasons, but their net beneficial effects may grow with the increased sophistication and size of projects completed and the additive effects of completing multiple projects in some watersheds.

In summary, resource-based activities such as timber harvest, agriculture, mining, shipping, and energy development are likely to continue to exert an influence on the quality of freshwater and estuarine habitat in the action area. The intensity of this influence is difficult to predict and is dependent on many social and economic factors. However, the adoption of industry-wide standards to reduce environmental impacts and the shift away from resource extraction to a mixed manufacturing and technology based economy should result in a gradual decrease in influence over time. In contrast, the populations of Oregon, Washington and Idaho are expected to increase in the next several decades with a corresponding increase in natural resource consumption. Additional residential and commercial development and a general increase in human activities are expected to cause localized degradation of habitat valuable for native fish and wildlife. Interest in restoration activities is also increasing as is environmental awareness among the public. This will lead to localized improvements to fish and wildlife habitat. When these influences are considered collectively, we expect trends in habitat quality to remain flat or improve gradually over time. This will, at best, have positive influence on population abundance and productivity for the species affected by this consultation. In a worst cases scenario, we expect cumulative effects would have a relatively neutral effect on population abundance trends. Similarly, we expect the quality and function of critical habitat PCEs or physical and biological features to express a slightly positive to neutral trend over time as a result of the cumulative effects.

8.0 Conclusions

After reviewing the status of the listed species addressed by this BO**,** the status of their designated critical habitats, the environmental baseline for the action areas, the effects of the proposed actions, and cumulative effects, we determine that the proposed program of restoration actions is not likely to jeopardize the continued existence of bull trout, Oregon chub or marbled murrelet and is not likely to adversely modify or destroy critical habitat for any of these three species.

The no jeopardy, no adverse modification or destruction finding for bull trout, Oregon chub, and marbled murrelet is supported by the following:

Bull Trout:

1. The primary objective of the proposed action is restoration of habitat for aquatic and terrestrial species. The majority of work that will occur under the proposed action will have immediate and long term benefits for aquatic and terrestrial species. A limited number of projects may cause short-term adverse effects to individuals but not at the local population, core area or interim recovery unit scale.

2. Bull trout specific conservation measures such as working within inwater work windows and coordination with FWS personnel when working in bull trout spawning and juvenile rearing areas will significantly limit the likelihood of harm to individuals.

Oregon Chub:

1. The primary objective of the proposed action is restoration of habitat for aquatic and terrestrial species. The majority of work that will occur under the proposed action will have immediate and long term benefits for aquatic and terrestrial species. A limited number of projects may cause short-term adverse effects to individuals but not at population, subbasin or range-wide scale.

2. Conservation measures have been designed to minimize or avoid adverse effects to Oregon chub and its critical habitat.

3. Harm and/or mortality of Oregon chub individuals associated with survey, capture, and habitat restoration projects is expected to be very low.

4. Habitat restoration projects in the vicinity of Oregon chub will occur outside of the spawning window for Oregon chub.

5. Given the history of projects funded under BPA's HIP I and II programs, we anticipate very few projects will occur in the vicinity of Oregon chub habitats.

Marbled Murrelet:

1. Adverse affects to murrelets will be limited to disturbance only; no adverse affects to habitat will be permitted under this programmatic BO.

2. Only a limited number of disturbance impacts are permitted annually during the nesting season within marbled murrelet recovery zones 2, 3 and 4.

3. Most nests exposed to disturbance are not expected to fail given the variability of responses to noise, rotor wash and visual disturbance.

4. No direct mortality of adult murrelets is anticipated, so there would be no reduction in the current population of breeding adults.

5. The HIP III action area only encompasses a very small geographic area of recovery zone 2 and zone 4, thus adverse affects will generally be limited to only one of the six recovery zones (zone 3 – Oregon coast).

9.0 Incidental Take Statement

Section 9(a) (1) of the ESA prohibits the taking of endangered species without a specific permit or exemption. Protective regulations adopted pursuant to section 4(d) extend the prohibition to threatened species. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the Service as an act which 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 (50 CFR 17.3). Harass is further defined by the Service as an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering (50 CFR 17.3).

Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the Terms and Conditions of this incidental take statement (ITS). Among other things, an action that harasses, wounds, or kills an individual of a listed species or harms a species by altering habitat in a way that significantly impairs its essential behavioral patterns is a taking (50 CFR 222.102). Incidental take refers to takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Section 7(o) (2) exempts any taking that meets the terms and conditions of a written ITS from the taking prohibition.

9.1 Amount or Extent of Take

9.1.1 Bull Trout

Any of the nine proposed restoration categories may result in short-term adverse impacts to bull trout, mainly from water quality changes (suspended sediment, temperature, dissolved oxygen, contaminants and chemical herbicides) and effects from in-stream construction, worksite isolation and associated fish handling. Depending on the species, project location, and timing, there is a varying likelihood of species presence, and thus exposure.

Take caused by the habitat-related effects of this action cannot be accurately quantified as a number of fish because the distribution and abundance of fish that occur within the action area are affected by habitat quality, competition, predation, and the interaction of processes that influence genetic, population, and environmental characteristics. These biotic and environmental processes interact in ways that may be random or directional and operate across far broader temporal and spatial scales than will be affected by the proposed action. Thus, the distribution and abundance of fish within the action area cannot be predicted precisely based on existing habitat conditions, nor can we precisely predict the number of fish that are reasonably certain to be harmed or harassed if their habitat is modified or degraded by the proposed action. In such circumstances we use the causal link established between the activity and the likely changes in habitat conditions affecting the listed species to describe the extent of take as a numerical level of habitat disturbance.

Short-term impacts to water quality (suspended sediment, temperature, etc.) and physical habitat features. Here, the best available indicators for the extent of incidental take associated with short-term impacts to water quality and physical habitat features are as follows:

1. The total length of stream reach that will be modified by construction each year.
2. The visible increase in suspended sediment associated with construction activities.

These variables are proportional to the amounts of harm and harassment that the proposed action is likely to cause through degradation of water quality or physical habitat. Suspended sediment is proportional to the water quality impairment that the proposed action will cause, including increased sediment, temperature, and contaminants, and reduced dissolved oxygen. Stream length is proportional to the amount of habitat that will be physically altered, including natural cover, floodplain connectivity, riparian vegetation, forage and safe passage conditions.

NMFS' HIP III BO (NMFS 2013) assumed up to 150 projects per year may be funded or carried out under BPA's HIP III programmatic per year based on the BA and information from the HIP I and II consultations between BPA and NMFS. For the purposes of our analysis, and for consistency between our HIP III BO and NMFS', we will assume the same. Based on previous implementation of BPA's HIP, at most half of these projects (n=75) will involve near or in-water work. The proposed action may be much localized (e.g., culvert replacement) or much larger in scope (e.g., channel reconstruction). Because we do not want to limit the scope of large, beneficial restoration projects, the extent of take is best identified by the maximum number of projects requiring near and in-water construction in any given year. Therefore, implementation of more than 90 projects per year (i.e., 15 projects more than the expected 75 projects per year with in-water work) that include near or in-water construction is a threshold for reinitiating consultation.

In addition, we assume that an increase in sediment will be visible in the immediate vicinity of construction associated with the proposed action as well as a distance downstream, and the distance that sediment will be visible is proportionate both to the size of the disturbance and to the width of the wetted stream as follows (see Rosetta 2005), and whether the area is subject to tidal or coastal scour. Therefore, a further threshold for reinitiating consultation is a visible increase in suspended sediment:

1. up to 50 feet from the project area in streams that are 30 feet wide or less;
2. up to 100 feet from the discharge point or nonpoint source of runoff for streams between 30 and 100 feet wide;
3. up to 200 feet from the discharge point or nonpoint source for streams greater than 100 feet wide; and
4. up to 300 feet from the discharge point or nonpoint source for areas subject to tidal or coastal scour.

If an exceedance of either the total linear stream feet limit or suspended sediment limits occurs, the project sponsor must modify the activity and continue to monitor every two hours. If an exceedance over the background level continues after the second monitoring interval, the activity must stop until the turbidity levels return to background.

Short-term water quality impacts from chemical herbicide application. Application of chemical herbicides will result in short-term degradation of water quality which will cause injury to fish in the form of sublethal adverse physiological effects. This is particularly true for herbicide applications in riparian areas or in ditches that may deliver herbicides to stream occupied by listed salmonids. These sublethal effects, described fully in the effects analysis for this opinion, will include increased respiration, reduced feeding success, and subtle behavioral changes that can result in increased susceptibility to predation. The future abundance and distribution of listed fish in relation to the effects of herbicide applications within HIP III is indeterminate and so a specific number of individuals taken cannot be predicted. For herbicide application, the extent of take is best identified by the total number of riparian acres treated each year. The BPA shall reinitiate consultation if more than 1,000 total riparian acres are treated in a calendar year under this programmatic consultation.

Fish Capture

Given the general locations of projects implemented under BPA's HIP program from 2003 to 2012, we estimate that 50 of the estimated 75 near or in-stream projects implemented annually under HIP III could occur within the range of the bull trout (SR or FMO habitat). While we expect the majority of ESA-listed fish captured as part of these projects would be salmon and steelhead, a portion of these fish are likely to be bull trout.

In the absence of empirical data, and for programmatic assessments where there is uncertainty as to where projects will be implemented across the action area, we often rely on professional judgment to develop formulas that help predict the likelihood of a listed species occurrence and rate of occurrence within a project area. Given that bull trout are an apex predator and generally persist in much lower abundance than other sympatric salmonids such as salmon, steelhead and other species of trout, we believe bull trout would comprise a relatively low percentage of the overall catch of salmonids within a given project area; probably somewhere between three and four percent for migratory populations, although there will be wide variation between project locations. Areas where resident bull trout populations exist may comprise a slightly higher proportion of the overall number of salmonids, somewhere near ten percent or possibly higher in some cases. While the overall percentage of bull trout to other salmonids may increase in SR habitat during summer and fall, the converse is true for FMO habitats during this time period because of warmer water temperatures and generally poorer water quality. Because the ratio of bull trout to other salmonids varies considerably across their range, and to err conservatively, we will estimate a ratio of bull trout to salmon and steelhead of .05 to 1 (i.e., bull trout are estimated to comprise on average five percent of all salmonids captured during isolation and capture efforts). Therefore based on NMFS' anticipated capture of 100 salmon and steelhead per in-stream project as described previously, we anticipate an average capture of five bull trout for each project within the range of bull trout where isolation and dewatering could be required. Based on information presented in the Effects section, we anticipate injury or mortality to five percent of the fish that are captured and released, with the remainder (95 percent) likely to survive with no long-term adverse effects. Data presented in the Effects section suggests that the injury/mortality number is more likely around two percent for fish captured and handled. Nonetheless, we are choosing to err on the side of caution and use the more conservative five percent figure. Thus, we anticipate up to 250 individual bull trout will be captured on average per year (estimated 50 in-stream projects within the range of bull trout x 5 bull trout per project on average) of which an estimated 13 individuals (.05 percent x 250 fish) will be injured or killed per year as a result of fish capture necessary to isolate in-water construction areas.

Overall, the effects of work area isolation on the abundance of bull trout in the Columbia River IRU are likely to be small. Almost all of these fish are anticipated to be juveniles, but a small number of adults could possibly be captured. For utility of operation we will not distinguish between take of juveniles and take of adults but will assume that most (95-99%) of the capture would be juveniles. Adult equivalents are discussed to show the likely effect to the overall Columbia River IRU population. These adult equivalents represent the effect the number of fish killed or injured (assuming these were all juveniles) would have on the adult population. As noted previously, we anticipate that few if any adult bull trout will be captured thus the threshold for reinitiating consultation is 250 bull trout juveniles captured and 13 injured or killed per calendar year under the HIP III proposed action.

9.1.2 Oregon Chub

Take Incidental to In-Water Work-Site Isolation

Oregon chub, in previously unknown populations, may be captured during in-water work-site isolation. Due to the wide variation in population abundance, we are unable to estimate the number of Oregon chub that could potentially be encountered. However, pre-project sampling efforts should reduce the potential that chub will be found unexpectedly during in-water work-site isolation. Therefore, we anticipate incidental take, due to capture, of no more than 150 Oregon chub. We anticipate that fewer than 5 percent (maximum of 8 individuals) of captured

Oregon chub may be injured or killed on an annual basis during capture or handling. We anticipate that all captured Oregon chub may be harassed.

Take Incidental to In-Water Construction Projects

The Service anticipates incidental take of Oregon chub due to effects downstream of in-water construction projects will be difficult to detect due to their small body size and because finding a dead or impaired specimen is unlikely. Instead we will use habitat area as a surrogate for Oregon chub. We estimate that up to a 30 percent reduction in one habitat (e.g. reduced water volume causing desiccation of vegetation used for spawning habitat, sedimentation reducing habitat area, increased flows resulting in habitat becoming unsuitable for chub) may occur annually as a result of these activities. Depending on the size of the remaining area of habitat, this may cause a decrease in the affected Oregon chub population.

9.1.3 Marbled Murrelet

Take of marbled murrelets will occur from disruption related to HIP III project activities within the action area. In the Columbia River Basin portion of the marbled murrelet's recovery Zone 2 (Washington Coast Range Zone) and the Oregon portion of Zone 4 (Siskiyou Coast Range Zone) between Cape Blanco to the south and the northern boundary of Zone 4 (North Bend, Coos County), we anticipate up to 2 nest may be disrupted per year in each zone with no five-year period exceeding disruption of more than 10 nest per zone. In zone 3 (Oregon Coast Range zone) we anticipate up to 5 nest may be disrupted per year, with no five-year period exceeding disruption of more than 25 nest.

This will result in the harassment (reduced fitness or greater risk of predation through disrupting normal behavioral patterns) of up to 45 marbled murrelets per five-year period in recovery zones 2, 3, and 4 under this programmatic BO.

9.2 Effect of Take

In the accompanying BO, we determined that this level of anticipated take is not likely to result in jeopardy to bull trout, Oregon chub or marbled murrelet, or result in the destruction or adverse modification of critical habitat for these species.

9.3 Reasonable and Prudent Measures and Terms and Conditions

"Reasonable and prudent measures" are nondiscretionary measures to minimize the amount or extent of incidental take (50 CFR 402.02). "Terms and conditions" implement the reasonable and prudent measures (50 CFR 402.14). These terms and conditions must be implemented for the exemption in section 7(o)(2) to apply.
The BPA shall:

1. Ensure completion of a comprehensive monitoring and reporting program regarding all actions funded or carried out by BPA under this programmatic biological opinion.

The measures described below are non-discretionary, and must be undertaken by BPA or, if an applicant is involved, must become binding conditions of any funding provided to the applicant, for the exemption in section 7(o)(2) to apply. BPA has a continuing duty to regulate the activity covered by this incidental take statement. If BPA (1) fails to assume and implement the terms and conditions or (2) fails to require an applicant to adhere to the terms and conditions of the incidental take statement through funding conditions, the protective coverage of section 7(o)(2) may lapse. To monitor the impact of incidental take, BPA must report the progress of the action and its impact on the species considered in this BO to USFWS as specified in the incidental take statement.

1. To implement reasonable and prudent measure #1 (monitoring and reporting), BPA shall:
    a. Submit a monitoring report to USFWS by April 15 each year that describes BPA's efforts to carry out this opinion. The report will include an assessment of overall program activity, a map showing the location and type of each action funded or carried out under this opinion, compliance with the biological opinion, and any other data or analyses BPA deems necessary or helpful to assess habitat trends as a result of actions completed under this opinion.
    b. BPA will host an annual coordination meeting with USFWS and NMFS by April 15 each year to discuss the annual monitoring report, compliance with the Service's biological opinion, and any actions that will improve conservation under this opinion, or make the program more efficient or accountable.

10.0 Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02). The following conservation recommendations are discretionary measures that USFWS believes is consistent with this obligation and therefore should be carried out by the Federal action agency:

The USFWS recommends that BPA and their project sponsors consider biological needs of lamprey spp. whenever they plan or conduct any instream or near-stream projects. An effort to follow all recommendations found in Best Management Practices to minimize adverse effect to Pacific Lamprey http://www.fws.gov/columbiariver/publications/BMP_Lamprey_2010.pdf will improve habitat conditions for all native fish, and may aid in the recovery of ESA-listed fish within the action area.

11.0 Reinitiation of Consultation

As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal action agency involvement or control over the action has been retained, or is authorized by law, and if: (1) The amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action on listed species or designated critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect on the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action.

If monitoring and reporting are not done in accordance with the description of the proposed action, the BPA needs to reinitiate formal consultation in accordance with the requirements of 402.16(c). Failure to adequately monitor and report constitutes a change in the proposed action that may facilitate effects to listed species or critical habitat that were not considered in the BO. To reinitiate consultation, contact the Oregon Fish and Wildlife Office of the USFWS and refer to Reference Number 01EOFW00-2013-F-0199.

12.0 Literature Cited

Ainley, D.G., S.G. Allen, and L.B, Spear. 1995. Offshore occurrence patterns of marbled murrelets in central California. Pages 361-369 in C.J. Ralph, G.L. Hunt, M.G. Raphael, and J.F. Piatt (eds.). Ecology and Conservation of the Marbled Murrelet. General Technical Report. PSW-GTR-152. Pacific Southwest Experimental Station, U.S. Forest Service, Albany, California. 420 pp.

Almack, J.A., W.L. Gaines, P.H. Morrison, J.R. Eby, R.H. Naney, G.F. Wooten, M.C. Snyder, S.H. Fitkin, and E.R. Garcia. 1993. North Cascades Grizzly Bear Ecosystem Evaluation: Final Report. Interagency Grizzly Bear Committee, Denver, CO.

Almack, J.A. and S.H. Fitkin. 1998. Grizzly bear and gray wolf investigations in Washington State 1994-1995. Final Progress Report. Washington Dept. of Fish and Wildlife, Olympia, WA. 80 pp.

Amsberry, K. 2001. Pers. comm. Oregon Department of Agriculture, Corvallis, Oregon.

Amsberry K. and R.J. Meinke. 2002. Reproductive Ecology of *Fritillaria gentneri*. Report from Oregon Department of Agriculture. Portland (OR): US Fish and Wildlife Service. 41 p.

Amsberry, K. 2012. Pers. comm. Oregon Department of Agriculture, Corvallis, Oregon.

Apps, C.D. 2000. Space-use diet, demographics, and topographic associations of lynx in the Southern Canadian Rocky Mountains: a study. Pages 351-371 *In*: Ruggerio et al Ecology and conservation of lynx in the United States. GTR-30WWW University Press of Colorado and the USDA, Rocky Mountain Research Station. 480 pp.

Archibald, W.R., R. Ellis, and A.N. Hamilton. 1987. Responses of grizzly bears to logging truck traffic in the Kimsquit River valley, British Columbia. International Conference on Bear Research and Management 7:251-257.

Audet, Suzanne. 2002. Pers. Comm. Wildlife Biologist, USDI Fish and Wildlife Service, Spokane, WA.

Bangs, B.L., P.D.Scheerer, S. Clements. 2012. Oregon chub investigations. Oregon Department of Fish and Wildlife Annual Progress Report. Oregon Department of Fish and Wildlife, Salem, Oregon. 23 pp. plus appendices.

Batt, P.E. 1996. State of Idaho bull trout conservation plan. Office of the Governor, Boise, ID. 20pp.

Battin, J., M.W. Wiley, M.H. Ruckelshaus, R.N. Palmer, E. Korb, K.K. Bartz, and H. Imaki. 2007. Projected impacts of climate change on salmon habitat restoration. Proceedings of the National Academy of Sciences of the United States of America.

Baxter, J.S., E.B. Taylor, R.H. Devlin, J. Hagen and J.D. McPhail. 1997. Evidence for natural hybridization between Dolly Varden (Salvelinus malma) and bull trout (S. confluentus) in a northcentral British Columbia watershed. Canadian Journal of Fisheries and Aquatic Sciences 54:421-429.

Baxter, C.V. 2002. Fish Movement and Assemblage Dynamics in a Pacific Northwest Riverscape. Ph.D. Dissertation, Oregon State University, Corvallis, OR. 174 pp.

Beauchamp, D.A. and J.J. VanTassell. 2001. Modeling seasonal trophic interactions of adfluvial bull trout in Lake Billy Chinook, Oregon. Transactions of the American Fisheries Society 130:204-16.

Becker, B.H. 2001. Effects of oceanographic variation on marbled murrelet diet and habitat selection. Ph.D. dissertation, University of California, Berkeley, California.

Becker, B.H., and S.R. Beissinger. 2006. Centennial decline in the trophic level of an endangered seabird after fisheries decline. Conservation Biology 20(2):470-479.

Becker, B.H., M.Z. Peery, and S.R. Beissinger. 2007. Ocean climate and prey availability affect the trophic level and reproductive success of the marbled murrelet, an endangered seabird. Marine Ecology Progress Series 329:267-279.

Beechie, T. J. and T. H. Sibley. 1997. Relationships between channel characteristics, woody debris, and fish habitat in northwestern Washington streams. Transactions of the American Fisheries Society 126: 217-229.

Behnke, R. J. & D. E. Benson, 1980. Endangered and threatened fishes of the upper Colorado River Basin. Colorado State University Cooperative Extension Service Bulletin 503A, Fort Collins, Colorado, USA

Beissinger, S.R. 1995. Population trends of the marbled murrelet projected from demographic analyses. Pp. 385-393 In: Ecology and conservation of the marbled murrelet (C.J. Ralph, G.L. Hunt, M.G. Raphael and J. F. Piatt, editors). Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture, Albany, CA.

Beissinger, S.R., and M.Z. Peery. 2003. Range-wide analysis of juvenile ratios from marbled murrelet monitoring programs: implications for demographic analyses. Unpublished report, University of California, Dept. of Environmental Science, Policy, and Management, Berkeley, California.

Beissinger, S.R., and M.Z. Peery. 2007. Reconstructing the historic demography of an endangered seabird. Ecology 88(2):296-305.

Bell, M.C. 1991. Fisheries handbook of Engineering requirements and biological criteria. Fish Passage Development and Evaluation Program. U.S. Army Corps of Engineers, North Pacific Division.

Berg, L., and T.G. Northcote. 1985. AChanges In Territorial, Gill-Flaring, and Feeding Behavior in Juvenile Coho Salmon (Oncorhynchus kisutch) Following Short-Term Pulses of Suspended Sediment.@ Canadian Journal of Fisheries and Aquatic Sciences 42:1410-1417.

Berg, R. K. and E. K. Priest. 1995. Appendix Table 1: A list of stream and lake fishery surveys conducted by U.S. Forest Service and Montana Fish, Wildlife and Parks fishery biologists in the Clark Fork River drainage upstream of the confluence of the Flathead River the 1950's to the present. Montana Fish, Wildlife, and Parks, Job Progress Report, Project F-78-R-1, Helena, Montana.

Beschta, R.L., R.E. Bilby, G.W. Brown, L.B. Holtby, and T.D. Hofstra. 1987. Stream temperature and aquatic habitat: fisheries and forestry interactions. Pages 191-232 in E.D. Salo and T.W. Cundy (eds). Streamside Management Forestry and Fisheries Interactions. Institute of Forest Resources, University of Washington, Seattle, Washington, Contribution No. 57.

Bilby, R. E., and J. W. Ward. 1989. Changes in characteristics and function of woody debris with increasing size of streams in western Washington. Transactions of the American Fisheries Society 118:368–378.

Bisson, P.A., B.E. Rieman, C. Luce, P.F. Hessburg, D.C. Lee, J.L. Kershner, G.H. Reeves, and R.E. Gresswell. In Press. Fire and aquatic ecosystems of the western USA: Current knowledge and key questions. Forest Ecology and Management.

Bjornn, T.C., and D.W. Reiser. 1991. Habitat requirements of salmonids in streams. Pages 83-138 in: W.R. Meehan, editor. Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication 19.

Bloxton, T.D., and M.G. Raphael. 2005. Breeding ecology of the marbled murrelet in Washington State: 2004 Season Summary, A report to the U.S. Fish and Wildlife Service, Western Washington Fish and Wildlife Office, Lacey, Washington; Pacific Northwest Research Station, U.S. Forest Service, Olympia, Washington. 14 pp.

Bloxton, T.D., and M.G. Raphael. 2006. At-sea movements of radio-tagged marbled murrelets in Washington. Northwestern Naturalist 87(2):162-162.

Boag, T.D. 1987. Food habits of bull char (Salvelinus confluentus), and rainbow trout (Salmo gairdneri), coexisting in a foothills stream in northern Alberta. Canadian Field-Naturalist 101(1):56-62.

Bond, C.E. 1992. Notes on the nomenclature and distribution of the bull trout and the effects of human activity on the species. Pages 1-4 in P.J . Howell, and D.V. Buchanan, eds. Proceedings of the Gearhart Mountain bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis, Oregon.

Bonneau, J.L., and D.L. Scarnecchia. 1996. Distribution of juvenile bull trout in a thermal gradient of a plunge pool in Granite Creek, Idaho. Transactions of the American Fisheries Society 125:628-630.

Bradley, R.W. 2002. Breeding ecology of radio-marked marbled murrelets (Brachyramphus marmoratus) in Desolation Sound, British Columbia. Department of Biological Sciences. Burnaby, BC, Simon Fraser University, 86 pp.

Bradley, R.W., F. Cooke, L.W. Lougheed, and W.S. Boyd. 2004. Inferring breeding success through radiotelemetry in the marbled murrelet. Journal of Wildlife Management 68(2):318-331.

Brenkman, S.J. and S.C. Corbett. 2005. Extent of Anadromy in Bull Trout and Implications for Conservation of a Threatened Species. North American Journal of Fisheries Management. 25:1073–1081.

Brewin, P.A., M.K. Brewin, and M. Monita. 1997. Distribution maps for bull trout in Alberta. Pages 206-216 in W.C. Mackay, M.K. Brewin, and M. Monita (eds). Friends of the Bull Trout Conference Proceedings. Bull Trout Task Force (Alberta), c/o Trout Unlimited Calgary, Alberta, Canada.

Brown, L.G. 1994. The zoogeography and life history of Washington native charr. Report # 94-04. Washington Department of Fish and Widlife, Fisheries Management Division, Olympia, WA, November, 1992, 47 pp.

Buchanan, D.V., M.L. Hanson, and R.M. Hooton. 1997. Status of Oregon's bull trout, distribution, life history, limiting factors, management considerations, and status. Report to Bonneville Power Administration. Contract No. 1994BI34342, Project No. 199505400 (BPA Report DOE/BP-34342-5). Oregon Department of Fish and Wildlife, Portland, OR. 185pp.

Buchanan, D.M., and S.V. Gregory. 1997. Development of water temperature standards to protect and restore habitat for bull trout and other cold water species in Oregon. Pages 1-8 in W.C. Mackay, M.K. Brewin and M. Monita (eds). Friends of the Bull Trout Conference Proceedings. Bull Trout Task Force(Alberta), c/o Trout Unlimited Calgary, Alberta, Canada.

Burger, A.E. 1995. Marine distribution, abundance, and habitats of marbled murrelets in British Columbia. Pp. 295-312 In: Ecology and conservation of the marbled murrelet (Ralph, C.J., G.L. Hunt, Jr., M.G. Raphael, and J.F. Piatt, eds.). U.S. Forest Service, General Technical Report PSW-GTR-152, Pacific Southwest Research Station, Albany, California.

Burger, A.E. 2001. Using radar to estimate populations and assess habitat associations of marbled murrelets. Journal of Wildlife Management 65:696-715.

Burger, A.E. 2002. Conservation assessment of marbled murrelets in British Columbia, a review of biology, populations, habitat associations and conservation. Pacific and Yukon Region, Canadian Wildlife Service. 168 pages.

Burkett, E.E. 1995. Marbled murrelet food habits and prey ecology. Pages 223-246 in C.J. Ralph, G.L. Hunt, M.G. Raphael, and J.F. Piatt (eds.). Ecology and conservation of the marbled murrelet. General Technical Report. PSW-GTW-152. Pacific Southwest Experimental Station, U.S. Forest Service, Albany, California. 420 pp.

Burkey, T.V. 1989. Extinction in nature reserves: the effect of fragmentation and the importance of migration between reserve fragments. Oikos 55:75-81.

Burkey, T.V. 1995. Extinction rates in archipelagoes: Implications for populations in fragmented habitats. Conservation Biology 9: 527-541.

Cam, E., L.W. Lougheed, R.W. Bradley, and F. Cooke. 2003. Demographic assessment of a marbled murrelet population from capture-recapture data. Conservation Biology 17(4):1118-1126.

Cannon, K. 2012. Email from Ken Cannon, Oregon Department of Transportation transmitting ODOT 2012 Fish Salvage Report. Personal Communication to Marc Liverman, National Marine Fisheries Service. February 4, 2012.

Carlson, J. Y., C. W. Andrus, and H. A. Froehlich. 1990. Woody debris, channel features, and macroinvertebrates of streams with logged and undisturbed riparian timber in northeastern Oregon, USA. Canadian Journal of Fisheries and Aquatic Sciences. 47:1103–1111.

Carter, H.R., and S.G. Sealy. 1986. Year-round use of coastal lakes by marbled murrelets. Condor 88:473-477.

Carter, H.R., and S.G. Sealy. 1990. Daily foraging behavior of marbled murrelets. Studies in Avian Biology 14:93-102.

Carter, H.R., and R.A. Erickson. 1992. Status and conservation of the marbled murrelet in California, 1892-k1987. In: H.R. Carter and M.L. Morrison (eds). Status and conservation of the marbled murrelet in North America. Proceedings of the Western Foundation for Vertebrate Zoology 5.

Cavender, T.M. 1978. Taxonomy and distribution of the bull trout, Salvelinus confluentus (Suckley), from the American northwest. California Fish and Game 64: 139-174.

CCR (Crescent Coastal Research). 2008. Population and productivity monitoring of marbled murrelets in Oregon during 2008, Final Report to USFWS Oregon State Office, Portland, Oregon. December 2008. 13 pp.

CCR (Crescent Coastal Research). 2012. Marbled murrelet productivity measures at sea in northern California during 2011: an assessment relative to Redwood National and State Park lands. Final annual report to USFWS Arcata Fish and Wildlife Office, Arcata, California. February 2012. 18 pp.

Cederholm, C.J., L.G. Dominguez, and T.W. Bumstead. 1997. Rehabilitating stream channels and fish habitat using large woody debris. Chapter 8 In: Slaney, P.A. and D. Zaldokas (editors). 1997. Fish Habitat Rehabilitation Procedures. Watershed Restoration Technical Circular No. 9. British Columbia Ministry of Environment, Lands and Parks. Vancouver, British Columbia.

Chamberlain, T. W., R. D. Harr, and F. H. Everest. 1991. Timber harvesting, silviculture and watershed processes. Pages 181-205 in W. R. Meehan (ed). Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication 19.

Chen, J, J.F. Franklin, and T.A. Spies. 1993. Contrasting microclimates among clearcut, edge and interior old-growth Douglas fir forest. Agric. and For. Meteorology 63:219-237.

Ciarniello, L.M., M.S. Boyce, D.C. Heard, and D.R. Seip. 2005. Denning behavior and den site selection of grizzly bears along the Parsnip River, British Columbia, Canada. Ursus 16:47–58.

Ciarniello, L.M., Boyce, M.S., Seip, D.R. & Heard, D.C. 2007. Grizzly bear habitat selection is scale dependent. Ecological Applications, 17, 1424–1440

Claar, J., N. Anderson, D. Boyd, M. Cherry, B. Conard, R. Hompesch, S. Miller, G. Olson, H. Ihsle Pac, J. Waller, T. Wittinger, and H. Youmans. 1999. Carnivores. Pages 7.1-7.63 in Joslin, G. and H. Youmans, coordinators. Effects of Recreation on Rocky Mountain Wildlife: A Review for Montana. Committee of Effects of Recreation and Wildlife. Montana Chapter of the Wildlife Society.Claar 1999

CLI (Climate Leadership Initiative) and NCCSP (National Center for Conservation Science and Policy). 2009. Preparing for climate change in the Upper Willamette River Basin of western Oregon: Co-Beneficial Planning for Communities and Ecosystems. Unpublished report. 47 pp.

Available at http://www.nccsp.org/files/climate-change/Upper Willamette Basin Report 3-24-09 FINAL.pdf

Compton, J. E., C. P. Andersen, D. L. Phillips, J. R. Brooks, M. G. Johnson, M. R. Church, W. E. Hogsett, M. A. Cairns, P. T. Rygiewicz, B. C. McComb and C. D. Shaff. 2006. Ecological and water quality consequences of nutrient addition for salmon restoration in the Pacific Northwest. Frontiers in Ecology and the Environment 4(1):18-26.

Conley, J.M. 1993. Bull trout management plan. Idaho Department of Fish and Game, Boise. April 1993.

Costello, A.B., T.E. Down, S.M. Pollard, C.J. Pacas, and E.B. Taylor. 2003. The influence of history and contemporary stream hydrology on the evolution of genetic diversity within species: an examination of microsatellite DNA variation in bull trout, Salvelinus confluentus (Pisces: Salmonidae). Evolution. 57(2):328-344.

Craig, S.D., and R.C. Wissmar. 1993. Habitat conditions influencing a remnant bull trout spawning population, Gold Creek, Washington (draft report). Fisheries Research Institute, University of Washington. Seattle, Washington.

Cramer, S.P., C.F. Willis, D. Cramer, M. Smith, T. Downey, and R. Montagne. 1996. Status of Willamette River spring Chinook salmon in regards to the federal endangered species act. Prepared for Portland General Electric and Eugene Water & Electric Board. Submitted to National Marine Fisheries Service.

Cramer, S.P. and nine others. 1997. Synthesis and analysis of the lower Columbia River steelhead initiative. Contract report, S.P. Cramer & Associates, Portland, prepared for private sector and local government stakeholders, submitted to National Marine Fisheries Service, Portland.

Cullen, S.A. 2002. Using radar to monitor populations and assess habitat associations of marbled murrelets within the Sunshine Coast Forest District. Surrey, BC, Ministry of Water, Land and Air Protection, 25 pp.

Davis, B. and R. Miller. 1967. Brain patterns in minnows of the genus Hybopsis in relation to feeding habits and habitats. Copeia 1967: 1-39.

Day, R.H. and D.A. Nigro. 2000. Feeding ecology of Kittlitz's and marbled murrelets in Prince William Sound, Alaska. Waterbirds 23(1):1-14.

Dechesne, S. B. C., and J. L. Smith. 1997. Wildlife inventory Queen Charlotte Islands/Haida Gwaii 1994-1996. Husby Group of Companies. 49 pages.

DeHaan, P., P. Scheerer, R. Rhew. 2010. Analysis of genetic variation in natural and re-introduced populations of Oregon chub (Oregonichthys crameri). Final Report to Oregon Fish and Wildlife Office, Portland, Oregon. 42 pp.

Delaney, D. K., T. G. Grubb, P. Beier, L. L. Pater, and M. H. Reiser. 1999a. Effects of helicopter noise on Mexican spotted owls. Journal of Wildlife Management 63:60-76.

DiTomaso, J.M., G.B. Kyser, and M.J. Pitcairn. 2006. Yellow starthistle management guide. California Invasive Plant Council. Berkley, California. Cal-IPC Publication 2006-03. 78 p. http://www.cal-ipc.org.

Donald, D.B., and D.J. Alger. 1993. Geographic distribution, species displacement, and niche overlap for lake trout and bull trout in mountain lakes. Canadian Journal of Zoology/Revue Canadien de Zoologie 71:238-247.

Doppelt, B., M. Scurlock, C. Frissell, and J. Karr. 1993. Entering the Watershed: A New Approach to Save America's River Ecosystems. Island Press, Washington, D.C. Escaño, Crisanto R. and Sonny P. Tababa 1998. Crops Research Division, Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD), Paseo del Valmayor, Los Baños, Philippines - 1998-09-01.

Dunham, J.B. and B.E. Rieman. 1999. Metapopulation structure of bull trout: Influences of physical, biotic, and geometrical landscape characteristics. Ecological Applications 9:642-655.

Dunham,J., B. Rieman & G. Chandler. 2003. Influences of Temperature and Environmental Variables on the Distribution of Bull Trout within Streams at the Southern Margin of Its Range. North American Journal of Fisheries Management 2003;23:894–904.

Ebbert, J. C. and M. H. Kim, 1998. Relation between irrigation method, sediment yields, and losses of pesticides and nitrogen. Journal of Environmental Quality 27(2):372-380.

Evans, D.E., W.P. Ritchie, S.K. Nelson, E. Kuo-Harrison, P. Harrison, and T.E. Hamer. 2003. Methods for surveying marbled murrelets in forests: a revised protocol for land management and research. Pacific Seabirds Group unpublished document available at http://www.pacificseabirdgroup.org.

Falxa, G., J. Baldwin, D. Lynch, S.L. Miller, S.K. Nelson, S.F. Pearson, M.G. Raphael, C. Strong, T. Bloxton, B. Galleher, B. Hogoboom, M. Lance, and R. Young. 2011. Marbled effectiveness monitoring, Northwest Forest Plan: 2009 and 2010 summary report. 26 p.

Falxa, G.A. 2013. Murrelet population survey 2000-2012 unpublished data, transmitted by email, USFWS, Arcata, CA.

Fausch, K.D. and Northcote, T.G. 1992. Large woody debris and salmonid habitat in a small coastal British Columbia stream. Can.J. Fish. Aquat. Sci. 49(4): 682–693.

Ferguson, J.W., G.M. Matthews, R.L. McComas, R.F. Absolon, D.A. Brege, M.H. Gessel, and L.G. Gilbreath. 2005. Passage of adult and juvenile salmonids through federal Columbia River power system dams. U.S. Dept. of Commerce. NOAA Technical Memorandum NMFS-NWFSC-64. 160 p.

Fishbase 2011. http://www.fishbase.org/summary/SpeciesSummary.php?genusname = Salvelinus&speciesname=confluentus

Fraley, J.J., and B.B. Shepard. 1989. Life history, ecology and population status of migratory bull trout (Salvelinus confluentus) in the Flathead Lake and River system, Montana. Northwest Science 63:133-143.

Frissell, C.A. 1993. A new strategy for watershed restoration and recovery of Pacific salmon in the Pacific Northwest. The Pacific Rivers Council, Eugene, Oregon

Frissell, C.A. 1997. A Spatial Approach to Species Viability: Conservation of Fishes in the Columbia River Basin. Open File Report. Flathead Lake Biological Station. The University of Montana, Polson.

Frissell, C.A. 1999. An ecosystem approach to habitat conservation for bull trout: groundwater and surface water protection. Open File Report Number 156-99. Flathead Lake Biological Station, University of Montana, Polson, MT, 46 pp.

Furniss, M.J., T.D. Roelofs, and C.S. Yee. 1991. Road construction and maintenance. American Fisheries Society Special Publication 19:297-323.

Gaines, W.L, P.H. Singleton, and R.C. Ross. 2003. *Assessing the cumulative effects of linear recreation routes on wildlife habitats on the Okanogan and Wenatchee National Forests*. General Technical Report, PNW-GTR-586. Portland, OR: Pacific Northwest Research Station, USDA Forest Service. 79 pp. Available online at http://www.fs.fed.us/pnw/pubs/gtr586.pdf (October 19, 2006).

Gamett, B.L. 2002. Telephone conversation 06/20/02 with Shelley Spalding, U.S. Fish and Wildlife Service, re: relationship between water temperature and bull trout distribution and abundance in the Little Lost River, Idaho.

Gerking, S.D. 1994. Feeding ecology of fish. Academic Press, San Diego, California. 51 pp.
Hoelscher, B. and T.C. Bjornn. 1989. Habitat, density, and potential production of trout and char in Pend Oreille Lake tributaries. Project F-710R-10, Subproject III, Job No. 8. Idaho Department of Fish and Game, Boise, Idaho.

Golightly, R. T., P. N. Hebert, and D. L. Orthmeyer. 2002. Evaluation of human-caused disturbance on the breeding success of marbled murrelets (Brachyramphus marmoratus) in Redwood National and State Parks, California. Bureau of Land Management, National Park Service, U.S. Fish and Wildlife Service, U.S. Geological Survey, California Department of Fish and Game, and California Department of Parks and Recreation. Arcata, CA. 61 pages.

Gregory, R. S., and T. G. Northcote. 1993. Surface, planktonic, and benthic foraging by juvenile chinook salmon (Oncorhynchus tshawytscha) in turbidlaboratory conditions. Canadian Journal of Fisheries and Aquatic Sciences 50:233–240.

Gregory, R.S. 1993. Effect of turbidity on the predator avoidance behavior of juvenile Chinook salmon (Oncorhynchus tshawytcha). Canadian Journal of Fisheries and Aquatic Sciences 50:241-246.

Gregory, R.S., and C.D. Levings. 1998. Turbidity Reduces Predation on Migrating Juvenile Pacific Salmon. Transactions of the American Fisheries Society 127: 275-285.

Giles, M.A., and M. Van der Zweep. 1996. Dissolved oxygen requirements for fish of the Peace, Athabasca and Slave River Basins: a laboratory study of bull trout (Salveninus Confluentus) and mountain whitefish (Prosopium Williamsoni), Northern River Basins Study Technical Report No. 120 ed.

Gilpin, M. 1997. Connectivity on the Clark Fork – The Bigger Picture. Faxed letter to Shelly Spalding, Montana Dept. Fish, Wildlife and Parks, from Mike Gilpin, University of California. 5p.

Goetz, F. 1989. Biology of the bull trout, Salvelinus confluentus, literature review. U.S. Forest Service, Willamette National Forest, Eugene, Oregon.

Goetz, F.A. 1994. Distribution and juvenile ecology of bull trout (Salvelinus confluentus) in the Cascade Mountains. M.S. thesis. Oregon State University, Corvallis.

Goetz, F., E. Jeanes, and E. Beamer. 2004. Bull trout in the nearshore. Preliminary draft. U.S. Army Corps of Engineers, Seattle, Washington, June, 2004, 396 pp.

Gresswell, R.E. 1999. Fire and aquatic ecosystems in forested biomes of North America. Transactions of the American Fisheries Society 128:193-221.

Haas, G.R., and J.D. McPhail. 1991. Systematics and distributions of Dolly Varden (Salvelinus malma) and bull trout (Salvelinus confluentus) in North America. Canadian Journal of Fisheries and Aquatic Sciences 48:2191-2211.

Haas, G.R., and J.D. McPhail. 2001. The post-Wisconsin glacial biogeography of bull trout (Salvelinus confluentus): a multivariate morphometric approach for conservation biology and management. Canadian Journal of Fisheries and Aquatic Sciences 58:2189-2203.

Hamer, T.E. and S.K. Nelson. 1995a. Nesting chronology of the marbled murrelet. In Ralph, C.J., G.L. Hunt, jr., M.G. Raphael, J.F. Piatt, tech. eds. 1995. Ecology and conservation of the marbled murrelet. Gen. Tech. Rep. PSW-GTR-152. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture.

Hamer, T.E. and Nelson, S.K. 1995b. Characteristics of marbled murrelet nest trees and nesting stands. In Ralph, C.J., G.L. Hunt, M.G. Raphael, J.F. Piatt, tech. eds. 1995. Ecology and conservation of the marbled murrelet. Gen. Tech. Rep. PSW-GTR-152. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture.

Hamer, T.E., and S.K. Nelson. 1998. Effects of disturbance on nesting marbled murrelets: summary of preliminary results. Portland, OR, U.S. Fish and Wildlife Service, 24 pp.

Hamer, T.E., S.K. Nelson, and T.I. Mohagen II. 2003. Nesting chronology of the marbled murrelet in North America. Unpubl.

Hard, J. 1995. A quantitative genetic perspective on the conservation of intraspecific diversity. American Fisheries Society Symposium 17: 304-326.

Hari, R. E., D. M. Livingstone, R. Siber, P. Burkhardt-Holm, and H. Guttinger. 2006. Consequences of climatic change for water temperature and brown trout populations in alpine rivers and streams. Global Change Biology 12:10–26.

Healey, M.C. and A. Prince. 1995. Scales of variation in life history tactics of Pacific salmon and the conservation of phenotype and genotype. American Fisheries Society Symposium 17:176-84.

Hebert, P.N., and R.T. Golightly. 2006. Movements, nesting, and response to anthropogenic disturbance of marbled murrelets (Brachyramphus marmoratus) in Redwood National and State Parks, California. California Department of Fish and Game, 2006-02, Sacramento, California, May, 2006. 321 pp.

Henjum, M.G., J.R. Karr, D.L. Bottom, D.A. Perry, J.C. Bednarz, S.G. Wright, S.A. Beckwitt, and E. Beckwitt. 1994. Interim protection for late-successional forests, fisheries, and watersheds. National forests east of the Cascade Crest, Oregon, and Washington. A report to the Congress and President of the United States Eastside Forests Scientific Society Panel. American Fisheries Society, American Ornithologists Union Incorporated, The Ecological Society of America, Society for Conservation Biology, The Wildlife Society. The Wildlife Society Technical Review 94-2.

Henkel, L.A., E.E. Burkett, and J.Y. Takekawa. 2003. At-sea activity and diving behavior of a radio-tagged marbled murrelet in central California. Waterbirds 26(4):9-12.

Hobson, K.A. 1990. Stable isotope analysis of marbled murrelets: evidence for fresh water feeding and determination of trophic level. Condor 92:897-903.

Hoelscher, B., and T.C. Bjornn. 1989. Habitat, density, and potential production of trout and char in Pend Oreille Lake tributaries. Project F-710R-10, Subproject III, Job No. 8. Idaho Department of Fish and Game, Boise, Idaho.

Howell, P.J., and D.V. Buchanan. 1992. Proceedings of the Gearhart Mountain Bull Trout Workshop. Oregon Chapter of the American Fisheries Society, Corvallis, Oregon.

Huff, Mark H., M.G. Raphael, S.L. Miller, K.S. Nelson, and J. Baldwin, tech. coords. 2006. Northwest Forest Plan—The first 10 years (1994-2003): status and trends of populations and nesting habitat for the marbled murrelet. General Technical Report PNW-GTR-650. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 149 pp.

Hull, C.L., G.W. Kaiser, C. Lougheed, L. Lougheed, S. Boyd, and F. Cooke. 2001. Intraspecific variation in commuting distance of marbled murrelets (Brachyramphus marmoratus): ecological and energetic consequences of nesting further inland. Auk 118:1036-1046.

IDFG (Idaho Department of Fish and Game). 1995.

IPCC (Intergovernmental Panel on Climate Change). 2007. Climate change 2007: the physical science basis. Available: www.ipcc.ch. (February 2007).

IGBC (Interagency Grizzly Bear Committee). 1998. *Grizzly bear/motorized access management*. Interagency Grizzly Bear Committee Taskforce Report. 7 pp.

ISAB (Independent Scientific Advisory Board). 2007. Climate change impacts on Columbia River basin fish and wildlife. ISAB 2007-2. Portland, Oregon. 2007.

ISG (Independent Science Group). 1996. Return to the river: restoration of salmonid fishes in the Columbia River ecosystem. ISG, Report #96-6, for the Northwest Power Planning Council, Portland, Oregon.

Johnson, G. L. 1990. Bull trout species management plan. Nevada Division of Wildlife, Reno, Nevada. Federal Aid Project No. F-20-26, Job No. 207.4. 17 pp.

Kasworm, W.F. and T.L. Manley. 1990. Road and trail influences on grizzly bears and black bears in northwest Montana. International Conference on Bear Research and Management, 8:79-84.

Kitaysky, A., J.C. Wingfield and J.F. Piatt. 2001. Corticosterone facilitates begging and affects resource allocation in the black-legged kittiwake. Behavioural Ecology 12: 619-625.Knight, R.L., and K.L. Gutzwiller, eds. 1995. Wildlife and recreationists: coexistence through management and research. Island Press, Washington, D.C.

Knight, R.L., and K.J. Gutzwiller, eds. 1995. Wildlife and recreationists: coexistence through management and research. Island Press, Washington, D.C.

Kuletz, K.J., and J.F. Piatt. 1999. Juvenile marbled murrelet nurseries and the productivity index. Wilson Bulletin 111(2):257-261.

Kuletz, K.J. 2005. Foraging behavior and productivity of a non-colonial seabird, the marbled murrelet (Brachyramphus marmoratus), relative to prey and habitat. Ph.D. dissertation, University of Victoria, Victoria, British Columbia.

Lank, David B., Nadine Parker, Elizabeth A. Krebs, and Laura McFarlane Tranquilla. 2003. Geographic distribution, habitat selection, and population dynamics with respect to nesting habitat characteristics, of marbled murrelets. Centre for Wildlife Ecology, Simon Fraser University, Burnaby, Canada. 66 pages.

LCREP (Lower Columbia River Estuary Program). 1999. Comprehensive Conservation and Management Plan. Volume 1: June 1999. LCREP, Portland, Oregon.

Leary, R.F., F.W. Allendorf, and S.H. Forbes. 1993. Conservation genetics of bull trout in the Columbia and Klamath River drainages. Conservation Biology [CONSERV. BIOL.] 7 856-865.

Leary, R.F., and F.W. Allendorf. 1997. Genetic confirmation of sympatric Bull trout and Dolly Varden in western Washington. Transactions of the American Fisheries Society 126:715-720.

Leathe, S.A., and P. Graham. 1982. Flathead Lake fish food habits study. Environmental Protection Agency, through Steering Committee for the Flathead River Basin Environmental Impact Study. Contract R008224-01-4 to Montana Department of Fish, Wildlife, and Parks.

Light, J., L. Herger, and M. Robinson. 1996. Upper Klamath basin bull trout conservation strategy, a conceptual framework for recovery. Part one. The Klamath Basin Bull Trout Working Group

Lloyd, D.S. 1987. Turbidity as a Water Quality Standard for Salmonid Habitats in Alaska. North American Journal of Fisheries Management 7:34-45.

Long, L.L., and C.J. Ralph. 1998. Regulation and observations of human disturbance near nesting marbled murrelets. 35 pp.

Long, L.L., S.L. Miller, C.J. Ralph, and E.A. Elias. 2008. Marbled murrelet abundance, distribution, and productivity along the coasts of Northern California and Southern Oregon, 2005-2007, Report to USFWS and Bureau of Land Management, Arcata, California, 2008. 49 pp.

Luginbuhl, J. M., J. M. Marzluff, J. E. Bradley, M. G. Raphael, and D. E. Varland. 2001. Corvid survey techniques and the relationship between corvid relative abundance and nest predation. Journal of Field Ornithology 72(4):556-572.

Mace, R.D. and J.S. Waller. 1996. *Grizzly bear distribution and human conflicts in Jewel Basin Hiking Area, Swan Mountains, Montana*. Wildlife Society Bulletin, 24(3):461-467.

Mace, R.D., J.S. Waller, T.L. Manley, L.J. Lyon, and H. Zuuring. 1996. *Relationships among grizzly bears, roads and habitat in the Swan Mountains, Montana*. Journal of Applied Ecology, 33:1395-1404.

Mace, R.D., J.S. Waller, T.L. Manley, K. Ake, and W.T. Wittinger. 1999. *Landscape evaluation of grizzly bear habitat in western Montana*. Conservation Biology, 13(2):367-377.

Manley, I. A. 1999. Behavior and habitat selection of marbled murrelets nesting on the Sunshine Coast. Masters of Science Thesis. Department of Biological Sciences, Simon Fraser University, Burnaby, Canada. 163 pages.

Manley, I.A., A. Harfenist, and G. Kaiser. 2001. Marbled murrelet telemetry study on Queen Charlotte Islands/Haida Gwaii. Smithers, BC, Ministry of Environment, Lands and Parks, 24 pp.

Markle, D., T. Pearsons and D. Bills. 1991. Natural history of Oregonichthys (Pisces: Cyprinidae), with a description of a new species from the Umpqua River of Oregon. Copeia (2): 277-293.

Mason, A., A.E. Burger, and B. Hansen. 2002. At-sea surveys of marbled murrelets in Clayoquot Sound, 1996-2000. In Burger, A., and T.A. Chatwin, eds., Multi-scale studies of populations, distribution and habitat associations of marbled murrelets in Clayoquot Sound, British Columbia: Victoria, British Columbia, Ministry of Water, Land and Air Protection, p 15-33.

Materna, E.J. and J. Buck. 2007. Assessment of impacts to aquatic organisms from pesticide use on the Willamette Valley National Wildlife Refuge Complex. U.S. Fish and Wildlife Service, Oregon Fish and Wildlife Office, Portland. 83 pp.

Mathews, N.J.C., and A.E. Burger. 1998. Diving depth of a marbled murrelet. Northwestern Naturalist 79:70-71.

Mattson, D.J., R.R. Knight, and B.M. Blanchard. 1987. *The effects of developments and primary roads on grizzly bear habitat use in Yellowstone National Park, Wyoming*. International Conference on Bear Research and Management, 7:259-273.

MBTRT (Montana Bull Trout Restoration Team). 2000. Restoration plan for bull trout in the Clark Fork River basin and Kootenai River basin, Montana. Montana Fish, Wildlife and Parks, Helena, Montana.

MBTSG (Montana Bull Trout Scientific Group). 1995a. Upper Clark Fork River drainage bull trout status report (including Rock Creek). Prepared for Montana Bull Trout Restoration Team. Helena, Montana.

MBTSG (Montana Bull Trout Scientific Group). 1995b. Bitterroot River drainage bull trout status report. Prepared for Montana Bull Trout Restoration Team. Helena, Montana.

MBTSG (Montana Bull Trout Scientific Group). 1995c. Blackfoot River drainage bull trout status report. Prepared for Montana Bull Trout Restoration Team. Helena, Montana.

MBTSG (Montana Bull Trout Scientific Group). 1995d. Flathead River drainage bull trout status report (including Flathead Lake, the North and Middle forks of the Flathead River and the Stillwater and Whitefish River). Prepared for Montana Bull Trout Restoration Team. Helena, Montana.

MBTSG (Montana Bull Trout Scientific Group). 1995e. South Fork Flathead River drainage bull trout status report (upstream of Hungry Horse Dam). Prepared for Montana Bull Trout Restoration Team. Helena, Montana.

MBTSG (Montana Bull Trout Scientific Group). 1996a. Swan River drainage bull trout status report (including Swan Lake). Prepared for Montana Bull Trout Restoration Team. Helena, Montana.

MBTSG (Montana Bull Trout Scientific Group). 1996b. Lower Clark Fork River drainage bull trout status report (Cabinet Gorge Dam to Thompson Falls). Prepared for Montana Bull Trout Restoration Team. Helena, Montana.

MBTSG (Montana Bull Trout Scientific Group). 1996c. Middle Clark Fork River drainage bull trout status report (from Thompson Falls to Milltown, including the lower Flathead River to Kerr Dam). Prepared for Montana Bull Trout Restoration Team. Helena, Montana.

MBTSG (Montana Bull Trout Scientific Group). 1996d. Lower Kootenai River drainage bull trout status report (below Kootenai Falls). Prepared for Montana Bull Trout Restoration Team. Helena, Montana.

MBTSG (Montana Bull Trout Scientific Group). 1996e. Middle Kootenai River drainage bull trout status report (between Kootenai Falls and Libby Dam). Prepared for Montana Bull Trout Restoration Team. Helena, Montana.

MBTSG (Montana Bull Trout Scientific Group). 1996f. Upper Kootenai River drainage bull trout status report (including Lake Koocanusa, upstream of Libby Dam). Prepared for Montana Bull Trout Restoration Team. Helena, Montana.

MBTSG (Montana Bull Trout Scientific Group). 1998. The relationship between land management activities and habitat requirements of bull trout. Prepared for Montana Bull Trout Restoration Team. Helena, Montana.

McElhany, P., M.H. Ruckelshaus, M.J. Ford, T.C. Wainwright and E.P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-42, Seattle, Washington, 156 p.

McIntosh, B.A., J.R. Sedell, J.E. Smith, R.C. Wissmar, S.E. Clarke, G.H. Reeves, and L.A. Brown. 1994. Management history of eastside ecosystems: Changes in fish habitat over 50 years, 1935 to 1992. U.S. Forest Service, Pacific Northwest Research Station, General Technical Report. PNW-GTR 321.

McLeay, D.J., G.L. Ennis, I.K. Birtwell, and G.F. Hartman. 1984. AEffects On Arctic Grayling (*Thymallus arcticus*) of Prolonged Exposure to Yukon Placer Mining Sediment: A Laboratory Study.@ Canadian Technical Report of Fisheries and Aquatic Sciences 1241.

McLeay, D.J., I.K. Birtwell, G.F. Hartman, and G.L. Ennis. 1987. AResponses of Arctic Grayling (*Thymallus arcticus*) To Acute and Prolonged Exposure to Yukon Placer Mining Sediment.@ Canadian Journal of Fisheries and Aquatic Sciences 44: 658-673.

McLellan, B.N. and D.M. Shackleton. 1988. *Grizzly bears and resource-extraction industries: effects of roads on behaviour, habitat use and demography*. Journal of Applied Ecology, 25:451-460.

McMichael, G.A., A.L. Fritts, and T.N. Pearsons. 1998. Electrofishing injury to stream salmonids; injury assessment at the sample, reach, and stream scales. North American Journal of Fisheries Management 18:894-904.

McPhail, J.D. and C. Murray. 1979. The early life history and ecology of Dolly Varden (Salvelinus malma) in the upper Arrow Lakes. Rpt to the BC Columbia Hydro and Power Authority and Kootenay Dept. of Fish and Wildlife.

McPhail, J.D., and J.S. Baxter. 1996. A review of bull trout (Salvelinus confluentus) life-history and habitat use in relation to compensation and improvement opportunities. Department of

Zoology, University of British Columbia. Fisheries Management Report No. 104. Vancouver, British Columbia, Canada.

McShane, C., T. Hamer, H. Carter, G. Swartzman, V. Friesen, D. Ainley, R. Tressler, K. Nelson, A. Burger, L. Spear, T. Mohagen, R. Martin, L. Henkel, K. Prindle, C. Strong, and J. Keany. 2004. Evaluation report for the 5-year status review of the marbled murrelet in Washington, Oregon, and California. Unpublished report. EDAW, Inc. Seattle, Washington. Prepared for the U.S. Fish and Wildlife Service, Region 1. Portland, Oregon.

Meager, J.J.; Domenici, P.; Shingles, A. and A.C. Utne-Palm. 2006. Escape responses in juvenile Atlantic cod (*Gadus morhua*): the effect of turbidity and predator velocity. Journal of Experimental Biology. 209: 4174-4184.

Meehan, W.R. 1991. Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. American Fisheries Society Special Publication 19.

Meekins, D. J., and T. E. Hamer. 1998. Use of radar to monitor marbled murrelets at inland sites in the North Cascades of Washington: Preliminary Report. USDA Forest Service. 16 pages.

Meffe, G.K., and C.R. Carroll. 1994. Principles of conservation biology. Sinauer Associates, Inc. Sunderland, Massachusetts.

Meyer, C.B., S.L. Miller, and C.J. Ralph. 2002. Multi-scale landscape and seascape patterns associated with marbled murrelet nesting areas on the U.S. west coast. Landscape Ecology 17: 95-115.

Miller, S.L., M.G. Raphael, G.A. Falxa, C. Strong, J. Baldwin, T. Bloxton, B.M. Galleher, M. Lance, D. Lynch, S.F. Pearson, C.J. Ralph, and R.D. Young. 2012. Recent population decline of the marbled murrelet in the Pacific Northwest. The Condor 114(4):771-781.

Miner, J. G., and R. A. Stein. 1996. Detection of predators and habitat choice by small bluegills: effects of turbidity and alternative prey. Transactions of the American Fisheries Society 125:97–103.

Mitsch, W.J. 1996. Ecological engineering: A new paradigm for engineers and ecologists. Pages 111-128 in P.C. Schulze, editor. Engineering within ecological constraints. National Academy of Engineering, National Academy Press, Washington, D.C.

Moberg, G.P. 2000. Biological response to stress: Implications for animal welfare. Pages 1-21. In: The biology of animal stress - basic principles and implications for animal welfare. G.P. Moberg, and J.A. Mench (editors). CABI Publishing. Cambridge, Massachusetts.

Moyle, P.B. 1976. Inland Fishes of California. University of California Press, Berkeley, California.

Myrick, C.A., F.T. Barrow, J.B. Dunham, B.L. Gamett, G. Haas, J.T. Peterson, B. Rieman, L.A. Weber, and A.V. Zale. 2002. Bull trout temperature thresholds. Peer review summary prepared for U.S. Fish and Wildlife Service.

Neff, J. M. 1985. Polycyclic aromatic hydrocarbons. In Fundamentals of Aquatic Toxicology. G. M. Rand and S. R. Petrocelli, editors. pp. 416–454. Taylor & Francis, Bristol, PA.

Nehlsen, W., J. Williams, and J. Lichatowich. 1991. Pacific salmon at the crossroads: stocks at risk from California, Oregon, Idaho, and Washington. Fisheries 16(02):4-21.

Nelson, S.K., and T.E. Hamer. 1995. Nest success and the effects of predation on marbled murrelets. Pp. 89-97. In: Ecology and conservation of the marbled murrelet (C.J. Ralph, G.L. Hunt, Jr., M.G. Raphael, and J.F. Piatt, eds). U.S. Forest Service, Gen. Tech. Rep. PSW-GTR-152, Albany, California.

Nelson, S.K. 1997. The birds of North America, No. 276 - Marbled Murrelet (Brachyramphus marmoratus). In: A. Poole and F. Gill (eds.). The birds of North America: life histories for the 21st century.
Nelson, S. K., and A. K. Wilson. 2002. Marbled murrelet habitat characteristics on state lands in western Oregon. Corvallis, OR: Oregon Cooperative Fish and Wildlife Research Unit, OSU, Department of Fisheries and Wildlife. 151 pages.

Newcombe, C.P., and D.D. MacDonald. 1991. Effects of Suspended Sediments on Aquatic Ecosystems.@ North American Journal of Fisheries Management 11: 72-82.

Newcombe, C.P., and J.O.T. Jensen. 1996. Channel suspended sediment and fisheries: A synthesis for quantitative assessment of risk and impact. North American Journal of Fisheries Management 16:693-727.

Newton, J.A., and S. Pribyl. 1994. Bull trout population summary: Lower Deschutes River subbasin. Oregon Department of Fish and Wildlife, The Dalles, Oregon. Oregon administrative rules, proposed amendments to OAR 340-41-685 and OAR 340-41-026. January 11, 1996.

NMFS (National Marine Fisheries Service). 2000. Reinitiation of Consultation on Operation of the Federal Columbia River Power System, Including the Juvenile fish Transportation Program, and 19 Bureau of Reclamation Projects in the Columbia Basin. Northwest Region Hydropower Program. December 2000.

NMFS. 2010. Endangered Species Act Programmatic Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Conservation Recommendations for Vegetation treatments Using Herbicides on Bureau of Land Management

(BLM) Lands Across Nine BLM Districts in Oregon (September 1, 2010) (Refer to NMFS No: 2009/05539).

NMFS. 2011. Endangered Species Act Section 7 Consultation biological opinion on the Environmental Protection Agency registration of pesticides 2,4-D, triclopyr BEE, diuron, linuron, captan, and chlorothalonil. Endangered Species Division of the Office of Protected Resources, National Marine Fisheries Service. Silver Spring, Maryland. http://www.epa.gov/espp/litstatus/final-4th-biop.pdf

NMFS. 2012. Endangered Species Act Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Invasive Plant Treatment Project on Deschutes National Forest, Ochoco National Forest and Crooked River National Grassland, Oregon. (February 2, 2012) (Refer to NMFS No: 2009/03048).

NMFS. 2013. Endangered Species Act Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for Bonneville Power Administration's Habitat Improvement Program III. (HIP III) KEC-4. Consultation #2013/9724.

NOAA Fisheries. 2004. Consultation on Remand for Operation of the Columbia River Power System and 19 Bureau of Reclamation Projects in the Columbia Basin (Revised and reissued pursuant to court order, NWF v. NMFS, Civ. No. CV 01-640-RE (D. Oregon)). NOAA Fisheries Northwest Region (F/NWR/2004/00727). November 30, 2004.

NWPPC (Northwest Power Planning Council). 1992. Information on water quality and quantity contained in the salmon and steelhead subbasin plans above Bonneville Dam. Document #93-8. Portland, Oregon.

ODEQ (Oregon Department of Environmental Quality). 1995. 1992-1994 Water quality standards review: Dissolved oxygen - Final issue paper. Oregon Department of Environmental Quality, Portland, OR.

Oregon. 1996. Oregon administrative rules, proposed amendments to OAR 340-41-685 and OAR 340-41-026. January 11, 1996.

Oregon. 1997. Coastal Salmon Restoration Initiative. The Oregon Plan. State of Oregon.

OWRD (Oregon Water Resources Department). 1993. Memorandum re: weak stocks and water supply conflicts, to D. Moscowitz et al. from T. Kline and B. Fuji, OWRD, Salem. September 17, 1993.

Paton, P. W. C., C. J. Ralph, and R. A. Erickson. 1992. Use of an inland site in northwestern California by marbled murrelets. Proceedings of the Western Foundation of Vertebrate Zoology 5:109-116.

Pearson, S.F., M.G. Raphael, M.M. Lance, and T.D. Bloxton, Jr. 2011. 2010 Washington at-sea marbled Murrelet population monitoring: Research progress report. Washington Department of Fish and Wildlife, Wildlife Science Division and USDA Forest Service Pacific Northwest Research Station, Olympia, WA. 17 pp.

Pearsons, T.N. 1989. Ecology and decline of a rare western minnow: the Oregon chub (Oregonichthys crameri). Master of Science Thesis. Oregon State University, Corvallis, Oregon. 86 pp.

Peery, M.Z., S.R. Beissinger, S.H. Newman, E.B. Burkett, and T.D. Williams. 2004. Applying the declining population paradigm: diagnosing causes of poor reproduction in the marbled murrelet. Conservation Biology 18(4):1088-1098.

Peery, M.Z., L.A. Hall, J.T. Harvey, and L.A. Henkel. 2008. Abundance and productivity of marbled murrelets off central California during the 2008 breeding season. Final Report Submitted to California State Parks, Half Moon Bay, CA. September 2008. 10 pp.

Peery, M.Z., and R.W. Henry. 2010. Abundance and productivity of marbled murrelets off central California during the 2009 breeding season. Final Report. California State Parks, Half Moon Bay, California, February 2010. 16 pp.

Perkins, D. L., J. Kahn, and G. G. Scoppettone. 2000a. The role of poor water quality and fish kills in the decline of endangered Lost River and shortnose suckers in Upper Klamath Lake. U.S. Geological Survey, Reno, Nevada.

Piatt, J.F., K.J. Kuletz, A.E. Burger, S.A. Hatch, V.L. Friesen, T.P. Birt, M.L. Arimitsu, G.S. Drew, A.M.A. Harding, and K.S. Bixler. 2007. Status review of the Marbled Murrelet (Brachyramphus marmoratus) in Alaska and British Columbia: U.S. Geological Survey Open-File Report 2006-1387, 258 p.

Porter, M. and M. Nelitz. 2009. A future outlook on the effects of climate change on bull trout (Salvelinus confluentus) habitats in the Cariboo-Chilcotin. Prepared by ESSA Technologies Ltd.for Fraser Salmon and Watersheds Program, B.C. Ministry of Environment, and Pacific Fisheries Resource Conservation Council.

Portz, D.E. 2007. Fish-holding-associated stress in Sacramento River Chinook salmon (Oncorhynchus tshawytscha) at South Delta fish salvage operations: Effects on plasma constituents, swimming performance, and predator avoidance. PHD Dissertation. University of California, Davis.

Pratt, K.L. 1985. Pend Oreille trout and char life history study. Idaho Department of Fish and Game in cooperation with the Pend Oreille Idaho Club

Pratt, K.L. 1992. A review of Bull trout life history. Pages 5-9 in P.J. Howell, and D.V. Buchanan, eds. Proceedings of the Gearhart Mountain Bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis, Oregon.

Pratt, K.L., and J.E. Huston. 1993. Status of bull trout (Salvelinus confluentus) in Lake Pend Oreille and the lower Clark Fork River. Draft report. Prepared for the Washington Water Power Company, Spokane, Washington.

Quigley, T.M., and S.J. Arbelbide, tech. eds. 1997. An assessment of ecosystem components in the Interior Columbia Basin and portions of the Klamath and Great Basins: volume III. Gen. Tech. Rep. PNW-GTR-405. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 4 vol.

Ralph, C.J., G.L. Hunt, Jr., M.G. Raphael, and J.F. Piatt, eds. 1995. Chapter 1: Ecology and conservation of the marbled murrelet. Within: U.S. Forest Service, General Technical Report PSW-GTR-152, Pacific Southwest Research Station, Albany, California. 3-22.

Raphael, M.G., D. Evans Mack, and Brian A. Cooper. 2002. Landscape-scale relationships between abundance of marbled murrelets and distribution of nesting habitat. Condor 104(2), 331-342.

Raphael, M.G., J.M. Olson, and T. Bloxton. 2007a. Summary report of field observation of marbled murrelets in the San Juan Islands, Washington. USDA Forest Service, Pacific NW Research Station, Olympia, Washington. 25 pp.

Raphael, M.G., J. Baldwin, G.A. Falxa, M.H. Huff, M. Lance, S.L. Miller, S.F. Pearson, C.J. Ralph, C. Strong, and C. Thompson. 2007b. Regional population monitoring of the marbled murrelet: field and analytical methods. General Technical Report. NNW-GTR-716. Pacific Northwest Research Station, U.S. Forest Service, Portland, Oregon. 70 pp.

Ratliff, D.E., and P.J. Howell. 1992. The status of bull trout populations in Oregon. Pages 10-17 in: P.J. Howell and D.V. Buchanan (eds). Proceedings of the Gearhart Mountain bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis.

Redding, J.M., C.B. Schreck, and F.H. Everest. 1987. Physiological Effects on Coho Salmon and Steelhead of Exposure to Suspended Solids. Transactions of the American Fisheries Society 116: 737-744.

Reeves, G.H., J.D. Hall, T.D. Roelofs, T.L. Hickman, and C.O. Baker. 1991. Rehabilitating and modifying stream habitats. Pages 519-557 in W.R. Meehan, editor. Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. American Fisheries Society, Special Publication 19, Bethesda, Md.

Rich, C.F., Jr. 1996. Influence of abiotic and biotic factors on occurrence of resident bull trout in fragmented habitats, western Montana. M.S. Thesis, Montana State University, Bozeman, Montana.

Rieman, B.E., and J.D. McIntyre. 1993. Demographic and habitat requirements for conservation of bull trout. U.S. Forest Service, Intermountain Research Station. General Technical Report INT-302.

Rieman, B.E., and J.D. McIntyre. 1995. Occurrence of bull trout in naturally fragmented habitat patches of varied size. Transactions of the American Fisheries Society 124:285-296.

Rieman, B.E., and J.D. McIntyre. 1996. Spatial and temporal variability in bull trout redd counts. North American Journal of Fisheries Management 16:132-141.

Rieman, B., and J. Clayton. 1997a. Wildfire and native fish: Issues of forest health and conservation of sensitive species. Fisheries 22:6-14.

Rieman, B.E., D.C. Lee and R.F. Thurow. 1997b. Distribution, status and likely future trends of Bull trout within the Columbia River and Klamath River basins. North American Journal of Fisheries Management 17:1111-1125.

Rieman, B.E., and J.B. Dunham. 2000. Metapopulations and salmonids: a synthesis of life history patterns and empirical observations. Ecology of Freshwater Fish 9:51-64.

Rieman, B.E., and F.W. Allendorf. 2001. Effective population size and genetic conservation criteria for bull trout. North American Journal of Fisheries Management 21:756-764. American Fisheries Society, Bethesda, Maryland.

Rieman, B.E., D. Lee, D. Burns, R. Gresswell, M. Young, R. Stowell, J. Rinne, P. Howell. 2003. Status of native fishes in the western United States and issues for fire and fuels management. Forest Ecology and Management, Vol. 178, Issues 1-2, p197-211.

Rieman, B.E., J.T. Peterson and D.L. Myers. 2006. Have brook trout (Salvelinus fontinalis) displaced bull trout (Salvelinus confluentus) along longitudinal gradients in central Idaho streams? Canadian Journal of Fisheries and Aquatic Sciences. Vol. 63, No. 1, pp. 63–78(16)

Rieman, B.E., D. Isaak, S. Adams, D. Horan, D. Nagel, C. Luce, D. Myers. 2007. Anticipated Climate Warming Effects on Bull Trout Habitats and Populations Across the Interior Columbia River Basin. Transactions of the American Fisheries Society. 136:1552-1565.

Robins, C.R., R.M. Bailey, C.E. Bond, J.R. Brooker, E.H. Lachner, R.N. Lea, and W.B. Scott. 1980. A list of common and scientific names of fishes from the United States and Canada. American Fisheries Society Special Publication 12, Bethesda, Maryland.

Rode, M. 1990. Bull trout, Salvelinus confluentus suckley, in the McCloud River: status and recovery recommendations. Administrative Report Number 90-15. California Department of Fish and Game, Sacramento, California.

Rodway, M. S., H. M. Regehr, and J. P. L. Savard. 1993. Activity patterns of marbled murrelets in old-growth forest in the Queen-Charlotte-Islands, British Columbia. Condor 95:831-848.

Rodway M. S., and H. M. Regehr. 2002. Inland activity and forest structural characteristics as indicators of marbled murrelet nesting habitat in Clayoquot Sound. Pages 57-87 in A. E. Burger and T. A. Chatwin, editors: Multi-scale studies of populations, distribution and habitat associations of marbled murrelets in Clayoquot Sound, British Columbia. Ministry of Water, Land and Air Protection, Victoria, British Columbia, Canada.

Rosetta, T. 2005. Technical basis for revising turbidity criteria (draft). Oregon Department of Environmental Quality, Water Quality Division. Portland, Oregon. October.

Samani, Z. and R. K. Skaggs. 2008. The multiple personalities of water conservation. Water Policy 10:285-294.

Saunders, D.A., R.J. Hobbs, and C.R. Margules. 1991. Biological consequences of ecosystem fragmentation: A review. Conservation Biology 5:18-32

Scannell, P.O. 1988. Effects of Elevated Sediment Levels from Placer Mining on Survival and Behavior of Immature Arctic Grayling. Alaska Cooperative Fishery Unit, University of Alaska. Unit Contribution 27.

Scheerer, P., and G.D. Apke. 1998. Oregon Chub Research. Middle Fork Willamette and Santiam River Drainages. Annual Progress Report (E96970022). 53 pp.

Scheerer, P.D. and P.J. McDonald. 2000. Oregon chub research: Middle Fork Willamette and Santiam River Drainages. Unpublished. Oregon Department of Fish and Wildlife, Fish Research Project October 1999-September 2000. Annual Progress Report, Portland. 90 pp.

Scheerer, P.D. and P.J. McDonald. 2003. Age, growth, and timing of spawning of an endangered minnow, the Oregon chub (Oregonichthys crameri), in the Willamette Basin, Oregon. Northwestern Naturalist 86:68-79.

Schill, D.J. 1992. River and stream investigations. Job Performance Report, Project F-73-R-13. Idaho Department of Fish and Game, Boise, Idaho

Sedell, J.R., and F.H. Everest. 1991. Historic changes in poo1 habitat for Columbia River Basin salmon under study for TES listing. Draft U.S. Department of Agriculture Report, PacificNorthwest Research Station, Corvallis, Oregon.

Servizi, J.A., and D.W. Martens. 1991. Effects of temperature, season, and fish size on acute lethality of suspended sediments to coho salmon. Canadian Journal of Fisheries and Aquatic Sciences 49:1389-1395.

Sexauer, H.M., and P.W. James. 1997. Microhabitat use by juvenile trout in four streams located in the eastern Cascades, Washington. Pages 361-370 in W.C. Mackay, M.K. Brewin and M. Monita (eds). Friends of the Bull Trout Conference Proceedings. Bull Trout Task Force (Alberta), c/o Trout Unlimited Calgary, Alberta, Canada.

Sigler, J.W., T.C. Bjornn, and F.H. Everest. 1984. Effects of Chronic Turbidity on Density and Growth of Steelheads and Coho Salmon. Transactions of the American Fisheries Society 113:142-150.

Simpson, J.C., and R.L. Wallace. 1982. Fishes of Idaho. University Press of Idaho. Moscow, Idaho.

Singer, S. W., D. L. Suddjian, and S. A. Singer. 1995. Fledging behavior, flight patterns, and forest characteristics at marbled murrelet tree nests in California. Northwestern Naturalist 76:54-62.

Snyder, J.O. 1908. Relationships of the fish fauna of the lakes of southeastern Oregon. Bulletin of the Bureau of Fisheries 17:69-102.

Snyder, D.E. 2003. Electrofishing and its harmful effects on fish: U.S. Geological Survey Information and Technology Report 2003-0002. 149 p.

Spalding, S., Peterson, N.P. and T.P. Quinn. 1995. Summer distribution, survival and growth of juvenile coho salmon under varying experimental conditions of brushy instream cover. Trans.Am. Fish. Soc. 124: 124–130.

Speckman, S.G. 1996. Marbled murrelet distribution and abundance in relation to the marine environment. Master's Thesis, University of Alaska, Fairbanks, Alaska, August 1996.

Spence, B.C., G.A. Lomnicky, R.M. Hughes, and R.P. Novitzki. 1996. An ecosystem approach to salmonid conservation. ManTech Environmental Research Services, Inc., Corvallis, Oregon, to National Marine Fisheries Service, Habitat Conservation Division, Portland, Oregon (Project TR-4501-96-6057).

Sprague, J.B., and D.E. Drury. 1969. Avoidance reactions of salmonid fish to representative pollutants. Pages 169-179. In: Advances in Water Pollution Research. Proceedings of the Fourth International Conference, Prague. S.H. Jenkins (editor). Pergamon Press. New York.

Spruell, P., B.E. Rieman, K.L. Knudsen, F.M. Utter, and F.W. Allendorf. 1999. Genetic population structure within streams: microsatellite analysis of Bull trout populations. Ecology of Freshwater Fish 8:114-121.

Spruell, P., A.R. Hemmingsen, P.J. Howell, N. Kanda, and F.W. Allendorf. 2003. Conservation genetics of bull trout: Geographic distribution of variation at microsatellite loci. Conservation Genetics 4:17-29

Stanford, J.A. and J.V. Ward. 1992. Management of aquatic resources in large catchments: recognizing interactions between ecosystem connectivity and environmental disturbance. Pages 91-124 in R. J. Naiman, editor. Watershed Management: Balancing Sustainability and Environmental Change. Springer-Verlag, publisher, New York.

Stehr, C.M., T.L. Linbo, D.H. Baldwin, N.L. Scholz, and J.P. Incardona. 2009. Evaluating the effects of forestry herbicides on fish development using rapid phenotypic screens. North American Journal of Fisheries Management 29(4):975-984. Aug.

Stenstrom, M.K. and M. Kayhanian. 2005. First flush phenomenon characterization. California Department of Transportation, Division of Environmental Analysis. CTSW-RT-05-73-02.6. Sacramento, California. August. http://149.136.20.66/hq/env/stormwater/pdf/CTSW-RT-05-073-02-6_First_Flush_Final_9-30-05.pdf.

Steventon, J.D., and N.L. Holmes. 2002. A radar-based inventory of marbled murrelets (Brachyramphus marmoratus), northern Mainland Coast of British Columbia. Prince Rupert Forest Region, British Columbia Ministry of Forests, 40 pp.

Stewart, D.B., N.J. Mochnacz, C.D. Sawatzky, T.J. Carmichael, and J.D. Reist. 2007. Fish life history and habitat use in the Northwest territories: Bull trout (Salvelinus confluentus). Canadian Manuscript Report of Fisheries and Aquatic Sciences 2801. Department of Fisheries and Oceans, Winnipeg, MB, Canada, 2007, 54 pp.

Strachan, G., M. McAllister, and C.J. Ralph. 1995. Marbled murrelet at-sea foraging behavior. Pages 247-253 in C.J. Ralph, G.L. Hunt, M.G. Raphael, and J.F. Piatt (eds). Ecology and conservation of the marbled murrelet. General Technical Report. PSW-GTW-152. Pacific Southwest Experimental Station, U.S. Forest Service, Albany, California. 420 pp.

Strong, C.S., B.K. Keitt, W.R. McIver, C.J. Palmer, and I.Gaffney. 1995. Distribution and population estimates of marbled murrelets at sea in Oregon during the summers of 1992 and 1993. Pages 339-352 in C.J. Ralph, G.L. Hunt, M.G. Raphael, and J.F. Piatt (eds). Ecology and conservation of the marbled murrelet. General Technical Report. PSW-GTW-152. Pacific Southwest Experimental Station, U.S. Forest Service, Albany, California. 420 pp.

Suttle, K. B., M. E. Power, J. A. Levine and F. C. McNeely. 2004. How fine sediment in river beds impairs growth and survival of juvenile salmonids. Ecological Applications 14:969-974
Taylor, B.E., S. Pollard, and D. Louie. 1999. Mitochondrial DNA variation in bull trout (Salvelinus confluentus) from northwestern North America: implications for zoogeography and conservation. Molecular Ecology 8:1155-1170.

Thomas, G. 1992. Status of bull trout in Montana. Report prepared for Montana Department of Fish, Wildlife and Parks, Helena, Montana.

Traill, L.W., B.W. Brook, R.R. Frankham, and C.J.A. Bradshaw. 2009. Pragmatic population viability targets in a rapidly changing world. Biological Conservation 143(1):28-34.

Trooien, T. P., F. R. Lamm, L. R. Stone, M. Alam, G. A. Clark, D. H. Rogers, G. A. Clark, and A. J. Schlegel. 2000. Subsurface drip irrigation using livestock wastewater: Dripline flow rates. Applied Engineering in Agriculture 16(5):505-508.

Upendram, S. and J.M. Peterson. 2007. Irrigation Technology and Water Conservation in the High Plains Aquifer Region. Journal of Contemporary Water Research and Education 137:40-46.

USDA (U.S. Department of Agriculture), and USDI (U.S. Department of the Interior). 1995. Decision Notice/Decision Record Finding of No Significant Impact, Environmental Assessment for the Interim Strategies for Managing Anadromous Fish-producing Watersheds in Eastern Oregon, and Washington, Idaho, and portions of California (PACFISH).

USFWS (U.S. Fish and Wildlife Service). 1983a. Endangered and threatened species listing and recovery priority guidelines. Federal Register 48:43098–43105.

USFWS (U.S. Fish and Wildlife Service). 1992. Endangered and threatened wildlife and plants; determination of threatened status for the Washington, Oregon, and California population of the marbled murrelet, final rule. Fish and Wildlife Service, Federal Register 50 CFR 17: 45328-45337.

USFWS (U.S. Fish and Wildlife Service). 1993. Determination of Endangered Status for the Oregon Chub. FR (58):53800-53804.

USFWS (U.S. Fish and Wildlife Service). 1996. Endangered and threatened wildlife and plants; determination of critical habitat for the marbled murrelet; final rule. Federal Register, 50 CFR 17: 26256-26320.

USFWS (U.S. Fish and Wildlife Service). 1997. Recovery plan for the threatened marbled murrelet (Brachyramphus marmoratus) in Washington, Oregon, and California. Fish and Wildlife Service, Portland, Oregon. 203 pp.

USFWS and NMFS (U.S. Fish and Wildlife Service and National Marine Fisheries Service). 1998. Endangered Species Consultation Handbook: Proceedures for conducting consultation and conference activities under section 7 of the Endangered Species Act.

USFWS (U.S. Fish and Wildlife Service). 1998a. Bull Trout Facts. Portland, OR

USFWS (U.S. Fish and Wildlife Service). 1998b. Recovery Plan for the Oregon Chub. Portland, OR. 86pp.

USFWS (U.S. Fish and Wildlife Service). 1999. Matrix of Pathway and Indicators. A assessment tool for section 7 consultations.

USFWS (U.S. Fish and Wildlife Service). 2002a. Bull trout (Salvelinus confluentus) draft recovery plan - Chapter 1: Introduction. U.S. Fish and Wildlife Service, Portland, Oregon, October, 2002, 137 pp.

USFWS (U.S. Fish and Wildlife Service). 2002b. Bull trout (Salvelinus confluentus) draft recovery plan - chapter 2 Klamath River. U.S. Fish and Wildlife Service, Portland, Oregon.

USFWS (U.S. Fish and Wildlife Service). 2002c. Bull trout (Salvelinus confluentus) draft recovery plan - Chapter 25 Saint Mary- Belly River. U.S. Fish and Wildlife Service, Portland, Oregon.

USFWS (U.S. Fish and Wildlife Service). 2002d. Chapter 20 of the bull trout (Salvelinus confluentus) draft recovery plan: Lower Columbia Recovery Unit, Washington. USFWS, Region 1, Portland, Oregon, 102 pp.

USFWS (U.S. Fish and Wildlife Service). 2002e. Chapter 9 of the bull trout (Salvelinus confluentus) draft recovery plan: John Day Recovery Unit, Washington. USFWS, Region 1, Portland, Oregon, 102 pp.

USFWS (U.S. Fish and Wildlife Service). 2003a. Short-term action plan for Lahontan cutthroat trout (Oncorhynchus clarki henshawi) in the Truckee River basin. U.S. Fish and Wildlife Service, Reno, Nevada. August, 2003. i-iv + 71 pp.

USFWS (U.S. Fish and Wildlife Service). 2003e. Appendix 1: Estimates of distances at which incidental take of murrelets and spotted owls due to harassment are anticipated from sound-generating, forest-management activities in Olympia National Forest, from the Biological Opinion and Letter of Concurrence for effects to bald eagles, marbled murrelets, northern spotted owls, bull trout, designated critical habitat for marbled murrelets and northern spotted owls from Olympic National Forest program of activities for August 5, 2003 to December 31, 2008 (FWS reference number 1-3-03-F-0833).

USFWS (U.S. Fish and Wildlife Service). 2004a. Draft Recovery Plan for the Coastal-Puget Sound Distinct Population Segment of Bull Trout (Salvelinus confluentus). U.S. Fish and Wildlife Service, Portland, Oregon.

USFWS (U.S. Fish and Wildlife Service). 2004b. Draft Recovery Plan for the Jarbidge Distinct Population Segment of Bull Trout (Salvelinus confluentus). U.S. Fish and Wildlife Service, Portland, Oregon.

USFWS (U.S. Fish and Wildlife Service). 2004e. Marbled murrelet 5-year review process: overview. Portland, Oregon. 28 pp.

USFWS (U.S. Fish and Wildlife Service). 2005. Chapter 5, Willamette River Recovery Unit, Oregon. 147p. In: U.S. Fish and Wildlife Service. Bull Trout (Salvelinus confluentus) Draft Recovery Plan. Portland, Oregon.

USFWS (U.S. Fish and Wildlife Service). 2005a. Chapter 5, Willamette River Recovery Unit, Oregon. 147 p. In: U.S. Fish and Wildlife Service. Bull Trout (Salvelinus confluentus) Draft Recovery Plan. Portland, Oregon.

USFWS (U.S. Fish and Wildlife Service). 2008a. Bull Trout (*Salvelinus confluentus*) 5-year review: Summary and evaluation. Portland, OR. 53 pp

USFWS (U.S. Fish and Wildlife Service). 2008b. 5-Year Status Review, Oregon chub (Oregonichthys crameri) . Portland, OR. 34 pp.

USFWS (U.S. Fish and Wildlife Service). 2008c. Biological opinion on the continued operation and maintenance of the Willamette River Basin Project and Effects to Oregon chub, bull trout, and bull trout critical habitat designated under the Endangered Species Act. Oregon Fish and Wildlife Office, Portland, Oregon. 205 pp.

USFWS (U.S. Fish and Wildlife Service). 2008d. Bull trout draft core area templates - complete core area by core area analysis. W. Fredenberg and J. Chan, editors. U. S. Fish and Wildlife Service. Portland, Oregon. 1,895 pages.

USFWS (U.S. Fish and Wildlife Service). 2009a. Programmatic Safe Harbor Agreement for the Oregon Chub. Portland, Oregon. 29 pp.

USFWS (U.S. Fish and Wildlife Service). 2009d. Marbled Murrelet (Brachyramphus marmoratus) 5 year review. U.S. Fish and Wildlife Service, Washington Fish and Wildlife Office, Lacey, WA, June 12, 2009. 108 pages.

USFWS (U.S. Fish and Wildlife Service). 2010a. Final Rule: Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for Oregon chub (Oregonichthys crameri). Federal Register 75: 11010-11067.

USFWS (U.S. Fish and Wildlife Service). 2010b. Final Rule, Correction: Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for Oregon chub (Oregonichthys crameri). Federal Register 75: 18107-18110.

USFWS (U.S. Fish and Wildlife Service). 2010c. Final Rule: Endangered and Threatened Wildlife and Plants; Reclassification of the Oregon Chub from Endangered to Threatened. Federal Register 75: 21179-21189.

USFWS (U.S. Fish and Wildlife Service). 2011a. http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=E065

USFWS (U.S. Fish and Wildlife Service). 2011b. Endangered and Threatened Wildlife and Plants; Revised Designation of Critical Habitat for the Marbled Murrelet: Final Rule. Federal Register 76: 61599-61621.

USFWS (U.S. Fish and Wildlife Service). 2013. Endangered and Threatened Wildlife and Plants; Initiation of 5-Year Status Reviews of 44 Species in Oregon, Hawaii, Guam, and the Northern Mariana Islands. Federal Register 78: 8185-8187.

USFWS (U.S. Fish and Wildlife Service) and NMFS (National Marine Fisheries Service). 1996. Policy Regarding the Recognition of Distinct Vertebrate Population Segments Under the Endangered Species Act. Federal Register 61: 4721-4725.

Venhuizen, D (1998). Sand filter/Drip irrigation systems solve water resources problems. In proceedings of the Eighth National Symposium on Individual and Small Community Sewage systems, American Society of Agricultural Engineers, St. Joseph, USA.

Vogel, J. L. and D.A.Beauchamp. 1999. Effects of light, prey size, and turbidity on reaction distances of lake trout (*Salvelinus namaycush*) to salmonid prey. Canadian Journal of Fisheries and Aquatic Sciences 56: 1293-1297.

Waterhouse, F. L., R. Bradley, J. Markila, F. Cooke, and L. Lougheed. 2002. Use of airphotos to identify, describe, and manage forest structure of marbled murrelet nesting habitat at a coastal British Columbia site. British Columbia Forest Service, Nanaimo, Canada. 19 pages.

WDFW (Washington Department of Fish and Wildlife). 1997. Grandy Creek trout hatchery biological assessment. FishPro Inc., and Beak Consultants.

WDFW (Washington Department of Fish and Wildlife). 1998. Washington State Salmonid Stock Inventory: Bull Trout/Dolly Varden. Washington Department of Fish and Wildlife, Fish Management. 437 pp.

WDFW, WDOT WDOE, and USACE (Washington Department of Fish and Wildlife, Washington Department of Transportation, Washington Department of Ecology, and the U.S. Army Corps of Engineers). 2003. Integrated Streambank Protection Guidelines, various pagination (April 2003) (http://www.wdfw.wa.gov/hab/ahg/ispgdoc.htm)

WDOE (Washington Department of Ecology). 2002. Evaluating criteria for the protection of freshwater aquatic life in Washington's surface water quality standards - dissolved oxygen: Draft discussion paper and literature summary. Publication Number 00-10-071. Washington Department of Ecology, Olympia, WA, 90 pp.

WWF (World Wildlife Fund). 2003. Buying time: a user's manual for building resistance and resilience to climate change in natural systems. Editors: L.J. Hansen, J.L Biringer, and J.R. Hoffman.

Ward, B. R., D. J. F. McCubbing and P. A. Slaney. 2003. Evaluation of the addition of inorganic nutrients and stream habitat structures in the Keogh River watershed for steelhead trout and coho salmon. Pages 127–148 in J. Stockner, editor. Nutrients in salmonid ecosystems: sustaining production and biodiversity. American Fisheries Society, Symposium 34, Bethesda, Maryland.

Ward, F. A. and M. Pulido-Velazquez. 2008. Water conservation in irrigation can increase water use. Proceedings of the National Academy of Sciences of the United States of America 105(47): 18215-18220.

Warren, C.E. 1971. Biology and water pollution control. W. B. Saunders Co., Philadelphia, Pennsylvania. 434 p.

Waters, T.F. 1995. Sediment in streams: sources, biological effects and control. American Fisheries Society, Bethesda, Md. 251 p.

Watson, G., and T.W. Hillman. 1997. Factors affecting the distribution and abundance of bull trout: and investigation at hierarchical scales. North American Journal of Fisheries Management 17:237-252.

Wedemeyer, G. A., B. A. Barton and D. J. McLeay. 1990. Stress and acclimation. *In*C. B. Schreck and P. B. Moyle, editors. Methods for fish biology, pp. 451–489. American Fisheries Society, Bethesda, Maryland.

WDOE (Washington Department of Ecology). 2002. Evaluating criteria for the protection of freshwater aquatic life in Washington's surface water quality standards - dissolved oyxgen: Draft discussion paper and literature summary. Publication Number 00-10-071. Washington Department of Ecology, Olympia, WA, 90 pp.

Whiteley, A.R., P. Spruell, F.W. Allendorf. 2003. Population Genetics of Boise Basin Bull Trout (Salvelinus confluentus). University of Montana, Division of Biological Sciences. Report to the U.S. Forest Service, Rocky Mountain Research Station, Boise, ID.

Whitesel, T.A. and 7 coauthors. 2004. Bull trout recovery planning: A review of the science associated with population structure and size. Science Team Report #2004-01, U.S. Fish and Wildlife Service, Region 1, Portland, Oregon.

Whitworth, D.L., S.K. Nelson, S.H. Newman, G.B. Van Vliet, and W.P. Smith. 2000. Foraging distances of radio-marked marbled murrelets from inland areas in southeast Alaska. Condor 102(2):452-456.

Williams, J.G., S.G. Smith, R.W. Zabel, W.D. Muir, M.D. Scheuerell, B.P. Sandford, D.M. Marsh, R.A. McNatt, and S. Achord. 2005. Effects of the Federal Columbia River Power System on salmon populations. U.S. Department of Commerce. NOAA Technical Memorandum NMFS-NWFSC-63. 150 p. http://www.nwfsc.noaa.gov/assets/25/6061_04142005_152601_effectstechmemo63final.pdf.

Wisdom, M.J., R.S. Holthausen, B.C. Wales, C.D. Hargis, V.A. Saab, D.C. Lee, W.J. Hann, T.D. Rich, M.M. Rowland, W.J. Murphy, and M.R. Eames. 2000. *Source habitats for terrestrial vertebrates of focus in the Interior Columbia Basin: Broad-scale trends and management implications*. General Technical Report, PNW-GTR-485. Portland, Oregon: Pacific Northwest Research Station, USDA Forest Service. 3 Volumes. Available online at http://www.icbemp.gov/sourcehabitat/docs/ (October 19, 2006).

Wissmar, R. C., J. E. Smith, B. A. McIntosh, H. W. Li, G. H. Reeves, and J. R. Sedell. 1994. A history of resource use and disturbance in riverine basins of eastern Oregon and Washington (early 1800s-1990s). Northwest Science 68:1-35.

Wood, T.M. 2001. Herbicide use in the management of roadside vegetation, western Oregon, 1999-2000: Effects on the water quality of nearby streams. U.S. Geological Survey. Water-Resources Investigations Report 01–4065. Portland, Oregon. http://or.water.usgs.gov/pubs_dir/Pdf/01-4065.pdf.

Ziller, J. S. 1992. Distribution and relative abundance of bull trout in the Sprague River subbasin, Oregon. Pages 18-29 in P.J. Howell, and D.V. Buchanan, eds. Proceedings of the Gearhart Mountain Bull Trout Workshop. Oregon Chapter of the American Fisheries Society, Corvallis, Oregon.

Appendix A – HIP III Reporting Process

Bonneville Power Administration's (BPA) habitat improvement program requires project notifications via email for each set of contract actions implemented under the terms and conditions of the Services HIP III BOs. This appendix contains BPA's internal standard operating procedures for submission of those email notifications. These procedures are subject to change based on annual review by BPA, FWS and NMFS.

For each project, environmental leads on the contract will submit a completed Project Notification/Completion form to a BPA HIP_Reporting mailbox for QA/QC**.** The HIP_Reporting mailbox manager will check the form before forwarding to FWS (hip3@fws.gov) and/or NMFS (hip.nwr@noaa.gov) for approval. Incomplete or incorrect forms will be returned and corrected forms must be re-submitted to the HIP_Reporting mailbox. The Project Notification/Completion (PNC) form (included within Appendix A) can be used to request approval of a minor variance when necessary. The "project completion" section of the form is for reporting success in meeting project requirement and fish capture/mortality.

The PNC form shall be submitted exclusively to the HIP_Reporting mailbox manager (currently Israel Duran) for BPA Environmental Compliance staff.

- Each email shall have only one PNC form attached.
- Each form will be for a single project. Please Note: If a contract has several phases that will be submitted at different times, please number each phase with the contract number and then the letter A, B, and so on (i.e. 47997A, 47997B, 47997C, etc.). This helps the HIP III email monitor to attach all the appropriate paperwork for each work element submission and prevents confusion.
- Follow the detailed instructions on the PNC form and enter information accurately. Inspect to ensure that all the appropriate boxes are checked in each section and that a signature is applied (typewritten name) and dated at the end of the form. It will be returned if this is not filled in.
- Forms will be forwarded to the FWS and NMFS email box in Adobe pdf format. If sent in any other format they will be returned.
- BPA will ensure that only a single PNC is submitted for the final project to prevent multiple submittals for a single project.
- The FWS and NMFS email box will be used only for submissions of standard forms as described herein. Do not send any other email correspondence to this address.

<u>When addressing HUC Number and HUC Name:</u>

- If the project is completely located within 1 HUC
  - provide 6th field level HUC number and name
- If the project covers less than or equal to 3 HUCs
  - determine a primary HUC and list it first as NMFS will enter only this HUC into the database
  - list all of the HUCs and Names in the following format –

6th field level HUC/Name; 6th field level HUC/Name; 6th field level HUC/Name

- If the project covers greater than or equal to 4 HUCs

  - List the 5th field level HUC number and name which envelopes all 6th field level HUCs
  - Include a note on the Project Notification form stating why the HUCs are listed at the 5th field level

Please pay particular attention to the email subject line conventions. Deviation from subject line conventions will obstruct notification processing, and constitutes noncompliance with terms and conditions. The common format for all HIP III email subject lines is:

FWS Field Office/NMFS branch office, notification type, project contact, water body, county, state.

The FWS Field Office or NMFS branch office with responsibility for the geographic area of a project is determined from the FWS field office jurisdiction maps in this BO (Appendix B) and NMFS branch office maps provided to BPA.

Notification type is one of four: notification, variance, completion, or withdrawal. **Project contact** is the first and last name of a single person that will be most familiar with and in control of the ongoing project and need not necessarily be a BPA employee. **Water body** is the name of the stream or river mostly affected by the project. **County** and **state** describe the project's location and if working in a water body dividing two counties/states list the county/state most affected by the project. Use two-letter state code.

The following are examples of subject line format:
1. **Eastern Oregon**, **notification,** John Doe, Rock Creek, Gilliam, OR.
2. **North Idaho**, **completion,** Dave Black, Lolo Creek, Clearwater, ID.
3. **Eastern Washington**, **withdrawal,** Bill Smith, Toppenish Creek, Yakima, WA.
4. **South Idaho**, **variance,** Jane Jones, Pahsimeroi River, Custer, ID.

Project Notification (without a minor variance request): Shall be submitted prior to commencement of any project activities that may affect listed species covered under the Services BOs. Follow the detailed instructions on the standard PNC form. All engineering design review must be completed prior to submission. Use the term "notification" in the email subject line. You will not receive a return-reply from FWS or NMFS. Should the need for a minor variance request and approval arise after this form is submitted, follow the instructions below for *Variance Request After Notification.*

Project Notification (with a minor variance request): If it is known that the project will require a minor variance request review at the notification stage, include the request on the standard PNC form. The form shall be submitted at least 30 days before commencement of any project activities that may affect listed species covered under the Services BOs. All engineering design review must be completed prior to project notification form submission. Follow he detailed instructions on the standard notification form. The “variance explanation” should explain why a minor variance is needed, and should provide persuasive rationale why the variance will not result in effects beyond those considered in the HIP III BO and incidental take authorization. Variances will not be granted for proposed changes that cause effects beyond those considered in the HIP III. Variance approval or disapproval will be provided by reply email from the FWS Field Office supervisor and/or NMFS branch chief responsible for the geographic area of the proposed project, to the “from” address of the BPA Environmental Compliance Lead submitting the request, with CC to: **nwr.hip@noaa.gov**, and FWS HIP mailbox hip3@fws.gov generally within two weeks of the request date. There will be no further opportunity for discussion of the variance request after a decision is made. BPA must have the variance approval in hand before commencement of any project activities that may affect listed salmon. FWS Field Office supervisors and NMFS Branch chiefs will reply only to variance requests. Use the term "variance" in the email subject line.

Variance Request After Notification: If a minor variance request was not foreseen and thus not requested on the original PNC form, fill in the minor variance request section of the original PNC form following closely the detailed instructions. Email the form to HIP_Reporting for review. Upon review it will be forwarded to the FWS hip mailbox hip3@fws.gov and **hip.nwr@noaa.gov** and then to the appropriate FWS Field Office supervisor or NMFS branch chief. The form should be submitted at least 30 days before commencement of any project activities that may affect federally listed species. Use the term "variance" in the email subject line. The “variance explanation” should explain why a minor variance is needed, and should provide persuasive rationale why the variance will not result in effects beyond those considered in the HIP III BO and incidental take authorization. Variances will not be granted for proposed changes that cause effects beyond those considered in the HIP III. Variance approval or disapproval will be provided by reply email from the FWS Field Office supervisor and/or NMFS branch chief responsible for the geographic area of the proposed project, to the “from” address of the BPA Environmental Compliance Lead submitting the request with CC to: FWS hip mailbox hip3@fws.gov and NMFS hip mailbox **hip.nwr@noaa.gov**, generally within two weeks of the request date. There will be no further opportunity for discussion of the variance request after a decision is made. BPA must have the variance approval in hand before commencement of any project activities that may affect listed species. Field Office supervisors and Branch chiefs will reply only to variance requests.

Project Completion: Shall be submitted within 120-days after project completion. Follow closely the detailed instructions on the standard PNC form. The 120-day countdown begins based on the "proposed project end date" provided on the PNC form. Use the term “completion" in the email subject line. Make sure that all sections are filled in prior to submitting the form. Submit the PNC form to HIP_Reporting for review. Upon review it will be forwarded to FWS hip mailbox hip3@fws.gov and/or NMFS h**ip.nwr@noaa.gov** and then to the appropriate FWS Field Supervisor and/or NMFS branch chief.

Withdrawal: There is no standard form to request the withdrawal of a submitted PNC form. Send a withdrawal request to the HIP _Reporting mailbox using the term "withdrawal" in the email subject line, and provide the reason for the withdrawal in the body of the email or as an attachment. Upon review it will be forwarded to FWS hip3@fws.gov and/or NMFS **hip.nwr@noaa.gov** and then to the appropriate FWS Field Office supervisor and/or NMFS branch chief. If a previously submitted project is rejected by the branch chief, then the HIP III mailbox manager will go into PCTS and show the project as “withdrawn” to take away the “active” status of the project. If a previously withdrawn project must be resubmitted, submit it as a new PNC form. Should the scope of a project expand after the PNC form has been submitted to FWS and/or NMFS (as could occur in a Fish Accord “expansion” project when additional work elements are added to a current contract), the BPA Staff would proceed through the Withdrawal Process and Re-submit a new PNC form with the additional activities included. BPA staff will contact BPA’s KEC HIP III FWS and NMFS liaison who will call FWS and/or NMFS and inform them of the change.

Special Note to BPA Staff: Correct and consistent operation of this email reporting system is crucial to the required implementation tracking of the HIP III biological opinions. The forms are entered into FWS and NMFS tracking systems when sent to the email address, therefore:

- Please do not send any email submission prematurely or carelessly.
- Be certain that all form fields are filled-in accurately, instructions are followed correctly, and form sections are complete.
- Wait until a project design and schedule are complete and final before submitting a PNC form.
- Avoid the need for a withdrawal by considering the project in its entirety before submitting a PNC form.
- Design projects to comply with the specific HIP III BO terms and conditions and mitigation measures for the project's actions.
- Avoid variance requests by thoroughly considering all actions and timing and possible difficulties with the proposed project implementation, and design the project around these issues as it is preferred that the project remains in compliance with the HIP III BOs terms and conditions and mitigation measures. Variance requests can be denied.
- It is **BPA’s responsibility to ensure that proposed projects are consistent with all HIP III criteria.** The HIP_Reporting mailbox manager will check forms before forwarding to FWS and NMFS for approval. Incomplete or incorrect forms will be returned and must be resubmitted to HIP_Reporting with corrections. FWS and NMFS will not routinely review PNC forms for compliance with the HIP III BO; however, the FWS and NMFS mailbox managers will consistently check whether the forms are filled in correctly before forwarding to the field for approval. If they are missing items or are incorrectly filled in, they will be returned to the HIP_Reporting mailbox manager and must be re-submitted once the corrections are made.
- Always submit a PNC form within 120 days after the project is complete. The 120-day countdown begins based on the "proposed project end date" provided on the PNC form.

NMFS Internal Administration: The mailbox manager will check the mailbox daily and forward each email to the chief of the branch office indicated at the start of the subject line. At that time, or at least weekly, the mailbox manager will make a PCTS entry for each submission and save the email and attachment electronically to "S:\Doc_Rec_Mngt\Read File\Programmatic Implementation Records\HIP 3" electronic docket file in Portland. Branch chiefs will reply only to variance requests. Chiefs will reply to the "from" address of the BPA Environmental Compliance Lead, with CC to NMFS, generally within two weeks of the request date. Branch offices will not maintain administrative record ("docket file") of HIP III implementation.

HIP III Programmatic - Consultation
Project Notification/Completion Form (Revised 7/17/13)

Bonneville Power Administration environmental staff will review and submit this completed action notification form with the following information to the project sponsor and to the appropriate consulting agency (NMFS/USFWS).

Lead Action Agency: BPA		
NMFS Tracking #: 2013/9724	**Statutory Authority:** ☐ ESA & EFH ☐ ESA	**USFWS Tracking #: 01EOFW00-2013-F-0199**

Date of Request: __________

Project Title: __________

BPA Project #: __________ **BPA Contract #:** __________

BPA EC Contact: __________ **Phone:** __________

Project Sponsor Contact: __________ **Phone:** __________

Project Design Contact: __________ **Phone:** __________

NMFS Branch Office: __________

USFWS Field Office: __________

Lat/Long: (in decimal degrees) __________ **Datum:** __________

6th Field HUC: __________ **HUC Name:** __________

Project Start Date: __________ **Project End Date:** __________

(Project Completion Form due ≤60-days after this date)

Is the Project Herbicide Application only?	Yes ☐ No ☐
Does the project require near- and/or in-water construction?	Yes ☐ No ☐
Does the project require near- and/or in-water work (no construction)?	Yes ☐ No ☐
Does the project require work area isolation?	Yes ☐ No ☐
Does the project require fish salvage?	Yes ☐ No ☐
Will the project increase the amount of impervious surfaces?*	Yes ☐ No ☐
Does the project require a variance?	Yes ☐ No ☐

**** A stormwater management plan will be required.***

Project Description (include O&M Plan if required)

List the project activities and describe the intended result(s); tell when the project is to occur; describe how the activities will be implemented; provide any other pertinent information. Please include Work Element for each activity.

Minor Variance Request

Describe how the effects of the requested variance fall within the range of effects described for the proposed activities in the HIP III Opinion, by addressing the following:

1) Define the requested variance and the relevant criterion by page number.
2) Environmental conditions anticipated at the time of the proposed work (flow and weather conditions).
3) Biological justification as to why a variance is necessary and a brief rationale why the variance will either provide a conservation benefit or, at a minimum, not cause additional adverse effects beyond the scope of the Opinion.
4) Include as attachments any necessary approvals from state agencies.

NMFS Species/Critical Habitat Present in Action Area:

Anadromous Fish:

- ☐ Lower Columbia River Chinook
- ☐ Lower Columbia River coho
- ☐ Lower Columbia River steelhead
- ☐ Middle Columbia River steelhead
- ☐ Upper Columbia River spring-run Chinook
- ☐ Upper Columbia River steelhead
- ☐ Columbia River chum
- ☐ Green sturgeon
- ☐ Upper Willamette River Chinook
- ☐ Upper Willamette River steelhead
- ☐ Snake River spring/summer-run Chinook
- ☐ Snake River fall-run Chinook
- ☐ Snake River Basin steelhead
- ☐ Snake River sockeye
- ☐ Pacific eulachon

Marine Mammals:

- ☐ Steller sea lion

Essential Fish Habitat Species:

- ☐ Salmon (West Coast Salmon FMP)
- ☐ Estuarine Composite (Ground fish, pelagics)

USFWS Species/Critical Habitat Present in Action Area:

Freshwater Fish Species:

- ☐ Bull Trout
- ☐ Oregon Chub

Mammalian Species:

- ☐ Canada lynx
- ☐ Gray wolf
- ☐ North American wolverine
- ☐ Pygmy rabbit
- ☐ Columbian White-tailed Deer
- ☐ Grizzly Bear
- ☐ Northern Idaho ground squirrel
- ☐ Woodland caribou

Avian Species:

- ☐ Marbled murrelet
- ☐ Streaked horned lark
- ☐ Northern spotted owl
- ☐ Western snowy plover

Invertebrate Species:

- ☐ Banbury Springs limpet
- ☐ Bruneau Hot springsnail
- ☐ Fender's blue butterfly
- ☐ Taylor's checkerspot butterfly
- ☐ Bliss Rapids snail
- ☐ Snake River Physa snail
- ☐ Oregon silverspot butterfly

Plant Species:

- ☐ Bradshaw's lomatium
- ☐ Gentner's fritillary
- ☐ Howell's spectacular thelypody
- ☐ Large-flowered wooly meadowfoam
- ☐ McFarlane's four o'clock
- ☐ Rough popcorn flower
- ☐ Slickspot peppergrass
- ☐ Umtanum Desert buckwheat
- ☐ Western lily
- ☐ White Bluffs bladderpod
- ☐ Cook's lomatium
- ☐ Golden paintbrush
- ☐ Kincaid's lupine
- ☐ Malheur wire-lettuce
- ☐ Nelson's checkermallow
- ☐ Showy stickseed
- ☐ Spalding's catchfly
- ☐ Wenatchee Mountain checkermallow
- ☐ Willamette daisy

Types of Action:

Identify the types of action(s) proposed.

1. Fish Passage Restoration (Profile Discontinuities)

- ☐ a. Dams, Water Control or Legacy Structure Removal
- ☐ b. Consolidate, or Replace Existing Irrigation Diversions
- ☐ c. Headcut and Grade Stabilization
- ☐ d. Low Flow Consolidation
- ☐ e. Providing Fish Passage at an Existing Facility

Fish Passage Restoration (Transportation Infrastructure)

- ☐ f. Bridge and Culvert Removal or Replacement
- ☐ g. Bridge and Culvert Maintenance
- ☐ h. Installation of Fords

2. River, Stream, Floodplain, and Wetland Restoration

- ☐ a. Improve Secondary Channel and Wetland Habitats
- ☐ b. Set-back or Removal of Existing, Berms, Dikes, and Levees
- ☐ c. Protect Streambanks Using Bioengineering Methods
- ☐ d. Install Habitat-Forming Natural Material Instream Structures (Large Wood, Boulders, and Spawning Gravel)
- ☐ e. Riparian Vegetation Planting
- ☐ f. Channel Reconstruction

3. Invasive and Non-Native Plant Control

- ☐ a. Manage Vegetation using Physical Controls
- ☐ b. Manage Vegetation using Herbicides

4. Piling Removal.

- ☐ Piling Removal

5. Road and Trail Erosion Control, Maintenance, and Decommissioning

- ☐ a. Maintain Roads
- ☐ b. Decommission Roads

6. In-channel Nutrient Enhancement

- ☐ In-channel Nutrient Enhancement

7. Irrigation and Water Delivery/Management Actions

- ☐ a. Convert Delivery System to Drip or Sprinkler Irrigation
- ☐ b. Convert Water Conveyance from Open Ditch to Pipeline or Line Leaking Ditches or Canals
- ☐ c. Convert from Instream Diversions to Groundwater Wells for Primary Water Sources
- ☐ d. Install or Replace Return Flow Cooling Systems
- ☐ e. Install Irrigation Water Siphon Beneath Waterway
- ☐ f. Livestock Watering Facilities
- ☐ g. Install New or Upgrade/Maintain Existing Fish Screens

8. Fisheries, Hydrologic, and Geomorphologic Surveys

- ☐ Fisheries, Hydrologic, and Geomorphologic Surveys

9. Special Actions (Terrestrial Species)

- ☐ a. Install/develop Wildlife Structures

☐ b. Fencing Construction for Livestock Control
☐ c. Implement Erosion Control Practices
☐ d. Plant Vegetation
☐ e. Tree Removal for LW Projects

NMFS Hydro Division Review

Does the project require approval from NMFS Hydro Division for:

Fish Passage Restoration Yes ☐ Date of NMFS approval:
No ☐
Bridge and Culvert Removal and Replacement Yes ☐ Date of NMFS approval:
No ☐
Install New or Upgrade/Maintain Existing Fish Screens Yes ☐ Date of NMFS approval:
No ☐

RRT REVIEW

Does the project contain any Medium or High Risk WEs that require RRT review? Yes ☐ No ☐

Date of RRT submittal: Date of RRT Approval: RRT Reviewer:

BPA Determination of Consistency with all Requirements of the HIP III Consultation

The BPA must certify that the proposed project is consistent with all requirements and applicable terms and conditions of the HIP III Consultation.

BPA EC Contact (constitutes your electronic signature): Date of Certification:

Project Completion reporting

Within 60 days of completing a project covered under the HIP III programmatic biological opinion, Bonneville Power Administration staff will review and submit this completed form with the following information to the project sponsor and-to NMFS at hip.nwr@noaa.gov and USFWS at hip@fws.gov.

Project Activity Start and End Dates: **Start**:12/31/31 **End**:12/31/31

Work Element	In-water Activities	Start Date	End Date
G	LWD	12/31/31	12/31/31

☐ **Check Box if project included instream work, but not in-water or near-water construction.**
☐ **Check Box if project included work area isolation.**

Fish Capture Reporting

The BPA will report the following information for all projects that involve work area isolation with associated fish capture and relocation. When available, provide a tally of ESA-listed salmonids by species and life stage.

Supervisory Natural Resource Specialist (name, contact info, address)		
Type of take	**Interior Columbia Basin**	**Lower Columbia (Hood River downstream) and Willamette**
Number of salmonids Captured		
Number of salmonids Injured		
Number of salmonids Killed		

Turbidity Reporting

The Project Sponsor shall complete and record the following water quality observations to ensure that any increase in suspended sediment is not exceeding the limit for HIP III compliance.

Work Element	**Upstream**			**Downstream**				
					0 hrs	**+4 hrs**	**+8 hrs**	**+12 hrs**
	Distance from turbidity source (ft)	Time	Measured Turbidity (NTUs)	Distance from turbidity source (ft)	Measured Turbidity (NTUs)	Measured Turbidity (NTUs)	Measured Turbidity (NTUs)	Measured Turbidity (NTUs)
G	100 ft	10:45	100	-50 ft	300	200	150	110

Linear extent of observed turbidity downstream	

Narrative Assessment

Provide a narrative assessment of the project sponsor's success in meeting all requirements including the terms and conditions of the HIP III BO consultation. Please include:

- For any action involving RRT review, a copy of information used to satisfy the data requirements and analysis as described below in the design criteria for the proposed activity.
- Photos of habitat conditions before, during, and after action completion.
- Any dates work ceased due to high flows.
- Evidence of compliance with fish screen criteria, for any pump used in fish-bearing waters.
- A summary of the results of pollution and erosion control inspections, including any erosion control failure, turbidity in exceedance of HIP III standards, contaminant release, and correction effort.
- The number, type, and diameter of any pilings removed or broken during removal.
- A description of the post-project condition of any riparian area cleared within 150 feet of Ordinary High Water.
- A description of site restoration completed and future site restoration plans.

Appendix B – Maps and Contacts for FWS Field Offices

The following list provides points of contact for this programmatic consultation for each FWS State office and associated Field Office's within the range of HIP III action area. The contacts below will likely direct species-specific inquiries to a local biologist or the species lead. Review and approval of variances and RRT reviews will require the signature of the following contacts for their respective areas of jurisdiction. The maps which follow (WA, OR, ID), provide information relative to areas of jurisdiction by each State and Field Office.

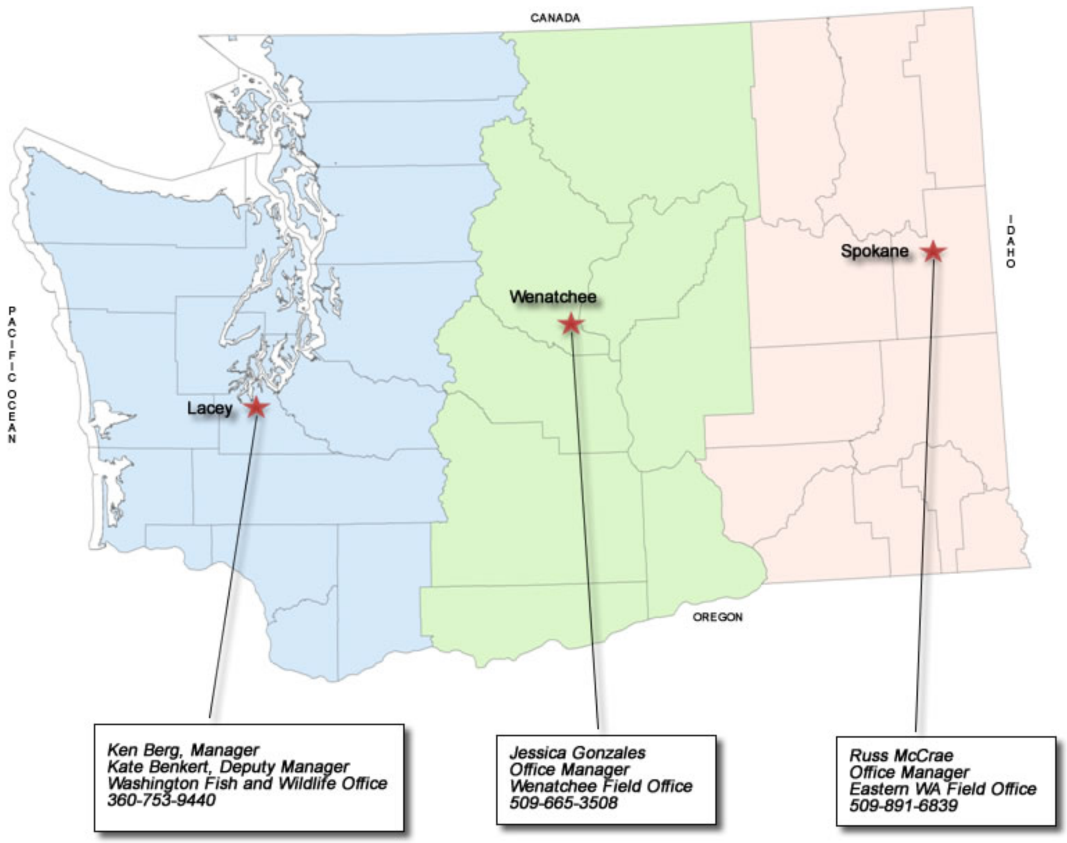
Washington Fish and Wildlife Office (WFWO)
Lacey (State Office) – Bridget Moran, Division Manager
Central Washington – Jessica Gonzales, FO Supervisor
Eastern Washington – Russ MacRae, FO Supervisor
**Michelle Eames – biologist and technical POC for WFWO for HIP III consultation

Oregon Fish and Wildlife Office (OFWO)
Portland (State Office) – ES Division Manager (Jeff Dillon)
Bend FO – Nancy Gilbert, FO Supervisor
La Grande FO – Gary Miller, FO Supervisor
Roseburg FO – Jim Thrailkill, FO Supervisor
Newport FO – Laura Todd, FO Supervisor
** Chris Allen – biologist in the Portland office and technical POC for OFWO for HIP III consultation

Idaho Fish and Wildlife Office (IFWO)
Boise (State Office) – Russ Holder, Assistant State Supervisor
Eastern Idaho FO – David Kampwerth, Field Office Supervisor
Northern Idaho FO – Ben Conard, Field Office Supervisor
**Pam Druliner – biologist & technical POC for IFWO for HIP III consultation

Montana Fish and Wildlife Office (MFWO)
Helena (State Office) – Jodi Bush, State Supervisor; Brent Esmoil, Assistant State Supervisor
Kalispel – Tim Bodurtha, Field Office Supervisor
**Shannon Downey – biologist & technical POC for MFWO for HIP III consultation

Washington


CANADA
IDAHO
PACIFIC OCEAN
OREGON
Spokane
Wenatchee
Lacey
Ken Berg, Manager
Kate Benkert, Deputy Manager
Washington Fish and Wildlife Office
360-753-9440
Jessica Gonzales
Office Manager
Wenatchee Field Office
509-665-3508
Russ McCrae
Office Manager
Eastern WA Field Office
509-891-6839