moderate cumulative spatial structure/diversity risk. Diversity risk will need to be reduced to low in order for this population to be considered highly viable, a requirement for recovery of the species (ICBTRT 2007).

Abundance and Productivity. Historical abundance of Snake River fall Chinook salmon is estimated to have been 416,000 to 650,000 fish (NMFS 2006a), but numbers declined drastically over the 20th century to natural returns of less than 100 fish in 1978 (ICBTRT 2010e). The first hatchery-reared Snake River fall Chinook salmon returned to the Snake River in 1981, and since then the number of hatchery returns has increased steadily, such that hatchery fish dominate the Snake River fall Chinook run. However, natural returns have also increased. The most recent 10-year (1998-2008) mean abundance of natural-origin fall Chinook passing Lower Granite Dam was 2,200 adults, and the most recent short-term trend in natural-origin spawners was strongly positive, with the population increasing at an average rate of 16% per year (Ford et al. 2010). However, current abundance remains below the ICBTRT's recovery goal of a minimum mean of 3,000 natural-origin spawners for the species' single extant population (Ford et al. 2010). Therefore, the ICBTRT assigned the population an abundance/productivity risk of moderate. The cumulative moderate risks for both abundance/productivity and spatial structure/diversity put this population at moderate risk of extinction over the next 100 years (ICBTRT 2010e).

Limiting Factors. Limiting factors and threats to Snake River fall-run Chinook salmon include the following (NOAA Fisheries 2011; NMFS 2006b):

- Lost access to historic spawning and rearing habitat above the Hells Canyon Dam complex;
- Mainstem Columbia River and Snake River hydropower impacts to spawning, rearing, and migration habitat;
- Alteration to freshwater habitat caused by upriver dams and water management. Major effects include changes in river flows, temperature regime, dissolved oxygen, substrate condition, and riparian vegetation;
- Hatchery-related effects;
- Harvest-related effects; and,
- Degraded estuarine and nearshore habitat.

2.2.1.4. Snake River Sockeye Salmon

This ESU includes all anadromous and residual sockeye salmon from the Snake River Basin, Idaho, as well as artificially propagated sockeye salmon from the Redfish Lake captive propagation program. The ESU was first listed as endangered under the ESA in 1991, the listing was reaffirmed in 2005 (70 FR 37160 & 37204). Reasons for the decline of this species include high levels of historic harvest, dam construction including hydropower development on the

Snake and Columbia Rivers, water diversions and water storage, predation on juvenile salmon in the mainstem river migration corridor, and active eradication of sockeye from Pettit, Stanley, and Yellowbelly Lakes in the 1950s and 1960s (56 FR 58619; ICBTRT 2003). On August 15, 2011, NMFS completed a 5-year review for the Snake River sockeye salmon ESU and concluded that the species should remain listed as endangered (76 FR 50448).

The Sawtooth Valley in central Idaho supports the only remaining run of Snake River sockeye salmon. Adult Snake River sockeye salmon enter the Columbia River primarily during June and July, and first arrive at Redfish Lake Creek in mid-July. Counts of migrating adult sockeye typically peak in August, but adult sockeye salmon continue arriving through early September. Spawning primarily occurs over submerged beach substrate in the lakes; however, recently IDFG staff has observed isolated instances of spawning occurring in the lake outlet (SNF 2011). The adults spawning activity peaks in mid-October (Bjornn *et al.* 1968). Eggs hatch in the spring between 80 and 140 days after spawning. Fry remain in the gravel for 3 to 5 weeks, emerge from April through May, and move immediately into the lake. Once there, juveniles feed on plankton for 1 to 3 years before they migrate to the ocean. Smolt out-migration from Redfish Lake begins in early April, peaks in mid-May, and is complete by mid-June (Bjornn et al. 1968). Snake River sockeye salmon usually spend 2 to 3 years in the Pacific Ocean and return to Idaho in their 4th or 5th year of life.

Spatial Structure and Diversity. Within the Snake River ESU, the ICBTRT identified historical sockeye salmon production in five Sawtooth Valley lakes, in addition to Warm Lake and the Payette Lakes in Idaho and Wallowa Lake in Oregon (ICBTRT 2003). The sockeye runs to Warm, Payette, and Wallowa Lakes are now extinct, and the ICBTRT identified the Sawtooth Valley lakes as a single MPG for this ESU. The MPG consists of the Redfish, Alturas, Stanley, Yellowbelly, and Pettit Lake populations (ICBTRT 2007). The only extant population is Redfish Lake, supported by a captive broodstock program. The ESU is entirely supported by adults produced through this captive propagation (broodstock) program at the present time. Hatchery fish from the Redfish Lake captive propagation program have also been outplanted in Alturas and Pettit Lakes since the mid-1990s in an attempt to "spread the risk" and reestablish those populations (Ford et al. 2010). Timing of releases are designed to emulate natural emigration patterns documented by Bjornn et al (1968). With such a small number of populations in this MPG, increasing the number of populations would substantially reduce the risk faced by the ESU (ICBTRT 2007).

Currently, the Snake River sockeye salmon run is highly dependent on a captive broodstock program operated at the Sawtooth and Eagle Hatcheries. Although the captive brood program rescued the ESU from the brink of extinction, diversity risk remains high without sustainable natural production (Ford et al. 2010).

Abundance and Productivity. Prior to the turn of the 20th century (ca. 1880), around 150,000 sockeye salmon ascended the Snake River to the Wallowa, Payette, and Salmon River Basins to spawn in natural lakes (Evermann 1896, as cited in Chapman et al. 1990). The Wallowa River sockeye run was considered extinct by 1905, the Payette River run was blocked by Black Canyon Dam on the Payette River in 1924, and anadromous Warm Lake sockeye may have been trapped in Warm Lake by a land upheaval in the early 20th century (ICBTRT 2003). In the Sawtooth Valley, IDFG eradicated sockeye from Yellowbelly, Pettit, and Stanley Lakes in favor of other species in the 1950s and 1960s, and irrigation diversions led to the extirpation of sockeye in Alturas Lake in the early 1900s (ICBTRT 2003) leaving only the Redfish Lake sockeye. From 1991 to 1998 a total of just 16 wild adult anadromous sockeye salmon returned to Redfish Lake. These 16 wild fish were incorporated into a captive broodstock program that began in 1992 and has since expanded so that the program currently releases hundreds of thousands of juvenile fish each year in the Sawtooth Valley (Ford et al. 2010). With the increase in hatchery production, adult returns to Sawtooth Valley have increased in past few years to 605 adults in 2008, 833 adults in 2009, and 1,355 adults in 2010 (IDFG 2011). The increased abundance of hatchery reared Snake River sockeye reduces the risk of immediate loss, yet levels of naturally produced sockeye returns remain extremely low (Ford et al. 2010). The ICBTRT's viability target is at least 1,000 naturally produced spawners per year in each of Redfish and Alturas Lakes and at least 500 in Pettit Lake (ICBTRT 2007).

The species remains at high risk across all four risk parameters (spatial structure, diversity, abundance, and productivity). Although the captive brood program has been highly successful in producing hatchery *O. nerka*, substantial increases in survival rates across all life history stages must occur in order to reestablish sustainable natural production (Ford et al. 2010).

Limiting Factors. Low survival rates outside of the Sawtooth Valley are limiting the recovery of the species (NMFS 2011):

- Migrating juvenile sockeye are heavily impacted by the hydrosystem on the mainstem Snake and Columbia Rivers.

- Predation on juvenile sockeye in the migration corridor is assumed to he high; piscivorous fish consume an estimated 8% of migrating juvenile salmon and terns and cormorants consume 12% of all salmon smolts reaching the estuary (NOAA Fisheries 2011).

- For returning adults, portions of the migration corridor in the Salmon River are impeded hy water quality and high temperature (IDEQ 2011). The natural hydrological regime in the upper mainstem Salmon River Basin has been altered by water withdrawals, which can lead to elevated summer water temperatures. In many years, sockeye adult returns to Lower Granite Dam suffer relatively high losses before reaching the Sawtooth Valley, perhaps due to high migration corridor water temperatures and poor initial fish condition or parasite loads (Ford et al. 2010).

2.2.2. Status of Critical Habitat

NMFS reviews the status of designated critical habitat affected by the proposed action by examining the condition and trends of essential physical and biological features throughout the designated area. These features are essential to the conservation of the listed species because they support one or more life stages of the species. NMFS refers to these features as the PCEs of critical habitat. Since the ESA-listed species addressed in this Opinion occupy many of the same geographic areas and have similar life history characteristics, PCEs are also similar (Table 8). In general, these PCEs include sites essential to support one or more life stages of the ESA-listed species (e.g., spawning, rearing, or migration), and contain physical or biological features essential to the conservation of the listed species (e.g., spawning gravels, water quality and quantity, side channels, or food).

Table 8. Types of sites and essential physical and biological features designated as PCEs, and the species life stage each PCE supports (70 FR 52630 and 58 FR 68543).

Site Type	Essential Physical and Biological Features	Species Life Stage
Snake River Steelhead[a]		
Freshwater spawning	Water quality, water quantity, and substrate	Adult spawning, embryo incubation, and larval development
Freshwater rearing	Floodplain connectivity, forage[b], natural cover[c], water quality, and water quantity	Fry emergence from gravel, juvenile growth and development
Freshwater migration	Free of artificial obstructions, water quality and quantity, and natural cover[c]	Juvenile migration, adult migration and holding
Snake River Spring/Summer Chinook, Fall Chinook, & Sockeye Salmon		
Spawning and juvenile rearing	Spawning gravel, water quality and quantity, cover/shelter, food, riparian vegetation, space (sockeye and Chinook); water temperature and access (sockeye only)	Adult spawning, embryo incubation, and juvenile growth and development
Migration	Substrate, water quality and quantity, water temperature, water velocity, cover/shelter, food[d], riparian vegetation, space, safe passage (sockeye and Chinook)	Juvenile migration, adult migration and holding

a Additional PCEs pertaining to estuarine, nearshore, and offshore marine areas have also been described for Snake River steelhead. These PCEs will not be affected by the proposed action and have therefore not been described in this Opinion.

b Forage includes aquatic invertebrate and fish species that support growth and maturation.

c Natural cover includes shade, large wood, log jams, beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.

d Food applies to juvenile migration only.

Table 9 describes the geographical extent within Idaho of critical habitat for each of the four ESA-listed species. Critical habitat includes the stream channel and water column with the lateral extent defined by the ordinary high-water line, or the bankfull elevation where the ordinary high-water line is not defined. In addition, critical habitat for the three salmon species includes the adjacent riparian zone, which is defined as the area within 300 feet of the line of high water of a stream channel or from the shoreline of standing body of water (58 FR 68543). The riparian zone is critical because it provides shade, streambank stability, organic matter input, and regulation of sediment, nutrients, and chemicals.

Table 9. Geographical extent of designated critical habitat for ESA-listed species considered in this Opinion.

ESU/DPS	Designation	Geographical Extent of Critical Habitat in Idaho
Snake River sockeye salmon	58 FR 68543, December 28, 1993	Snake and Salmon Rivers; Alturas Lake Creek; Valley Creek, Stanley Lake, Redfish Lake, Yellowbelly Lake, Pettit Lake, Alturas Lake; all inlet/outlet creeks to those lakes
Snake River spring/summer Chinook salmon	58 FR 68543, December 28, 1993; 64 FR 57399, October 25, 1999	All river reaches presently or historically accessible, except river reaches above impassable natural falls and Dworshak and Hells Canyon Dams
Snake River fall Chinook salmon	58 FR 68543, December 28, 1993	Snake River to Hells Canyon Dam; Clearwater River from its confluence with the Snake River upstream to Lolo Creek; North Fork Clearwater River from its confluence with the Clearwater River upstream to Dworshak Dam; and all other river reaches presently or historically accessible within the Clearwater, Lower Clearwater, Lower Snake Asotin, Hells Canyon and Lower Salmon subbasins.
Snake River Basin steelhead	70 FR 52630, September 2, 2005	Specific stream reaches are designated within the Snake, Salmon, and Clearwater River Basins. Table 21 in the Federal Register details habitat areas within the DPS's geographical range that are excluded from critical habitat designation.

Spawning and rearing habitat quality in tributary streams in the Snake River varies from excellent in wilderness and roadless areas to poor in areas subject to intensive human land uses (NMFS 2011d). Critical habitat throughout much of the Snake River Basin has been degraded by intensive agriculture, alteration of stream morphology (*i.e.*, channel modifications and diking), riparian vegetation disturbance, wetland draining and conversion, livestock grazing, dredging, road construction and maintenance, logging, mining, and urbanization. Reduced summer stream flows, impaired water quality, and reduction of habitat complexity are common problems for critical habitat in non-wilderness areas. Human land uses throughout the basin have caused streams to become straighter, wider, and shallower, thereby reducing rearing habitat and increasing water temperature fluctuations.

In many stream reaches designated as critical habitat in the Snake River Basin, stream flows are substantially reduced by water diversions (NMFS 2011d). Withdrawal of water, particularly during low-flow periods that commonly overlap with agricultural withdrawals, often increases summer stream temperatures, blocks fish migration, strands fish, and alters sediment transport (Spence *et al.* 1996). Reduced tributary stream flow has been identified as a major limiting factor for Snake River spring/summer Chinook and Snake River Basin steelhead in particular (NMFS 2011; NMFS 2011b; NMFS 2011d).

Many stream reaches designated as critical habitat are listed on the state of Idaho's CWA section 303(d) list for impaired water quality, such as elevated water temperature (IDEQ 2011). Many areas that were historically suitable rearing and spawning habitat are now unsuitable due to high summer stream temperatures. Removal of riparian vegetation, alteration of natural stream morphology, and withdrawal of water for agricultural or municipal use all contribute to elevated stream temperatures. Water quality in spawning and rearing areas has also been impaired by high levels of sedimentation and by heavy metal contamination from mine waste (e.g., IDEQ and USEPA 2003; IDEQ 2001).

Migration habitat quality for Snake River salmon and steelhead has also been severely degraded, primarily by the development and operation of dams and reservoirs on the mainstem Columbia and Snake Rivers (NMFS 2008b). Hydroelectric development has modified natural flow regimes in the migration corridor, resulting in higher water temperatures, changes in fish community structure leading to increased rates of piscivorous and avian predation on juvenile salmon and steelhead, and delayed migration for both adult and juveniles. Physical features of dams such as turbines also kill migrating fish.

For many ESA-listed species of salmon and steelhead in the Pacific Northwest, NMFS convened a critical habitat analytical review team (CHART) to assess the conservation value of each watershed with designated critical habitat (NMFS 2005). Of the four Snake River species, a CHART assessment has only been completed for Snake River Basin steelhead. However, the PCEs/essential physical and biological features of critical habitat for each Snake River species are similar, and there is considerable overlap in the geographic extent of critical habitat areas. The CHART results presented below for steelhead therefore give an approximation of the conservation value of each watershed for other listed species, keeping in mind that fall Chinook and sockeye salmon do not occupy many of the smaller tributaries occupied by steelhead.

For Snake River Basin steelhead, NMFS ranked watersheds within designated critical habitat at the scale of the fifth-field HUC as to the conservation value they provide to the species[6]; conservation rankings are high, medium, or low. To determine the conservation value of each watershed to the species viability, the CHART for Snake River Basin steelhead evaluated the quantity and quality of habitat features (e.g., spawning gravels, wood and water condition, side channels), the relationship of the area compared to other areas within the species' range, and the significance to the species of the population occupying that area (NMFS 2005). Thus, even a location that has poor quality of habitat could be ranked at high conservation value if that location was essential due to factors such as limited availability (e.g., one of a very few spawning areas), the unique contribution of the population it served (e.g., a population at the extreme end of geographic distribution), or other important role (e.g., obligate area for migration to upstream spawning areas).

Table 10 shows the CHART's conservation ranking for watersheds in the Snake River Basin. The CHART determined that relatively few watersheds have PCEs in good to excellent condition (score 3), with no potential for additional improvement for steelhead habitat (also score 3). In Idaho, many of those watersheds are located in the Middle Fork Salmon River, Selway River, and Lochsa River drainages. Far more watersheds in the Snake River Basin are in fair-to-poor (score 1) or fair-to-good (score 2) condition, with some potential for improvement.

---

[6] The conservation value of a site depends upon "(1) the importance of the populations associated with a site to the ESU [or DPS] conservation, and (2) the contribution of that site to the conservation of the population through demonstrated or potential productivity of the area" (NMFS 2005).

Table 10. Current and potential quality of PCEs, by watershed, for Snake River Basin steelhead (NMFS 2005).

Subbasin (4th field HUCs) and Watershed Names (5th field HUC)s	Current Quality	Potential Quality
Lower Snake River #1706010xxx		
Snake River/Granite (101)	3	3
Upper Salmon & Pahsimeroi #1706020xxx		
Germania (111) & Warm Springs (114) Creeks; Lower Pahsimeroi River (201); Alturas Lake (120), Redfish Lake (121), Upper Valley (123) & West Fork Yankee (126) Creeks	3	3
Basin Creek (124)	3	2
Salmon River/Challis (101); East Fork Salmon River/McDonald Creek (105); Herd Creek (108); Upper East Fork Salmon River (110); Salmon River/Big Casino (115), Fisher (117) & Fourth of July (118) Creeks; Upper Salmon River (119); Valley Creek/Iron Creek (122); & Morgan Creek (132)	2	3
Salmon River/Bayhorse Creek (104); Salmon River/Slate Creek (113); Upper Yankee Fork (127) & Squaw Creek (128); Pahsimeroi River/Falls Creek (202)	2	2
Yankee Fork/Jordan Creek (125)	1	3
Salmon River/Kinnikinnick Creek (112); Garden Creek (129); Challis Creek/Mill Creek (130); & Patterson Creek (203)	1	2
Road Creek (107)	1	1
Unoccupied habitat in Hawley (410), Eighteenmile (411) & Big Timber (413) Creeks	Conservation Value for ST "Possibly High"	
Middle Salmon, Panther & Lemhi #1706020xxx		
Salmon River/Colson (301), Pine (303) & Moose (305) Creeks; Indian (304) & Carmen (308) Creeks, North Fork Salmon River (306); & Texas Creek (412)	3	3
Deep Creek (318)	3	2
Salmon River/Cow Creek (312) & Hat (313), Iron (314), Upper Panther (315), Moyer (316) & Woodtick (317) Creeks; Lemhi River/Whimpey Creek (402); Hayden (414), Big Eight Mile (408), & Canyon (408) Creeks	2	3
Salmon River/Tower (307) & Twelvemile (311) Creeks; Lemhi River/Kenney Creek (403); Lemhi River/McDevitt (405), Lemhi River/Yearian Creek (406); & Peterson Creek (407)	2	2
Owl (302) & Napias (319) Creeks	2	1
Salmon River/Jesse Creek (309); Panther Creek/Trail Creek (322); & Lemhi River/Bohannon Creek (401)	1	3
Salmon River/Williams Creek (310)	1	2
Agency Creek (404)	1	1
Panther Creek/Spring Creek (320) & Clear Creek (323)	0	3
Big Deer Creek (321)	0	1
Mid-Salmon-Chamberlain, South Fork, Lower, & Middle Fork Salmon #1706020xxx		
Lower (501), Upper (503) & Little (504) Loon Creeks; Warm Springs (502); Rapid River (505); Middle Fork Salmon River/Soldier (507) & Lower Marble Creek (513); & Sulphur (509), Pistol (510), Indian (511) & Upper Marble (512) Creeks; Lower Middle Fork Salmon River (601); Wilson (602), Upper Camas (604), Rush (610), Monumental (611), Beaver (614), Big Ramey (615) & Lower Big (617) Creeks; Middle Fork Salmon River/Brush (603) & Sheep (609) Creeks; Big Creek/Little Marble (612); Crooked (616), Sheep (704), Bargamin (709), Sabe (711), Horse (714), Cottonwood (716) & Upper Chamberlain Creek (718); Salmon River/Hot Springs (712); Salmon River/Kitchen Creek (715);	3	3

Lower Chamberlain/McCalla Creek (717); & Slate Creek (911)		
Mid-Salmon-Chamberlain, South Fork, Lower, & Middle Fork Salmon #1706020xxx (Cont.)		
Marsh (506); Bear Valley (508) Yellow Jacket (604); West Fork Camas (607) & Lower Camas (608) Creeks; & Salmon River/Disappointment Creek (713) & White Bird Creek (908)	2	3
Upper Big Creek (613); Salmon River/Fall (701), California (703), Trout (708), Crooked (705) & Warren (719) Creeks; Lower South Fork Salmon River (801); South Fork Salmon River/Cabin (809), Blackmare (810) & Fitsum (812) creeks; Lower Johnson Creek (805); & Lower (813), Middle (814) & Upper Secesh (815) Rivers; Salmon River/China (901), Cottonwood (904), McKenzie (909), John Day (912) & Lake (913) Creeks; Eagle (902), Deer (903), Skookumchuck (910), French (915) & Partridge (916) Creeks	2	2
Wind River (702), Salmon River/Rabbit (706) & Rattlesnake (710) Creeks; & Big Mallard Creek (707); Burnt Log (806), Upper Johnson (807) & Buckhorn (811) Creeks; Salmon River/Deep (905), Hammer (907) & Van (914) Creeks	2	1
Silver Creek (605)	1	3
Lower (803) & Upper (804) East Fork South Fork Salmon River; Rock (906) & Rice (917) Creeks	1	2
Little Salmon #176021xxx		
Rapid River (005)	3	3
Hazard Creek (003	3	2
Boulder Creek (004)	2	3
Lower Little Salmon River (001) & Little Salmon River/Hard Creek (002)	2	2
Selway, Lochsa & Clearwater #1706030xxx		
Selway River/Pettibone (101) & Gardner (103) Creeks; Bear (102), White Cap (104), Indian (105), Burnt Knob (107), Running (108) & Goat (109) Creeks; & Upper Selway River (106); Gedney (202), Upper Three Links (204), Rhoda (205), North Fork Moose (207), Upper East Fork Moose (209) & Martin (210) Creeks; Upper (211), Middle (212) & Lower Meadow (213) Creeks; Selway River/Three Links Creek (203); & East Fork Moose Creek/Trout Creek (208); Fish (302), Storm (309), Warm Springs (311), Fish Lake (312), Boulder (313) & Old Man (314) Creeks; Lochsa River/Stanley (303) & Squaw (304) Creeks; Lower Crooked (305), Upper Crooked (306) & Brushy (307) forks; Lower (308), Upper (310) White Sands, Ten Mile (509) & John's (510) Creeks	3	3
Selway River/Goddard Creek (201); O'Hara Creek (214) Newsome (505) Creeks; American (506), Red (507) & Crooked (508) rivers	2	3
Lower Lochsa River (301); Middle Fork Clearwater River/Maggie Creek (401); South Fork Clearwater River/Meadow (502) & Leggett Creeks; Mill (511), Big Bear (604), Upper Big Bear (605), Musselshell (617), Eldorado (619) & Mission (629) Creeks, Potlatch River/Pine Creek (606); & Upper Potlatch River (607); Lower (615), Middle (616) & Upper (618) Lolo Creeks	2	2
South Fork Clearwater River/Peasley Creek (502)	2	1
Upper Orofino Creek (613)	2	0
Clear Creek (402)	1	3
Three Mile (512), Cottonwood (513), Big Canyon (610), Little Canyon (611) & Jim Ford (614) Creeks; Potlatch River/Middle Potlatch Creek (603); Clearwater River/Bedrock (608), Jack's (609) Lower Lawyer (623), Middle Lawyer (624), Cottonwood (627) & Upper Lapwai (628) Creeks; & Upper (630) & Lower (631) Sweetwater Creeks	1	2
Lower Clearwater River (601) & Clearwater River/Lower Potlatch River (602), Fivemile Creek (620), Sixmile Creek (621) and Tom Taha (622) Creeks	1	1

Note: Current conditions are ranked as either poor (score 0), fair-to-poor (score 1), fair-to-good (score 2), or good-to-excellent (score 3). Potential conditions are ranked as having little or no improvement potential (score 0), some improvement potential (score 1), high improvement potential (score 2), or are highly functioning and are at their historic potential (score 3).

2.3. 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).

2.3.1. Biological Requirements of Salmon and Steelhead

The biological requirements of salmon and steelhead in the action area vary depending on the life history stage and natural range of variation present within that system. Generally, during spawning migrations, adult salmon require clean water with cool temperatures and access to thermal refugia, dissolved oxygen near 100% saturation, low turbidity, adequate flows and depths to allow passage over barriers to reach spawning sites, and sufficient holding and resting sites. Anadromous fish select spawning areas that are based on species-specific requirements of flow, water quality, substrate size, and groundwater upwelling. Embryo survival and fry emergence depend on substrate conditions (e.g., gravel size, porosity, permeability, and oxygen concentrations), substrate stability during high flows, and, for most species, water temperatures of 55.4°F or less. Habitat requirements for juvenile rearing include seasonally suitable microhabitats for holding, feeding, and resting. Migration of juveniles to rearing areas - whether the ocean, lakes, or other stream reaches - requires access to these habitats. Physical, chemical, and thermal conditions may all impede movements of adult or juvenile fish.

Each ESA-listed fish species considered resides in or migrates through the action area. Thus, for this action area, the biological requirements for salmon and steelhead are the habitat characteristics that would support successful spawning, rearing, and migration of the ESA-listed species considered in this document, and the PCEs for freshwater spawning sites, rearing sites, and freshwater migration corridors associated with those species.

2.3.1.1. Effects of Land Management and Development

In general, the environment for ESA-listed species in the referenced basins has been dramatically affected by the development and operation of the Federal Columbia River Power System (FCRPS). Storage dams have eliminated mainstem spawning and rearing habitat, and have altered the natural flow regime of the Snake and Columbia Rivers, decreasing spring and summer flows, increasing fall and winter flow, and altering natural thermal patterns. The FCRPS kills (approximately 46%) or injures a portion of the smolts passing through the system (NMFS 2004). Slowed water velocity and increased temperatures in reservoirs delays smolt migration timing and increases predation in the migratory corridor (NMFS 2004; Independent Scientific Group 1996; National Research Council 1996). Formerly complex mainstem habitats have been reduced to predominantly single channels, with reduced floodplains and off-channel habitats eliminated or disconnected from the main channel (Sedell and Froggatt 2000; Independent Science Group 2000; Coutant 1999). The amount of large woody debris in these rivers has declined, reducing habitat complexity and altering the rivers' food webs (Maser and Sedell 1994).

Other anthropogenic activities that have degraded aquatic habitats or affected native fish populations in the Snake River Basin include stream channelization, elimination of wetlands, construction of flood-control dams and levees, construction of roads (many with impassable culverts), timber harvest, splash dams, mining, water withdrawals, unscreened water diversions, agriculture, livestock grazing, urbanization, outdoor recreation, fire exclusion/suppression, artificial fish propagation, fish harvest, and introduction of non-native species (Henjum et al. 1994; Rhodes et al. 1994; National Research Council 1996; Spence et al. 1996; Lee et al. 1997; NMFS 2004). In many watersheds, land management and development activities have:

- Reduced connectivity (i.e., the flow of energy, organisms, and materials) between streams, riparian areas, floodplains, and uplands;

- Elevated fine sediment yields, degrading spawning and rearing habitat;

- Reduced large woody material that traps sediment, stabilizes streambanks, and helps form pools;

- Reduced vegetative canopy that minimizes solar heating of streams;

- Caused streams to become straighter, wider, and shallower, thereby reducing rearing habitat and increasing water temperature fluctuations;

- Altered peak flow volume and timing, leading to channel changes and potentially altering fish migration behavior; and,

- Altered floodplain function, water tables and base flows (Henjum et al. 1994; McIntosh et al. 1994; Rhodes et al. 1994; Wissmar et al. 1994; National Research Council 1996; Spence et al. 1996; and Lee et al. 1997).

2.3.1.2. Basins in Action Area

The action area covers 18 subbasins (4th -field HUCs), encompassing all areas potentially affected directly or indirectly by this programmatic consultation. Because of the potential for downstream effects and additive effects within watersheds, the action area encompasses entire subbasins where ESA-listed species and designated critical habitat occur. A general review of the environmental baseline has been divided up into the three major basins within the action area: (1) the Clearwater River Basin; (2) the Salmon River Basin; and (3) the Snake River Basin.

Clearwater River Basin. The Clearwater River Basin is located in north-central Idaho between the 46th and 47th latitudes in the northwestern portion of the continental United States. It is a region of mountains, plateaus, and deep canyons within the Northern Rocky Mountain geographic province. The basin is bracketed by the Salmon River Basin to the south and St. Joe River subbasin to the north.

The Clearwater River drains approximately a 9,645-mi^2 area. The basin extends approximately 100 miles north to south and 120 miles east to west (Maughan 1972). There are four major tributaries that drain into the mainstem of the Clearwater River: the Lochsa, Selway, South Fork Clearwater, and North Fork Clearwater Rivers. The Idaho–Montana border follows the upper watershed boundaries of the Lochsa and Selway Rivers, and the eastern portion of the North Fork Clearwater River in the Bitterroot Mountains. The North Fork Clearwater River then drains the Clearwater Mountains to the north, while the South Fork Clearwater River drains the divide along the Selway and Salmon Rivers. Dworshak Dam, located 2 miles above the mouth of the North Fork Clearwater River, is the only major water regulating facility in the basin. Dworshak Dam was completed in 1972 and eliminated access to one of the most productive systems for anadromous fish in the basin. The mouth of the Clearwater is located on the Washington–Idaho border at the town of Lewiston, Idaho, where it enters the Snake River 139 river miles upstream of the Columbia River (NPPC 2004).

More than two-thirds of the total acreage of the Clearwater River Basin is evergreen forests (over 4 million acres), largely in the mountainous eastern portion of the basin. The western third of the basin is part of the Columbia plateau and is composed almost entirely of crop and pastureland. Most of the forested land within the Clearwater Basin is owned by the Federal government and managed by the USFS (over 3.5 million acres), but the State of Idaho and Potlatch Corporation also own extensive forested tracts. The western half of the basin is primarily in the private ownership of small forest landowners and timber companies, as well as farming and ranching families and companies. There are some small private in-holdings within the boundaries of USFS lands in the eastern portion of the basin. Nez Perce Tribe lands are located primarily within or adjacent to Lewis, Nez Perce, and Idaho Counties within the current boundaries of the Nez Perce Indian Reservation. These properties consist of both Fee lands owned and managed by the Nez Perce Tribe, and properties placed in trust status with the Bureau of Indian Affairs. Other agencies managing relatively small land areas in the Clearwater Basin include the National Park Service, the BLM, Idaho Transportation Department, and IDFG (NPPC 2004).

Water quality limited segments are streams or lakes which are listed under section 303(d) of the CWA for either failing to meet their designated beneficial uses, or for exceeding state water quality criteria. The current list of 303(d) listed segments was compiled by the Idaho Department of Environmental Quality (IDEQ) in 2010, and includes 79 defined stream reaches within the Clearwater River Basin. Individual stream reaches are listed for parameters such as water temperature, sedimentation/siltation, fecal coliform, ammonia, oil and grease, dissolved oxygen, etc. Please refer to the following website for reach-specific 303(d) listed stream segments: http://www.deq.idaho.gov/water-quality/surface-water/monitoring-assessment/integrated-report.aspx.

Small-scale irrigation, primarily using removable instream pumps, is relatively common for hay and pasture lands scattered throughout the lower elevation portions of the subbasin, but the amounts withdrawn have not been quantified. The only large-scale irrigation/diversion system within the Clearwater Basin is operated by the Lewiston Orchards Irrigation District within the Lower Clearwater subbasin.

Seventy dams currently exist within the boundaries of the Clearwater Basin. The vast majority of existing dams exist within the Lower Clearwater (56), although dams also currently exist in the Lower North Fork (3), Lolo/Middle Fork (5), and South Fork (6) watersheds (NPPC 2004).

The seven largest reservoirs in the basin provide recreational and other beneficial uses. Dworshak, Reservoir A, Soldiers Meadows, Winchester, Spring Valley, Elk River, and Moose Creek Reservoirs all provide recreational fishing opportunities. Reservoir A and Soldiers Meadows Reservoir are also part of the Lewiston Orchards Irrigation District irrigation system. Capacity of other reservoirs within the Clearwater Basin is limited to 65 acre-feet or less, and in most cases is less than 15 acre-feet, limiting their recreational capacity (NPPC 2004).

Agriculture primarily affects the western third of the basin on lands below 2,500 feet in elevation, primarily on the Camas Prairie both south and north of the mainstem Clearwater and the Palouse. Additional agriculture is found on benches along the main Clearwater and its lower tributaries such as Lapwai, Potlatch, and Big Canyon Creeks. Hay production in the meadow areas of the Red River and Big Elk Creek in the American River watershed accounts for most of the agriculture in the South Fork Clearwater (Clearwater Basin Bull Trout Technical Advisory Team 1998). Total cropland and pasture in the subbasin exceeds 760,000 acres. Agriculture is a particularly large part of the economy in Nez Perce, Latah, Lewis, and Idaho Counties, which all have large areas of gentle terrain west of the Clearwater Mountains. Small grains are the major crop, primarily wheat and barley. Landscape dynamics, hydrology, and erosion in these areas are primarily determined by agricultural practices (NPPC 2004).

Subwatersheds with the highest proportion of grazeable area (less than 50%) within the Clearwater Basin are typically associated with USFS grazing allotments in lower-elevation portions of their ownership areas. However, the majority of lands managed by the USFS within the Clearwater Basin are not subjected to grazing by cattle or sheep, including all or nearly all of the Upper Selway, Lochsa, and Upper and Lower North Fork watersheds. Subwatersheds outside of the USFS boundaries typically have less than 25% of the land area defined as grazeable, although this is as much as 75% for some. Privately owned property within the basin typically contains a high percentage of agricultural use, with grazeable lands found only in uncultivated areas. In contrast, grazing allotments on USFS lands are typically large, often encompassing multiple HUCs, resulting in higher proportions of grazeable area than those contained in primarily privately owned lands (NPPC 2004).

Mines are distributed throughout all eight watersheds in the Clearwater Basin, with the lowest number of occurrences in the Upper and Lower Selway. Ecological hazard ratings for mines (delineated by the Interior Columbian Basin Ecosystem Management Project) indicate that the vast majority of mines throughout the subbasin pose a low relative degree of environmental risk. However, clusters of mines with relatively high ecological hazard ratings are located in the South Fork Clearwater River and in the Orofino Creek drainage (Lolo/Middle Fork) (NPPC 2004.

Salmon River Basin. The Salmon River flows 410 miles north and west through central Idaho to join the Snake River. The Salmon River is the largest subbasin in the Columbia River drainage, excluding the Snake River, and has the most stream miles of habitat available to anadromous fish. The total subbasin is approximately 14,000 square miles in size. Major tributaries include the Little Salmon River, South Fork Salmon River, Middle Fork Salmon River, Panther Creek, Lemhi River, Pahsimeroi River, and East Fork Salmon River (IDFG et al. 1990).

Public lands account for approximately 91% of the Salmon River Basin, with most of this heing in Federal ownership and managed by seven National Forests or the BLM. Public lands within the basin are managed to produce wood products, domestic livestock forage, and mineral commodities; and to provide recreation, wilderness, and terrestrial and aquatic habitats. Approximately 9% of the basin is privately owned. Private lands are primarily in agricultural cultivation, and are concentrated in valley bottom areas within the upper and lower portions of the basin.

Land management practices within the basin vary among landowners. The greatest proportion of National Forest lands are Federally designated wilderness area or areas with low resource commodity suitability. One-third of the National Forest lands in the basin are managed intensively for forest, mineral, or range resource commodity production. The BLM lands in the basin are managed to provide domestic livestock rangeland and habitats for native species. State of Idaho endowment lands within the basin are managed for forest, mineral, or range resource commodity production. Near-stream or in-channel activities of relevance to fish and wildlife conservation include efforts by landowners, private or otherwise, to modify stream channels in order to protect property. Examination of the geographic distribution of permitted channel alterations during the past 30 years suggests that the long-term frequency of these activities was relatively consistent across much of the Salmon River Basin, but less common in the Upper Middle Fork Salmon, Lower Middle Fork Salmon, Middle Salmon-Chamberlain, and Pahsimeroi subbasins. It is unclear to what degree channel-modifying activities completed without permits may have had on the observed pattern. Stream channels in the basin are also altered, albeit on a smaller scale, by recreational dredging activities (NPPC 2004).

Water quality in many areas of the hasin is affected to varying degrees by land uses that include livestock grazing, road construction, logging and mining (NPPC 2004). Water quality limited segments are streams or lakes which are listed under section 303(d) of the CWA for either failing to meet their designated beneficial uses, or for exceeding state water quality criteria. The current list of 303(d) listed segments was compiled by the IDEQ in 2010, and includes 96 defined stream reaches within the Salmon River Basin. Individual stream reaches are listed for parameters such as water temperature, escherichia coli, sedimentation/siltation, fecal coliform, ammonia, copper, etc. Please refer to the following website for reach-specific 303(d) listed stream segments: http://www.deq.idaho.gov/water-quality/surface-water/monitoring-assessment/integrated-report.aspx.

In the Lemhi, Upper Salmon, Pahsimeroi, and Middle Salmon-Panther subbasins, less than 20% of the larger streams meet all designated uses (i.e., specific uses identified for each waterbody through state and tribal cooperation, such as support of salmonid fishes, drinking water supplies, maintenance of aquatic life, consumption of fish, recreational contact with water, and agriculture) (NPPC 2004).

Partial and seasonal barriers have been created on a few of these streams. Partial to complete barriers to anadromous fish exist on Panther Creek in the form of acid mine drainage, and on the Lemhi, Pahsimeroi and upper Salmon Rivers at water diversions for irrigation. Twenty minor tributaries contain dams that are used for numerous purposes such as irrigation, recreation, and fish propagation (IDFG 1990).

The diversion of water, primarily for agricultural use within the Salmon River Basin, has a major impact on developed areas – particularly the Lemhi, Pahsimeroi, the mainstem Salmon, and several tributaries of the Salmon River. Although many diversions are screened, many need repair and upgrading. A major problem is localized stream dewatering. In addition to water diversions, numerous small pumping operations for private use occur throughout the subbasin. Impacts of water withdrawal on fish production are greatest during the summer months, when streamflows are critically low (IDFG 1990).

The Salmon River Basin encompasses portions of five USFS wilderness areas. The Frank Church River of No Return Wilderness area, one of the five within the subbasin, is the largest wilderness area in the contiguous United States. Specific management guidelines for wilderness areas generally prohibit motorized activities and allow natural processes to function in an undisturbed manner.

Mining, though no longer a major land use as it was historically, it is still very prevalent in parts of the Salmon River Basin. Impacts from mining include severe stream alterations in substrate composition, channel displacement, bank and riparian destruction, and loss of instream cover and pool-forming structures. All of these impacts are typical of large-scale dredging and occur with other types of mining. Natural stream channels within the Yankee Fork, East Fork South Fork, and Bear Valley Creek, have all had documented spawning and rearing habitat destroyed by dredge mining. Furthermore, heavy metal pollution from mine wastes and drainage can eliminate all aquatic life and block access to valuable habitat as seen in Panther Creek (IDFG 1990).

Snake River Basin. The Snake River originates at 9,500 feet, along the continental divide in the Wyoming portion of Yellowstone National Park. The Snake River flows 1,038 miles westward toward the Idaho-Oregon border, northwest to its confluence with Henry's Fork near Rexburg, and then to Pasco, Washington, where it flows into the Columbia River. The Snake River is a large river that is one of the most important water resources in the State of Idaho. The Boise, Payette, and Weiser Rivers in Idaho, and the Owyhee, Malheur, Burnt, and Powder Rivers in Oregon, join the Snake River in this Idaho-Oregon border reach. The Snake River passes through Hells Canyon and Idaho Power Company's Hells Canyon Complex. Brownlee Dam, near River Mile 285, is the uppermost facility, with Oxbow and Hells Canyon dams downstream. The basin includes agriculture, and private and Federal irrigation.

The Snake River Basin upstream from Brownlee Dam includes 31 dams and reservoirs with at least 20,000 acre-feet of storage each. The Bureau of Reclamation (BOR), Idaho Power Company, and a host of other organizations own and operate various facilities. These facilities have substantial influence on water resources, supplies, and the movement of surface and groundwater through the region. The total storage capacity of these reservoirs is more than 9.7 million acre-feet. In addition, there are numerous smaller state, local, and privately owned and operated dams and reservoirs throughout the upper Snake River Basin.

The Bonneville Power Administration administers dams and power plants on the Snake River and the Columbia River. They report the annual flow of the Snake River averages about 14 million acre-feet per year into Brownlee Reservoir and about 37 million acre-feet below Lower Granite Dam, downstream from Lewiston. This compares to annual average flows of 135 million acre-feet for the Columbia River at The Dalles, Oregon, and 198 million acre-feet at the mouth of the Columbia River. As of 2002, about 3.3 million acres were being irrigated in the State of Idaho. This includes some acreage outside the Snake River Basin but does not include about 170,000 acres of land in the Snake River Basin in eastern Oregon currently irrigated as part of BOR projects. Although irrigated acreage served by Federal projects has changed little since 1959, total irrigation in Idaho has increased by more than 25%. Much of the new, private irrigation during this period uses groundwater.

The area includes rugged mountains, semi-arid desert, fertile agricultural land (primarily irrigated), and barren outcrops of lava flows. Rangeland, lava flows, and timber are the dominant land covers in the basin. Pine and spruce forests inhabit the higher elevations. Most of the land in the basin is owned by the Federal government (USFS, BLM, and U.S. Department of Energy).

One of the most prominent physiographic features of the basin is the Snake River Plain. This curved topographic feature extends across southern Idaho into eastern Oregon. The Snake River plain is approximately 350 miles long and varies in width from 30 to 75 miles. The Snake River is the dominant hydrologic feature of the basin and is the only river discharging from the area. The Snake River extends from its source in Jackson Lake, Wyoming, to its confluence with the Columbia River in Washington.

The Snake River has many tributary streams that are important components of the river system. The tributaries provide a means of collecting the precipitation that accumulates in the mountains surrounding the Snake River Plain. Water collected in the tributaries, enters the Snake River directly as surface flows, evaporates, or infiltrates into the subsurface where it later enters the river as spring flows. Fifteen of the nation's 65 class one springs (greater than 100 ft^2/s discharge) are in the Snake River Basin. These springs support fish hatcheries that produce the majority of the Nation's commercial trout and produce juvenile fish for planting in lakes and streams.

The amount of natural flow in most of the streams varies throughout the year due to the annual cycle of precipitation. Water accumulates during the winter snowfalls and is released by spring melting of the snow pack. The normally hot, dry periods of late summer and early fall are additional factors driving the cyclic nature of flow volumes. In many locations the annual variation in streamflow volume is altered depending on the operational needs of the many reservoirs that have been constructed within the system.

The Snake River and its tributaries, including the aquifers that make up the groundwater system, provide water for many uses including agricultural use, municipalities, industrial and domestic use, recreation, Native American cultural needs, and habitat for fish and wildlife. The BOR, along with other state and Federal agencies and private groups, are attempting to manage the water resources of the basin for the many, sometimes competing, uses.

The middle Snake River is a managed water system where normal flow regimes are no longer present. Development of the middle and upper Snake River for irrigation, and later for hydroelectricity, severely impedes historic and contemporary aquatic conditions. Development for irrigation began in the late 1860s when the first major irrigation diversion was built. The first hydroelectric dam (Swan Falls) was built in 1901 (Milner in 1905; Minidoka in 1906). Today, there are conservatively 44 hydroelectric projects and countless diversions in the subbasin that have greatly affected the hydrology of the Snake River and its tributaries and the aquatic species present. The downstream projects act as barriers to fish migration and have eliminated anadromous fish, not only impacting the fisheries populations, but also resulting in a significant decrease in biomass input to the terrestrial ecosystems and influencing wildlife population potentials. Upstream projects (e.g., Milner and American Falls Dams) greatly changed the hydrograph. The hydrology of all of the major tributaries in this subbasin is severely modified; some reaches are seasonally dewatered because of irrigation diversion, and many tributaries are impacted by irrigation return flows. Stream habitat degradation occurs because of these hydrologic modifications. Water withdrawals and returns, coupled with a loss of riparian vegetation stabilizing streambanks, results in channel down-cutting and widening, which can be a major source of habitat degradation and sedimentation (e.g., Rock Creek).

Within the action area, water quality limited segments are streams or lakes which are listed under section 303(d) of the CWA for either failing to meet their designated beneficial uses, or for exceeding state water quality criteria. The current list of 303(d) listed segments was compiled by the IDEQ in 2010, and includes 7 defined stream reaches within the Hells Canyon and Lower Snake River Asotin 4^{th}-field HUCs. Individual stream reaches are listed for parameters such as water temperature, sedimentation/siltation, escherichia coli, dissolved oxygen, pH, and nutrient/eutrophication biological indicators. Please refer to the following website for reach-specific 303(d) listed stream segments: http://www.deq.idaho.gov/water-quality/surface-water/monitoring-assessment/integrated-report.aspx.

Hydroelectric development throughout the middle Snake River, as well as hydrologic modification in the upper Snake, have impacted snail species through inundation of lotic habitats, isolating segmented populations, and reducing suitable shallow water shoreline. Declines in snail populations have been attributed in part to water quality degradation due to tributary and agricultural return flows laden with sediment; nutrients; runoff from dairies and feedlots; effluent from aquaculture, industrial and municipal facilities; and stormwater runoff.

2.4. Effects of the Action on the Species and Their Designated Critical Habitat

Long-term adverse effects to ESA-listed fish and their habitat are generally not expected to occur as a result of the proposed action. To the contrary, the overall impact of this action is expected to be beneficial over the long-term. Replacement or removal of existing fish passage barriers or undersized stream crossings is expected to: (1) Restore spatial and temporal connectivity between and within watersheds; (2) reduce existing habitat fragmentation, allowing for full expression of all natural life history forms within current or potentially occupied habitats; (3) provide for maintenance of more natural stream dynamics and geometry including bedload movement, sediment transport, and passage of moderately-sized woody debris; (4) improve the number, distribution, and reproductive potential of ESA-listed fish species; (5) alleviate existing risks of stream crossing failures at undersized crossing locations; (6) reduce fine sediment delivery to the stream by reducing erosion associated with improper design and maintenance activities; and (7) increase potential productivity of treated watersheds. All projects will not achieve "properly functioning condition" (PFC) for all matrix pathways/indicators at all sites. Stream channels will remain channelized to some degree wherever a crossing remains. NMFS expects the PDT to consider design options that would allow for beneficial effects to other pathways/indicators and move them towards the PFC that is desired.

NMFS anticipates potential effects to water quality (i.e., suspended sediment, temperatures, and chemical contamination), potential effects to habitat (i.e., temporary passage blockage, sediment deposition, and streambank alteration [riprap]), potential effects from use of explosives, and direct effects to fish related to handling, relocation, and stranding. The magnitude of these effects will vary as a result of the nature, extent, and duration of the construction activities in the water or riparian areas and whether ESA-listed fish are present at the time of implementation. The action agencies determined that implementation of the proposed programmatic action was "Likely to Adversely Affect" Snake River spring/summer Chinook salmon, Snake River Basin steelhead, and critical habitat for Snake River steelhead, Chinook salmon, and sockeye salmon within the action area.

Adult spring/summer Chinook and steelhead will not be present during the construction phase of these actions due to conservation measures included in the proposed action (low water work windows and fish avoidance measures). Juvenile spring/summer Chinook salmon and steelhead could be present and therefore may experience short-term adverse effects from temporary passage blockage, turbidity, and fish handling. Neither adult or juvenile sockeye salmon are expected to experience adverse effects resulting from temporary passage blockage or fish handling, as no blocking nets, seining, electrofishing, or other direct handling of sockeye salmon is permitted through this consultation. However, short-term adverse effects from turbidity and disturbance may occur to adult or juvenile sockeye salmon.

Within sockeye salmon migration habitat, which includes then entire length of the mainstem Salmon River up to and including the outlet streams of Redfish, Alturas, and Pettit Lakes, the absence of sockeye salmon can seldom be assured. Adult sockeye salmon presence in the Upper Salmon River can span the months of July through September, with some fish potentially remaining into October as spawning begins. Out-migrating sockeye salmon smolts can be present in the upper Salmon River anytime between late-March to late-May, and occasionally into the month of June. The Upper Salmon Basin Watershed Project Technical Team has also identified potential sockeye salmon out-migration occurring in the months of September through November. The complex and variable nature of the Snake River sockeye salmon migrations can subject some adult and/or juvenile fish to non-lethal adverse effects from even the most carefully timed bridge construction projects in migratory habitat.

Critical habitat for spring/summer Chinook, steelhead, and sockeye salmon may experience short-term adverse effects from habitat sedimentation resulting from in-channel construction activity and/or post-project precipitation that carries sediment to streams and rivers. The extent, duration, and severity of these potential adverse effects are addressed below. Critical habitat for spring/summer Chinook and steelhead may also incur temporary passage blockages from in-channel work activities, but no such blockages are permitted within sockeye salmon migratory habitat.

The BA identified seven different activity types that may be implemented under the proposed action. Sections 1.3.1.1 through 1.3.1.7 of this Opinion identify and describe the seven activity categories. Each activity category has the potential to modify the stream crossing and available habitat in a slightly different manner. Activity category descriptions, along with the design criteria and prohibited projects, were developed to minimize or reduce any potential influence on ESA-listed habitats or individuals. As previously discussed, activities of this nature have the potential to affect species directly through fish handling, disturbance, and use of explosives. These types of activities also have the potential to affect fish and/or fish habitat through effects to water quality and/or alteration of instream habitat. Considering the design criteria proposed this Opinion will now analyze the likelihood and magnitude of these potential effects.

2.4.1. Disturbance/Noise

Implementation of the proposed action may affect individual fish. Noise from heavy equipment operating adjacent to live water may disturb juvenile Chinook salmon, steelhead, and migrating sockeye salmon in the immediate vicinity causing short-term displacement. Heavy equipment operation near action area streams will create noise, vibration, and potentially water surface disturbance. Popper et al. (2003) and Wysocki et al. (2007) discussed potential impacts to fish from long-term exposure to anthropogenic sounds, predominately air blasts and aquaculture equipment, respectively. Popper et al. (2003) identified possible effects to fish including temporary, and potentially permanent hearing loss (via sensory hair cell damage), reduced ability to communicate with conspecifics due to hearing loss, and masking of potentially biologically important sounds. Studies evaluated noise levels ranging from 115 to 190 decibels (dB). Wysocki et al. (2007) did not identify any adverse impacts to rainbow trout from prolonged exposure to three sound treatments common in aquaculture environments (115, 130, and 150 dB). In the studies identified by Popper et al. (2003) that caused ear damage in fishes, all evaluated fish were caged and thus incapable of moving away from the disturbance.

Machinery operation adjacent to the stream will be intermittent with actual activity near the stream occurring only in daylight hours on any given day. The Federal Highway Administration (2008) indicates backhoe, grader, loader, and truck noise production ranging between 80 and 89 dB. Because the decibel scale is logarithmic, there is nearly a 100-fold difference between noise levels expected from the action and noise levels known to have generated adverse effects to surrogate species, as discussed above. Therefore, noise related disturbances of this magnitude are unlikely to result in injury or death. It is unknown if the expected dB levels will cause fish to temporarily move away from the disturbance or if fish will remain present. Even if fish move, they are expected to migrate only short distances to an area they feel more secure and only for a few hours in any given day (i.e., harassment only). Each day fish are routinely disturbed by passing birds, walking mammals, and other fish. NMFS does not anticipate short-term movements caused by construction equipment noise will result in effects different than those typically experienced by fish. Therefore, expected noise levels and level of disturbance will be minimal and not expected to result in mortality.

2.4.2. Fish Handling

Conservation measures proposed for the site dewatering phase may trap individual spring/summer Chinook salmon and steelhead in blocknets, or capture, handle and transport individuals through a variety of methods[7]. Additionally, dewatering is likely to result in stranding of some of these fish.

Mitigation measures provided in the proposed action are designed to reduce the potential for injury and mortality throughout the dewatering and subsequent fish handling procedures. However, NMFS expects that stream dewatering and the capture, handling, transport, and release of ESA-listed fish will strand some fish, disrupt normal behavior, and cause short-term stress, injury, and occasional mortality. Conservation measures in the proposed action include the incorporation of NMFS electrofishing guidelines, IDFG collection permit direction, and NMFS steelhead collection permit direction in order to minimize stress, mortality, and competitive

[7] Note: Because bridge replacement projects in migratory sockeye salmon habitat will allow only single span bridges, dewatering of work areas for these types of projects will not be required, and handling or salvage of Endangered Snake River sockeye salmon is not allowed or authorized by this opinion.

effects (NMFS 2000). It will be critical to ensure consistent application of approved electrofishing and fish handling procedures. Any methods that may result in fewer stranded individuals should also be explored.

Due to design criteria and timing of the proposed action, only juvenile fish are expected to be handled or disturbed. Movement of fish is proposed to occur in one of two ways, volitionally or manually. The action proposes a combination of both methods in an effort to reduce manual handling and disturbance to the greatest extent possible. Fish handling and capture methods result in unavoidable adverse impacts to individuals. This section describes the amount and type of fish handling to be expected and what level of harm or take is likely to occur as a result of that handling. Additionally, the number of fish expected to be stranded as a result of the programmatic action is also disclosed. Normally, stream dewatering, fish capture/relocation, stream rerouting, and flow reintroduction to the new crossing will not last more than 1 day. However, unique, difficult, and large sites are expected to take 1 week or more to complete. The action agencies recognize that the longer the construction period, the greater the urgency for adequate erosion control measures and this is reflected in the proposed conservation measures.

Within the action area, up to 156 projects are annually proposed in occupied habitats. Based on experience from previous stream crossing restoration work activities, approximately 39 of these 156 projects would likely need to use electrofishing in combination with seining, dip-netting and volitional movement of fish to clear work areas of ESA-listed fish. The remaining 117 projects in occupied habitat would occur in steep habitat with less complex habitat conditions and where partial stream dewatering should facilitate passive movement of fish without electrofishing. However seining, dip-netting, and block netting is still likely to occur at these sites and may potentially harm some individuals. Fish stranding is likely to occur at all occupied sites (156), including those where rapid stream dewatering and reliance on volitional movement and dip-netting of fish occurs (117 sites). These various methods of worksite clearing will be referred to as 'electrofishing sites' and 'volitional sites,' throughout the remainder of this document. Blocknets are likely to be deployed at the upstream end of both electrofishing and volitional sites. Blocknets will prevent additional fish from entering the work area during dewatering or construction activities. There is potential for fish to become entrained in the blocknets and some mortality may occur. This is discussed below.

Following installation of the upper block net at electrofishing sites, fish (i.e., juvenile Chinook and/or steelhead) are likely to be hazed out of the proposed dewatered sections by walking seines downstream from the upstream block net location to the end of the work site in an attempt to 'herd' fish out of the worksite. The downstream block net would then be installed and efforts to capture remaining fish with dip-nets would follow. Electrofishing gear would be used last in an attempt to clear the work area and only where determined necessary. As proposed, dewatering of the site would occur after fish removal efforts. Some fish are likely to remain in the work area and will likely be stranded.

At volitional sites, the block net would be first installed at the upstream end of the work site. Flows would then be reduced to encourage downstream volitional migration of any fish inhabiting the work site. A seine net would then be used to 'herd' fish downstream and out of the partially dewatered channel. The downstream block net would then be installed and any remaining fish in isolated pools would be captured with dip-nets. Similar to electrofishing sites, some fish may be entrained in the blocknets while others are likely to be stranded.

NMFS expects all captured fish will be held in 5 gallon buckets filled with stream water for a period only long enough to transport fish to an appropriate release site immediately upstream of the individual project sites. Buckets would likely be placed into the water and slowly inverted to allow captured fish to move into the selected release sites.

2.4.2.1. Blocknets

Blocknets will be used at the upstream and downstream end of all work areas to prevent fish migration into the work site from upstream or downstream habitats. It is assumed that the downstream blocknets will not be deployed until after seining actions at electrofishing sites and after volitional movement occurs at non electrofished sites. Use of blocknets at these sites poses an alternative source of harm and potential for take.

The FWS (2002) conducted a study on sampling efficiency with the use of blocknets that observed five mortalities as a result of block net impingement out of 704 bull trout handled. Although not all fish are thought to have encountered the blocknets this mortality figure represents approximately a 0.7% block net mortality rate for fish handled in the study. All mortalities were either fry or juvenile bull trout.

A determination of the number or percent of juvenile fish that may be entrained in the blocknets was not calculated for this Opinion as the risk of mortality is considered discountable because: (1) The upstream block net will be located above the target barrier and only fish from above the net would be likely to encounter the nets; (2) seining and or flow reductions will reduce the number of fish in the work area prior to the downstream block net being installed, thereby, minimizing exposure; and (3) personnel will be present to check blocknets and release any impinged fish. Furthermore, all work sites are likely barriers to juvenile fish passage and many are barriers to adult salmonids. This likely results in lower juvenile densities above the barrier than below and presumably fewer juvenile fish that could be exposed to the blocknets. No conservation measures were proposed for the mesh size of blocknets to be used. Common block net mesh sizes are approximately 0.28 inches (7mm) and constructed of nylon materials (Gries and Letcher 2002; Peterson et al. 2005).

2.4.2.2. Seining

Seines are expected to be used at all sites within the analysis area each year. The use of fish seines is expected to cause some fish to flee downstream out of the proposed dewatered site; but, it is expected that some fish will simply retreat to hiding cover within the work area and have to be removed with alternative methods (i.e., dip-netting and/or electrofishing). Seining of fish is likely to cause some elevated stress levels from the contact with the seine and personnel. The number of fish that may be directly 'harassed' in this manner is unquantifiable. No conservation measures were proposed for the mesh size of seines to be used. Common seine mesh size for this type of activity is approximately 0.28 inches (7mm) and constructed of nylon materials (Gries and Letcher 2002; Peterson et al. 2005).

2.4.2.3. Dip-netting

Dip-netting of fish from isolated pool areas is likely to occur at all sites and may cause some stress and harm from handling individuals. Capturing and handling fish causes them stress, though they typically recover fairly rapidly from the process. Types of stress likely to occur during project implementation include increased plasma levels of cortisol and glucose (Frisch and Anderson 2000; Hemre and Krogdahl 1996). Even short-term, low intensity handling may cause reduced predatory avoidance for up to 24 hours (Olla et al. 1995). The primary contributing factors to stress and death from handling are differences in water temperatures (between the river and wherever the fish are held), dissolved oxygen conditions, 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 64.4°F 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. Table 11 provides an estimate of the number of fish to be handled under the proposed action. NMFS has assumed that all handled fish will be held in five gallon buckets filled with stream water for a period only long enough to transport fish to an appropriate release site immediately upstream of the individual project sites. Buckets would likely be placed into the water and slowly inverted to allow captured fish to move into the selected release sites. Handling fish in this manner is likely to minimize the potential stress fish experience.

2.4.2.4. Electrofishing

The effects of electrofishing on juvenile Snake River Basin steelhead and Snake River spring/summer Chinook salmon would be limited to the direct and indirect effects of exposure to an electric field, capture by netting, and the effects of handling associated with transferring the fish back to the river (see above for more detail on capturing and handling effects). Most of the studies on the effects of electrofishing have been conducted on adult fish greater than 12 inches in length (Dalbey et al. 1996). The relatively few studies that have been conducted on juvenile salmonids indicate that spinal injury rates are substantially lower than they are for large fish. Smaller fish intercept a smaller head-to-tail potential than larger fish (Sharber and Carothers 1988) and may therefore be subject to lower injury rates (e.g., Dalbey et al. 1996; Thompson et al. 1997). McMichael et al. (1998) found a 5.1% injury rate for juvenile middle Columbia River steelhead captured by electrofishing in the Yakima River subbasin while Ainslie et al. (1998) reported injury rates of 15% for direct current applications on juvenile rainbow trout. The incidence and severity of electrofishing damage is partly related to the type of equipment used and the waveform produced (Sharber and Carothers 1988; Dalbey et al. 1996; Dwyer and White 1997). Continuous direct current or low-frequency (equal or less than 30 Hz) pulsed direct current have been recommended for electrofishing (Fredenberg 1992; Dalbey et al. 1996) hecause lower spinal injury rates, particularly in salmonids, occur with these waveforms (Fredenherg 1992; Dalbey et al. 1996; Ainslie et al. 1998). Only a few recent studies have examined the long-term effects of electrofishing on salmonid survival and growth (Ainslie et al. 1998; Dalbey et al. 1996). These studies indicate that although some of the fish suffer spinal injury, few die as a result. However, severely injured fish grow at slower rates and sometimes they show no growth at all (Dalbey et al. 1996). As discussed earlier the conservation measures presented in the proposed action (NMFS electrofishing guidelines [NMFS 2000], IDFG collection permit direction and NMFS steelhead collection permit direction) are expected to adequately minimize the levels of stress, mortality, and competitive effects related to electrofishing.

2.4.2.5. Flow Reduction

The proposed action identified the use of 'slow dewatering' to reduce effects to individual fish, although the term was not defined. Discussions with Tom Curet, Fisheries Biologist, IDFG (2005), suggest that initial removal of approximately 80% of the base flow results in the greatest number of fish volitionally moving out of the dewatered work area. This 80% flow reduction is assumed to represent the intention of the conservation measure that required 'slow dewatering' of the sites and is applied in this analysis.

The IDFG estimated that approximately 50-75% of the fish at a proposed dewatering site will voluntarily move downstream when this 80% flow reduction recommendation is implemented. The IDFG has had success implementing this type of procedure on multiple project work sites. NMFS is assuming the lower value of 50% volitional movement at electrofished sites due to higher complexity of habitat and presumed lower stream gradients that may reduce volitional movement. NMFS assumes the 75% value for volitional sites due to small stream size, higher stream gradient, and less complex habitats that are thought to encourage a greater percentage of fish to voluntarily migrate out of the dewatered area. These conditions are often the reason why sites are not chosen for electrofishing in the first place as the practice is less effective in larger, more complex habitats (Peterson et. al 2004). Applied to the potential electrofishing sites, this conservation measure is expected to result in approximately 50% of the post removal population volitionally migrating out of the work area while the discharge is reduced 80%.

Under the proposed action, partial dewatering at the electrofished sites would not be implemented until fish removal activities have occurred. This results in a greater number of fish being exposed to dip-netting, electrofishing and handling effects than if the site was dewatered first, which would allow fish to move out of the work area, avoiding capture and handling. Non-electrofishing sites propose to employ the dewatering conservation measure prior to any other fish removal activity. Therefore, approximately 75% of the pre-project fish population is expected to migrate out of the area and avoid any handling effects. This conservation measure results in approximately 25% of any volitional site's fish population being exposed to the dip-netting and handling effects discussed below.

2.4.2.6. Take Calculations

Within the action area there are 14 subbasins occupied by spring/summer Chinook salmon, and 18 subbasins occupied by steelhead. Based on this species distribution, and assuming equal distribution of projects across subbasins, calculations suggest that annually, roughly 17 projects (44% of 39 total electrofishing sites) may use electrofishing that adversely affect juvenile spring/summer Chinook salmon, and roughly 22 projects (56% of 39 total electrofishing sites) may use electrofishing that adversely affects juvenile steelhead (USFS 2005). Applying the same species distribution percentages to the 117 projects at volitional sites; 52 (44%) are likely to affect juvenile spring/summer Chinook salmon and 66 projects (56%) are likely to affect juvenile steelhead.

The proposed action did not identify how many electrofishing passes would he employed during fish salvage. NMFS assumes that a three pass electrofishing effort will be employed because it is a standard practice. The proposed action stated that NMFS' electrofishing guidelines (NMFS 2000) will be followed in all projects employing electrofishing equipment. The guidelines require that field crews be trained in observing animals for signs of stress and shown how to adjust electrofishing equipment to minimize that stress. Electrofishing is not done in the vicinity of redds or spawning adults. All electrofishing equipment operators are trained by qualified personnel to be familiar with equipment handling, settings, maintenance, and safety. Only direct current units will be used, and the equipment will be regularly maintained to ensure proper operating condition. Voltage, pulse width, and rate will be kept at minimal levels and water conductivity will be tested at the start of every electrofishing session so those minimal levels can be determined. When such low settings are used, shocked fish normally revive instantaneously. Fish requiring revivification will receive immediate care. Although McMichael et al. (1998) indicated electrofishing injury rates for wild salmonids were only 5%, NMFS has assumed a more conservative injury rate of 25% of the total number of fish electrofished to account for variable site conditions and experience levels.

The BA analysis applied a FWS Opinion (2004b) stranding rate of 5% for all project sites. The FWS (2004b) consultation was for a similar proposed action in Oregon and Washington. This value appeared to rely on abnormally high electrofishing capture efficiency (~100%) and was considered by NMFS to be an overestimate. NMFS conducted this Opinion's analysis with a more realistic electrofishing capture efficiency of 45% for three pass electrofishing (Peterson et. al 2004). After applying this assumption, NMFS calculated an expected stranding rate of 8% (of total exposed population) for both electrofished and non-electrofished sites. It may be necessary to incorporate additional protective measures in order to meet the 5% stranding rate that was targeted in the BA.

This analysis assumes the same injury and mortality rates per project (for some variables) that were determined by FWS (2004b), for bull trout (for a similar action), apply to juvenile spring/summer Chinook salmon and steelhead. Some changes to the potential exposure assumptions were made in order to be consistent with the action area and NMFS trust species and have been discussed above and further documented in the project record. Assumptions used to determine the annual number of fish injured or killed included: (1) Densities of juvenile spring/summer Chinook salmon approximate 7.2 fish per 100 $feet^2$ (carrying capacity for "good" habitat); (2) densities of parr steelhead approximate 1.3 fish per 100 $feet^2$ (carrying capacity for "good" habitat) and fry steelhead approximate 2.6 fish per 100 $feet^2$ (Herb Pollard, Fishery Biologist, NMFS, personal communication, 2005); (3) average barrier pipe length is 46.4 feet; (4) average dewatered stream length of 175 feet and average bankfull width is 8.2 feet; (5) average length of occupied habitat within dewatered reach is 128.6 feet (dewatered length or average barrier pipe length); (5) after manual fish removal at the 39 electrofishing sites, 50% of remaining fish will voluntarily migrate out of the work site during dewatering; (6) 75% voluntary migration[8] at sites where electrofishing is not deemed necessary (117 sites annually); (7) 70% capture rate with nets regardless of pre- or post-volitional movement (FWS 2004b); (8) 45% electroshocking capture efficiency (Peterson et. al 2004); (9) 25% electroshocking injury rate; (10) 5% electroshocking mortality rate (additional to the 25% electroshocking injury rate) for all species (NMFS 2004); and (11) 8% "stranded fish" rate at all sites (applied to total exposed fish population). These assumptions are based on the best available commercial and scientific information.

For this analysis, the annual number of Chinook salmon and steelhead injured or killed per project and annually for the entire action area (Table 11), was estimated by first extrapolating the method-specific number of Chinook salmon and steelhead expected to be killed, handled, or injured by activity type (as described above) to the assumed densities of Chinook and steelhead. This figure was then multiplied by the number of projects within the action area where electrofishing, handling, and stranding of juvenile Chinook salmon (17) and steelhead (22) is anticipated. The table also quantifies take for volitional sites anticipated to rely on volitional movement and dip-netting only. Volitional sites are expected to cause stranding, block net impingement or netting related take to juvenile Chinook salmon at 52 sites and juvenile steelhead at 66 sites.

Estimates presented in Table 11 are expected to represent a worst case scenario, as the fish densities used to calculate the values represent carrying capacities for "good" habitat (Hall-Griswold et al. 1995), and it is not likely that any potential project sites are currently at carrying capacity when the current status of the species is considered (Section 2.2.1). Furthermore, not all habitat units are expected to represent "good" habitat conditions when the environmental baseline is considered (Section 2.4), so lower fish densities are expected at some work sites. Therefore, the estimates presented in Table 11 are likely to be overestimates of actual take but are used in this Opinion to give the species the highest level of deference available.

[8] The 75% value was the upper range of volitional movement suggested by T. Curet (Personal Comm. 05). This value is considered appropriate as the Forest Service generally chooses not to electrofish sites that are of higher gradient, smaller channels or less complex habitat and therefore greater volitional movement is expected.

Table 11. Number of fish per project and across the action area (in parentheses), disturbed, injured, hazed or killed due to seining, netting, block net impingement[9], electroshocking, and/or dewatering as a result of the annual implementation of the proposed action. See above text for assumptions[10].

	Electrofishing Sites			Volitional Sites (no electrofishing)		
	Sp/Su Chinook Salmon Parr	Steelhead Parr	Steelhead Fry	Sp/Su Chinook Salmon Parr	Steelhead Parr	Steelhead Fry
# Projects to Handle Fish in Action Area Annually	17	22	22	52	66	66
# Fish Injured, handled or hazed per project *(annual in parenthesis)*						
a) Seined, Dip-netted, Handled or Hazed	53 *(906)*	10 *(210)*	19 *(419)*	13 *(680)*	2 *(157)*	5 *(315)*
b) Electrofished	10 *(175)*	1 *(20)*	2 *(40)*	N/A	N/A	N/A
c) Injured as a result of electrofishing	3 *(44)*	<1 *(5)*	<1 *(10)*	N/A	N/A	N/A
d) Total Fish Harmed	63 *(1,081)*	11 *(230)*	21 *(459)*	13 *(680)*	2 *(157)*	5 *(315)*
Number of Fish Killed						
a) Electrofishing Mortality	0.5 *(9)*	<1 *(1)*	<1 *(2)*	N/A	N/A	N/A
b) Stranding Mortality	6.2 *(107)*	1.6 *(35)*	3.2 *(70)*	5.7 *(291)*	1 *(67)*	2.1 *(135)*
c) Total Mortality	7 *(116)*	2 *(36)*	3 *(72)*	5.7 *(291)*	1 *(67)*	2.1 *(135)*
Total Number Fish Injured Annually (sum of electrofished and non electrofished sites)				**1,761**	**387**	**774**
Total Number Fish Killed Annually (sum of electrofished and non electrofished sites)				**407**	**103**	**206**

Due to the low water work window and the need to abide by state water quality permit work periods, NMFS assumes that the vast majority of projects will occur between June 1 and August 15 (within the state recommended instream work window). Spring/summer Chinook salmon in the action area are considered 'stream type' with juvenile's rearing in freshwater for only 1 year (Taylor 1990). Therefore, only 1 year class of spring/summer Chinook salmon has potential to be affected each year. All juvenile Chinook affected by the proposed action will be referred to as 'parr' in the following analyses. Steelhead exhibit an alternative life history with juveniles

[9] Actual injury or mortality as a result of block net deployment could not be determined. The value is expected to be insignificant.

[10] A detailed description of the assumptions and calculations made to complete Table 4 can be found in the project record.

rearing in tributary streams up to 7 years but with most fish residing in freshwater 1-3 years prior to smoltification (Good 2005; Quinn 2005). Steelhead may emerge from redds within the project area as late as the end of June in major creeks and rivers and potentially as late as September in smaller tributaries. Due to later emergence by steelhead, it is likely that age 0 fish (termed fry here) as well as parr (age 1+) will be affected by the action and therefore they have a take estimate presented in Table 11.

Evaluation of Table 11 indicates that, under the applied assumptions, per-project, lethal take of juvenile salmonids is likely to be 19% higher at electrofished sites than at non-electrofished sites. However, annual mortality is 2.5 times greater for the non-electrofished sites due to the number of projects implemented under the different salvage operations. Stranding rates for juvenile fish at both types of sites contribute the greatest percentage to total project mortality.

The total number of fish harmed, injured, or hazed is 4.8 times greater for the electrofished sites than it is for the non-electrofished sites. This is primarily due to the fact that the dewatering conservation measure requires fish to be cleared of the worksite prior to dewatering at electrofishing sites and not at non-electrofished sites. If dewatering were to occur prior to fish salvage efforts, a greater number of fish may volitionally move from the work area prior to being hazed, captured, handled, or electrofished. Therefore, dewatering prior to fish salvage at electrofishing sites would likely reduce the level of take. Adequate monitoring of the number of fish killed and handled will be necessary to validate these assumptions and to adaptively manage the programmatic consultation to reduce take levels over time.

In summary, the proposed action is estimated to result in the hazing, capture, handling and subsequent transport of approximately 1,761 juvenile Chinook salmon and 1,161 juvenile steelhead (parr and fry) annually. This handling is likely to result in various levels of harm and stress that may lead to eventual death. Death may occur as a result of actual stress levels and increased cortisol production, physical trauma, or increased predation rates on released fish. However, it is impossible to quantify the level of mortality that may occur from handling. Application of design criteria provided in the proposed action should effectively reduce the potential harm to individuals during capture and transport such that the risk of death is minimized.

NMFS has estimated that the proposed action is likely to directly result in the death of up to 407 juvenile spring/summer Chinook salmon and 309 juvenile steelhead (parr and fry) annually. The process of dewatering work sites is designed to reduce direct effects to protected fish that would otherwise occur if the project were implemented in free flowing water. Although dewatering is a design criterion that results in mortality, it is considered an improvement over the potential harm and mortality that would occur without dewatering the project sites. Further, the long-term increase in available habitat following barrier removal is thought to outweigh any short-term adverse effects to individuals.

No provisions for directly handling Snake River sockeye salmon adult or juveniles are included in the proposed programmatic action addressed in this Opinion. No dewatering or other in-channel work that could impede sockeye salmon migratory movements are permitted, and only single-span bridges with abutments that are positioned above the high-water mark will be involved within the scope of this consultation. These restrictions, in concert with all other Conservation Measures included in this Opinion, eliminate activities that could result in lethal take or salvage of sockeye salmon. For these reasons, no expectation of sockeye salmon mortality has been included in this Opinion. Also, because Snake River fall Chinook do not inhabit stream or river segments where stream crossing structure replacement and removal activities associated with the programmatic action are expected to be implemented, no take of this species is expected or addressed in this Opinion. Any river crossings that may be designed in mainstem river habitats occupied by Snake River fall Chinook salmon would exceed the parameters of the stream crossing structure replacement and removal activities involved in this consultation.

2.4.3. Water quality

2.4.3.1. Suspended Sediment

Water quality in the analysis area may be degraded as a result of the proposed action. All ground disturbing activities and the return of flow through the dewatered work site have potential to create increased levels of suspended sediment in the water column. Site preparation, excavation of road fill and diversion channel, dewatering of construction site, diversion removal, backfill to road surface, site rehabilitation and maintenance construction phases all have potential to introduce sediment to the stream system and adversely affect water quality. The majority of sediment introduction is expected to occur during site preparation, excavation of road fill/diversion channel, diversion removal, and the maintenance construction phases.

Water quality may also be affected through increases in stream temperatures and/or through chemical contamination. Clearing of riparian vegetation could result in increases in stream temperature. Riparian clearing is most likely to occur during site preparation, excavation of road fill and diversion channel construction phases, and perhaps during maintenance activities. Chemical contamination may occur any time construction equipment is working within or adjacent to the stream channel and could potentially occur during any of the proposed construction phases.

Conservation measures presented as part of the proposed action are intended to prevent the majority of sediment from being delivered to stream habitat but cannot prevent all sediment due to the nature of the ground disturbing work. Juvenile spring/summer Chinook salmon, juvenile steelhead, and migrating sockeye salmon may experience short-term adverse effects as a result. However, because stream crossing replacement projects in sockeye salmon migratory habitat will only involve installation of single-span structures and will not require dewatering of the stream channel, sediment-related impacts to migrating sockeye salmon will occur at reduced magnitudes and frequencies when compared to that of juvenile steelhead and spring/summer Chinook salmon.

The most critical aspects of a sediment effects analysis are timing, duration, intensity and frequency of exposure (Bash et al. 2001). Depending on the level of these parameters, turbidity can cause lethal, sublethal, and behavioral effects in juvenile and adult salmonids (Newcombe and Jensen 1996). For salmonids, elevated suspended sediment (i.e., turbidity) has been linked to a number of behavioral and physiological responses (*i.e.*, gill flaring, coughing, avoidance, and increase in blood sugar levels) which indicate some level of stress (Bisson and Bilby 1982; Sigler *et al.* 1984; Berg and Northcote 1985; Servizi and Martens 1992). The magnitude of these stress responses is generally higher when turbidity is increased and particle size decreased (Bisson and Bilby 1982; Servizi and Martens 1987; Gregory and Northcote 1993). Although turbidity may cause stress, Gregory and Northcote (1993) have shown that moderate levels of turbidity (35-150 nephelometric turbidity units [NTUs]) accelerate foraging rates among juvenile Chinook salmon, likely because of reduced vulnerability to predators (camouflaging effect). Timing of sediment inputs from construction related activities would generally occur during low background sediment levels in the stream system (during low flow season and during a lack of precipitation) while sediment generated during spring rains or runoff would occur when background sediment levels are higher. Bash et al. (2001) reported that protective mucus levels of individual fish are lower during the low sediment background period; therefore, effects to fish may be amplified at this time.

Substrate may inadvertently fall from excavation equipment buckets or accidentally be pushed over road or bank edges while working in close proximity to the live stream channel during site preparation, crossing excavation, diversion channel digging, road backfilling, during rehabilitation efforts, and during any needed maintenance activities. Proper design of site clearing, staging areas, access routes, and stockpile areas should minimize the risk of sediment delivery into stream channels. Sediment barriers will be placed around potentially disturbed sites where needed to prevent sediment from entering a stream directly or indirectly. An adequate supply of erosion control materials (e.g., silt fence and straw bales) will be on site to respond to emergencies and unforeseen problems. Heavy machinery is prohibited from working within the live channel in occupied habitats to reduce direct fish impacts and decrease substrate disturbance. Instream sediment retention barriers (e.g., Sedimat®, straw bale retentions, and off channel sediment settling ponds) may be installed and maintained throughout construction to minimize sediment delivery as well. The PDTs will delineate construction impact areas to confine work to the minimum area necessary to complete the project. Sediment transport from the temporary bypass channel will be minimized due to the provision for lined channels or the use of plastic pipes to convey water around the construction site. Where necessary, pumps will be used to remove water from the work site, pumping it to an approved upland location to further reduce sediment delivery. All in-channel sediment retention structures will be appropriately maintained and removed to ensure captured sediment is removed from the system to minimize potential suspended sediment increases. All of these conservation measures help minimize the potential for sediment introductions and increased suspended sediment resulting from project implementation. The proposed action did not identify site preparation conservation measures as being needed to be applied for 'Maintenance' activities which have potential to elevate sediment levels during these construction phases. However, Sedimat® and straw bale retentions and off channel settling ponds may be used at these sites and are expected to reduce the potential for sediment delivery.

It is recognized that rain events during and following construction activities may also result in mobilization of disturbed soils resulting in stream delivery, even with sediment control measures in place (Foltz and Yanosek 2005). Any substrate introduced during these stages will increase suspended sediment levels to some degree and potentially affect any exposed fish downstream. These types of disturbances are likely to be of short duration as small amounts of substrate are infrequently and inadvertently introduced to the stream channel. Peak suspended sediment and turbidity values are expected to occur when the excavators are physically in the creek, when excavators are moving streambed rocks, when placing vegetation on the creek banks, or when temporary dams are removed at the end of a project (Foltz et al. 2012). Based on review of the literature, NMFS expects that any resulting sediment plumes should be limited to less than 600 feet and should dissipate within a few hours (Casselli et al. 2000; Jakober 2002; FWS 2004a; USFS 2005). In addition to effects remaining within 600 feet of the disturbance, affected streams are likely to quickly return to background suspended sediment levels considering the expected small volume of substrate likely to be introduced (Jakober 2002, Casselli 2000). The sediment mitigation measures of diverting the creek around the road crossing and temporary in-creek dams have proven effective in keeping the turbidity values within state regulatory requirements (at or below Idaho state instantaneous criteria of 50 NTU above the background) (Foltz et al. 2012).

Unoccupied Habitat. The proposed action includes an undetermined number of crossing removal/replacement actions that may occur in 'unoccupied' habitat. Providing conservation measures described in Appendix C are appropriately implemented and unoccupied habitats are identified correctly, dewatering of the construction site within unoccupied habitats is not expected to have any indirect or direct effects to ESA-listed species or their habitat. The stream channel between the diversion inlet and outlet would be dewatered. Conservation measures designed to minimize earth moving related erosion and requirements for site rehabilitation will ensure that soil exposure does not result in increased sediment delivery to the adjacent stream channel. As previously discussed, NMFS expects that with implementation of the proposed conservation measures, any resulting sediment plume should be limited to less than 600 feet and should dissipate within a few hours (Casselli et al. 2000; Jakober 2002; FWS 2004a; USFS 2005). Therefore, even short turbidity pulses, if they were to occur, are not likely to affect individual fish due to fish being absent within at least 600 feet downstream of the worksite as described in this Opinion's definition of 'unoccupied sites.'

Occupied Habitat. Newcombe and Jensen (1996) calculated "severity-of-ill-effect scores" for various durations and intensities of juvenile salmonid exposure to suspended sediment. These values can easily be broken down into four basic classes as it relates to take under the ESA. A severity rating of '0' has no behavioral effect and thus no 'harm.' Severity levels 1-4 represent alarm reactions, abandonment of cover, avoidance response, and short-term reduction in feeding rates (<2 hours), and are considered minor but temporary impacts to individuals. Severity levels 5-9 represent ascending levels of sublethal effects that can be assumed to cause 'harm' to listed salmonids and include physiological stress, habitat degradation, impaired homing, reduced growth rate, and delayed hatching. Suspended sediment concentrations resulting in severity levels 10-14 result in lethal effects to the subjected individuals.

Foltz and Yanosek (2005) reported suspended sediment levels exceeding 28,000 mg/l at one culvert replacement project site. These levels would have resulted in mortality to exposed fish. However, the site in Foltz and Yanosek's study did not utilize any mitigation measures and occurred in a first order tributary too steep for fish. The proposed action utilizes many design measures that will limit suspended sediment to much lower levels and therefore potential effects from the proposed action will be far less than those reported in the Foltz and Yanosek study.

Jakober (2002) conducted a study to measure the intensity and duration of suspended sediment levels in a small stream as a result of a culvert replacement project in Idaho. Jakober's study (2002) observed higher suspended sediment levels than are expected for the proposed action (due to increased conservation measures in the proposed action). However, for this analysis, NMFS uses Jakober's suspended sediment values as the worst case scenario to determine the potential effects of turbidity on ESA-listed species downstream of individual project sites. Using Jakober's findings on duration and intensity of observed suspended sediment values and applying the ratings found in Newcombe and Jensen (1996) allowed NMFS to estimate the duration and "severity-of-ill-effect scores" that may occur for a typical project completed under the proposed action.

Jakober (2002) observed several short suspended sediment pulses ranging from 4.53 to 34 mg/l during the site preparation and through new culvert installation construction phases. When applied to Newcombe and Jensen's (1996) "severity-of-ill-effect scores," these observed suspended sediment levels result in severity levels ranging between 1 and 4. Duration of this disturbance is expected to be temporary (<2 hours) as sediment introductions are infrequent and of small size. Noggle (1978 as cited in Newcombe and Jensen 1996) reported concentrations of 25 mg/l for 1 hour caused decreased feeding rates, and concentrations of 6,000 mg/l for 1 hour led to avoidance behavior in juvenile coho salmon. Fish exposed to the projected suspended sediment levels during the site preparation phase through the new crossing installation phase are anticipated to exhibit reduced feeding rates, avoidance responses, cover abandonment, or an alarm reaction. These behavioral effects are considered temporary in nature and are not expected to reach levels that result in mortality.

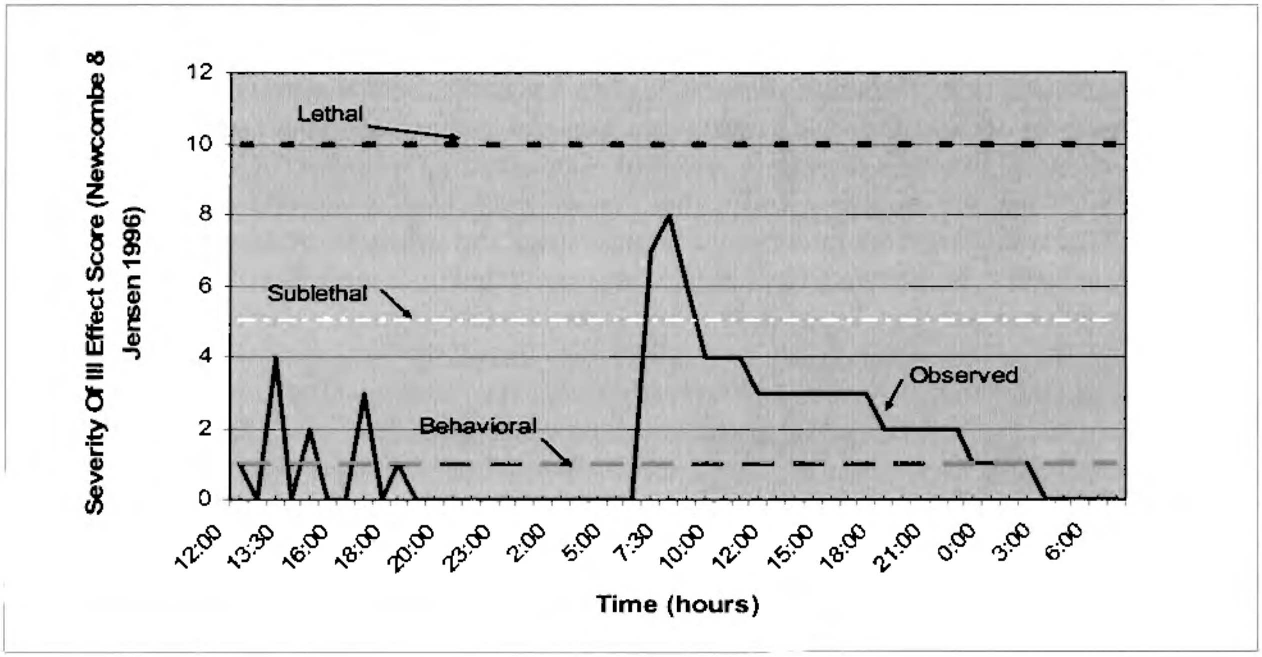
During the slow rewatering of various worksites, all freshly disturbed substrates within the dewatered worksites will be highly prone to suspension and mobilization in the water column. The BA cited personal observations of projects similar to the proposed action that observed about 90% of turbidity and sediment increases occur during flow reintroduction to the dewatered channel. Jakober (2002) also found that 95% of construction-related sediment was introduced in the first 2 hours after the diversion was removed and water returned to the new crossing site. Casselli (2000) observed a similar response. In Jakober's study (2002), sediment concentrations instantaneously rose from a background of 1.69 mg/l of suspended sediment pre-diversion removal, to a high of 15,588 mg/l for 30 minutes during re-watering of the channel. Suspended sediment levels then continuously dropped over time, decreasing to 105-677 mg/l 1 hour after re-watering, to 17-29 mg/l 2.5 hours after re-watering, to 1.13 mg/l 26 hours after rewatering the site. In a similar monitoring effort, Bakke (2002) recorded sediment concentrations up to 514-2,060 mg/l following removal of culverts. These concentrations reportedly lasted less than 1 hour.

Re-watering of project sites is likely to result in the greatest turbidity/suspended sediment levels achieved during project implementation (Foltz et al. 2012) with values reaching a severity of effects score of up to 8, for approximately 1 hour. However, intensity levels are expected to be reduced due to conservation measures in the proposed action such as: (1) Instream sediment retention structures (e.g., Sedimat®, straw bales, silt fence, off channel settling ponds); (2) pre-washing work site prior to diversion dam removal, and (3) maintenance and removal of sediment retention structures prior to re-watering. Considering application of these conservation measures, NMFS expects that re-watering the channel could result in suspended sediment levels triggering effects ranging from minor physiological stress and increased rates of coughing and respiration at level 5, to moderate physiological stress at level 6, to moderate habitat degradation and impaired homing at level 7, and to fish demonstrating indicators of major physiological stress at level 8. All these effects can be considered to 'harm' the fish exposed to these conditions and temporarily degrade habitat rearing capacity. Suspended sediment levels are expected to steadily decrease for the next 2 hours, dropping from level 4 to 3 and having similar avoidance and alarm reactions as discussed above. Suspended sediment levels are not anticipated to exceed 22,026 mg/l at any time and therefore severity levels 9-14 will not be reached and no lethal take is expected to occur as a result of sediment exposure. Figure 2 illustrates the level of impacts and duration of exposure for a typical culvert replacement/removal project.

By analyzing Figure 2 it is apparent that even in the worst case scenario, lethal take levels are not expected to be achieved under the proposed action. Juvenile spring/summer Chinook salmon, juvenile steelhead, and/or migrating sockeye salmon may experience short, low intensity sediment pulses during site clearing phases. Juvenile spring/summer Chinook salmon and/or juvenile steelhead are expected to be exposed to additional sublethal sediment levels during diversion installation and for approximately 2 hours immediately after re-watering project work sites. Sediment conditions will then steadily improve with a less intensive plume for up to 20 additional hours resulting in various behavioral modifications that are less likely to harm exposed individuals. Fish exposure may be further minimized as fish are likely to seek less turbid conditions downstream or to the margins of the generated sediment plume (Bisson and Bilby 1982; Noggle 1978; Servizi and Martens 1992).

Mitigation measures presented as part of the proposed action, such as dewatering the channel where inwater work is required, use of Sedimat® and other in-channel sediment retention devices, and washing down the new stream channel before re-watering were not reported for the comparative studies (although Jakober dewatered the channel). Therefore, NMFS believes the suspended sediment concentrations presented are higher than those likely to be observed during any replacement/removal actions authorized by this consultation. Sedimat® is able to contain an estimated 600 lbs of direct in-channel sediment delivered from culvert replacements (NYSEGC 1993). Sedimat has been demonstrated to be approximately 95% effective in trapping sediment that may be delivered during in-channel activities (NYSEGC 1993). Although local observations have not seen this level of effectiveness, there is wide acceptance of their efficacy (Personal Comm. 2005: D. Newberry, Fisheries Biologist, USFS; K. Grover-Weir, Hydrologist, USFS).

Figure 2. Illustration of the potential duration, intensity and frequency of sediment exposure under implemented projects. Jakober data (2002) is used to represent the worst case scenario.



Projects completed under the action as proposed, especially multiple projects that may be completed within the same stream channel or in the same subwatershed, could result in sediment concentrations similar to those reported by Jakoher (2002) and Bakke et al. (2002). Associated adverse, but non-lethal effects to ESA-listed fish and adverse impacts to fish habitat may also occur. Mitigation measures such as complete bypass of project sites by dewatering, use of Sedimat®, straw bales, and silt fences, and washing down the new channel before rewatering will decrease the quantity of suspended sediment generated by project actions. Therefore, proposed mitigation measures will decrease the potential for associated adverse effects on ESA-listed fish and fish habitat below those reported in the literature and displayed in Figure 2.

There is potential for additional sediment inputs beyond the short-term effects from culvert replacement/removal actions. Bakke et al. (2002) monitored Waddell Creek near Olympia, Washington and found that channel incision or lateral scour during channel readjustments following removal/replacements are likely to produce more sediment delivery than that produced during construction. They also concluded that quantifying sedimentation impacts to threatened fish stocks from culvert removals could be extremely complex (Bakke et al. 2002). Timing of these sediment inputs is likely to occur during large storm events or during spring snow melt and associated peak channel flows. Therefore, sediment loading during this period is additive to the peak sediment loads being transported at this time. The FWS determined that sediment inputs from projects similar to those as the proposed action, and at this temporal period, appeared minor relative to the annual sediment budget of the affected watersheds (FWS 2004b). The amount of sediment introduced via culvert actions is generally recognized as far less than what may be delivered if the same culvert were to fail if the crossing were left unchanged.

Fish Exposure to Suspended Sediment. Some of the same assumptions previously used to quantify the impacts of fish handling can also be used to identify the potential number of fish affected by increased suspended sediment levels. As stated in the BA, suspended sediment levels are expected to extend up to 600 feet downstream from the bottom of the dewatered area. Average bankfull stream width was estimated to be 8.2 feet (Personal Comm. 2005: M. Kellett, Fisheries Biologist, USFS; J. Chatel, Fisheries Biologist, USFS; and C. Zurstadt, Fisheries Biologist, USFS). The product of length and width determines the exposure area; approximately 4,930 $feet^2$ for the average project site. Applying the fish densities previously described in Section 2.5.1.6 of this Opinion and the exposure area noted above results in approximately 352 spring/summer Chinook salmon, 64 steelhead parr, and 128 steelhead fry potentially being exposed to the elevated suspended sediment levels and the above mentioned effects at each project site[11].

Due to the species distribution across the action area, the maximum number of projects that could affect spring/summer Chinook salmon and steelhead each year is 69 and 87 respectively. Multiplying the number of fish affected at each site by the total number of projects, NMFS estimates that approximately 24,166 spring/summer Chinook salmon, 5,598 steelhead parr, and 11,196 steelhead fry could be affected by the increased suspended sediment levels to some degree each year. As stated previously, densities applied for this analysis are likely an overestimate of the actual number of fish present due to both the current status of the species and the quality of existing habitat. Since sediment will likely settle out as it moves downstream, suspended sediment levels are likely to diminish with increasing distance downstream. Decreasing suspended sediment levels with increasing distance is likely to result in individual fish being less impacted the further downstream individuals are from the project site. Further, fish are expected to temporarily migrate to less turbid waters found downstream, thus lessening the degree of impact elevated suspended sediment levels are likely to have on individuals (Bisson and Bilby 1982; Noggle 1978; Servizi and Martens 1992). These considerations provide another level of overestimation of the potential effects. This conservative estimate is being used to provide the greatest benefit of doubt to the species by analyzing the worst case scenario. Reviewing Figure 2, it is evident that exposed fish will exhibit behavioral modifications for up to 8 hours and sublethal effects for approximately 1 hour immediately following work site rewatering.

2.4.3.2. Temperature

The proposed action may reduce streamside shade that in turn can result in increased steam temperatures. The greatest potential for riparian disturbance (shade removal) will occur during

[11] Sediment exposure density calculations have been limited to the numbers of juvenile steelhead and spring/summer Chinook salmon present as they rear in action area streams throughout the construction windows and will be present during most projects. In the few projects expected to occur in habitat occupied by sockeye salmon, sockeye are not expected to be rearing in project areas and are expected to quickly continue their migrating through project-related turbidity. NMFS is not able predict the number of projects that will occur in migratory sockeye salmon habitat nor the densities of migrating sockeye salmon that will be exposed to these projects when they occur.

site preparation, culvert excavation, and the digging of the diversion channel. Elevated water temperatures may adversely affect salmonid physiology, growth, and development, alter life history patterns, induce disease, and may exacerbate competitive predator-prey interactions (Spence et al. 1996).

As identified in the proposed action, tree removal and riparian disturbance will be minimized to that which is necessary to facilitate structure installation. No trees greater than 8 inches dbh will be removed during site rehabilitation. Because actions completed under this programmatic consultation will occur at existing stream crossing locations, riparian vegetation removal is expected to be so minimal as to have insignificant effects to stream shade. In certain instances though, installation of a wider structure may also require increasing structure length which could necessitate removal of up to three trees (NMFS assumption based on previous project experience). Conservation measures indicate that riparian disturbance will be limited to that necessary to complete the project and should be minimal due to existing disturbed nature of the sites. Any removed trees will remain on site and be used in-channel rehabilitation efforts (Appendix C, F6.a.2). The removal of up to three trees at a project site has the potential to reduce local stream shading by increasing the amount of solar radiation reaching the stream surface (Spence et al 1996). However, NMFS considers the potential for stream temperature increase to be insignificant because the number of removed trees or extent of riparian disturbance will not likely be of a magnitude capable of changing the amount of solar radiation at project sites.

Although generally considered adequate to ensure effects to temperature are adequately minimized and inconsequential, conservation measures outlined in the proposed action do not indicate how the action agencies propose to minimize the potential for streambank disturbance associated with bypass channel construction adjacent to stream channels. Conservation measures do ensure that staging and associated stockpile areas will be located outside of specific buffers and on existing disturbed areas where possible (road prisms or turnouts). Very little site preparation activity is expected to occur in riparian areas and no site preparation activity is expected in the stream channel. Clearing (if needed) will occur outside of the designated buffers. Buffer delineation will be completed by the PDT. Any riparian vegetation removed will be stockpiled and transplanted back to the riparian area during site rehabilitation. However, conservation measures do not effectively describe how limits to riparian disturbance or tree removal will be effectively managed, only that they will be minimized.

2.4.3.3. Chemical Contamination

Heavy machinery used adjacent to stream channels raises concern for the potential of an accidental spill of fuel, lubricants, hydraulic fluid and similar contaminants into the riparian zone, or directly into the water where they could adversely affect habitat, injure or kill aquatic food organisms, or directly impact ESA-listed species.

Petroleum-based contaminants such as fuel, oil, and some hydraulic fluids, contain poly-cyclic aromatic hydrocarbons, which can cause chronic sublethal effects to aquatic organisms (Neff

1985). Ethylene glycol (the primary ingredient in antifreeze) has been shown to result in sublethal effects to rainbow trout at concentrations of 20,400 mg/L (Beak Consultants Ltd. 1995, as cited in Staples 2001). Brake fluid is also a mixture of glycols and glycol ethers, and has about the same toxicity as antifreeze.

The majority of work is anticipated to occur outside of flowing water which limits the potential for chemical contamination to occur. To further prevent toxic materials from entering live water, the USFS and BLM developed specific prevention measures that were presented as part of the proposed action. The action agencies are also requiring a spill prevention, containment and control plan (SPCCP) to be developed for all projects and submitted to Level 1 Teams during the pre-project review. Level 1 Teams will ensure that all SPCCPs are adequate to sufficiently discount the potential hazards from the chemicals being used during project completion. In addition, it is unlikely that antifreeze, brake or transmission fluid will be present on-site or spilled in volumes or concentrations large enough to harm salmonids in or downstream from project sites. NMFS feels that fuel spill and equipment leak contingencies and preventions described in the proposed action, in combination with individual project SPCCP reviews, should be sufficient to effectively minimize the risk of negative impacts to ESA-listed fish and fish habitat from toxic contamination.

2.4.4. General Habitat Conditions

NMFS expects that implementation of the proposed action may adversely affect habitat conditions within the analysis area. Use of a temporary diversion structure may temporarily block upstream fish passage. Near and in-channel excavations are likely to increase in-channel sediment deposition; and excavation of project sites and installation of riprap may alter streambank conditions.

2.4.4.1. Temporary Passage Blockage

Diversion channels may temporarily block upstream fish passage. In many cases, the dewatered section will be a continuation of the existing passage barrier being replaced. In these cases, no additional adverse impacts to upstream movements are expected during implementation. Due to project timing and the short duration that sites will be dewatered, temporary blockage of upstream movements will not affect adult ESA-listed fish as none are expected to be present during construction. NMFS anticipates that effects from this temporary blockage of fish passage on juvenile ESA-listed fish will be negligible, particularly when considered in relation to the long-term benefit of restoring year-round fish passage to all age classes in these stream systems. While Snake River spring/summer Chinook salmon and Snake River steelhead juvenile fish may experience short-term, temporary blockages to their migratory movements, no such interruption to migratory movement of Snake River sockeye salmon is acceptable or expected.

2.4.4.2. Sediment Deposition

The methods for sediment introduction to the stream channel were described in the suspended sediment discussion above. The same suite of conservation measures proposed to reduce the potential for suspended sediment, similarly minimize the potential for in-channel sediment deposition.

The potential effects of sediment deposition on fish habitat can be described by evaluating the literature reported effects. Egg-to-emergence survival and size of alevins is negatively affected by fine sediment intrusion into spawning gravel (Cedarholm et al. 1981; Young et al. 1991). Fine sediment deposition in spawning gravel ultimately reduces the oxygen supply rate to the redd (Wu 2000). However, redds should not be present within the work site nor within the expected extent of sediment deposition (~600 feet) and direct effects to incubating eggs or alevins are not anticipated as a result of habitat sedimentation (FWS 2004b; USFS 2005). Fall fish spawning following project implementation is not likely to inhibited by the expected levels of sedimentation as the initial winnowing of fine sediment by females during redd construction cleans out the gravel and increases permeability and interstitial flow (Kondolf et al. 1993). Fine, redeposited sediments have the potential to adversely affect primary and secondary productivity (Spence *et al.* 1996; Suttle et al. 2004) and reduce cover for juvenile salmonids (Bjornn and Reiser 1991). Suttle (2004) found that increases in fine sediment concentration led to a change from available aquatic insects (surface grazers and predators) to unavailable burrowing species. It is expected that primary production will be affected in the short term within the individual 600 foot affected stream reaches. Recolonization of affected areas is expected to occur rapidly. Fine sediment can fill pools and interstitial spaces in rocks and gravels used by fish for thermal cover and for predator avoidance (Waters 1995). Any temporary loss of habitat that occurs is likely to be of a temporary nature (< 6 months) within the project area and not have any long term effects to ESA-listed fish. Adequate monitoring of any known redds downstream of 600 feet may be necessary to ensure that this level of protection is maintained.

The construction of stream simulation crossings is expected to reduce annual maintenance levels, reduce risk of crossing failure, and reduce channel erosion associated with improperly designed or sized culverts. These sediment reductions will likely benefit the receiving stream systems and habitat over all temporal scales.

In summary, potential effects of increased sediment deposition on fish habitat will likely occur in the immediate work site and up to 600 feet downstream of the dewatered area. Project-related sediment that settles on downstream substrates is expected to be flushed out during fall/winter/spring high flows after project completion (USFS 2005). Therefore, NMFS expects that long-term adverse impacts to spawning gravels are not likely to occur. Further, NMFS expects that project-related sediments introduced into the stream channel should be insignificant, relative to the annual sediment budget of a watershed, supporting the BA conclusion that long-term sediment/turbidity impacts will not occur. Introduced sediment levels are expected to be insignificant due to the projected success of the proposed design criteria in limiting sediment introduction to the stream channels.

2.4.4.3. Bank Alteration

Some projects implemented under the proposed action will require the installation of rock riprap and or gradient control structures. Design parameters in the proposed action prohibit exposed riprap within the bankfull channel unless necessary to meet fish passage objectives, maintain channel features, or to protect the structures. The placement of riprap is known to cause adverse effects to stream morphology, fish habitat, and fish populations (Schmetterling *et al.* 2001; Garland *et al.* 2002; Quigley and Harper2004). Riprap fails to provide the intricate habitat requirements for all age classes or species that are provided by naturally vegetated banks. Streambanks with riprap often have fewer undercut banks, less low-overhead cover, and are less likely than natural streambanks to deliver large woody debris to streams (Schmetterling et al. 2001; Quigley and Harper 2004). All these effects can be considered to simplify habitat and render it less productive to aquatic organisms. Excessive riprap may also reduce sinuosity, thereby increasing gradient, and potentially resulting in-channel incision and related floodplain abandonment where finer substrates are present. Peters et al. (1998, as cited in Schmetterling et al. 2001) and Quigley and Harper (2004) reported that salmonid abundance was lower at locations where banks had riprap modifications compared to natural banks.

Riprap use in this programmatic is designed to maintain the beneficial channel modifications created by constructing stream simulation crossings. The use of riprap for project completion will likely have small, localized effects on fish distribution and rearing success for as long as the stream crossing and riprap structures are in place. Riprap use is expected to be limited to the length of the average stream crossing in the action area (less than 38 feet). The proposed action is not likely to use extensive riprap and its extent will likely be less than the 38 foot maximum, further minimizing the potential for adverse affects. The amount of habitat affected by riprap will be very small across the action area and effects will be insignificant.

2.4.4.4. Available Habitat

Dewatering of sites may temporarily (1 day to 1 week) reduce the amount of available fish habitat (approximately 129 feet/site [average barrier length – average dewatered length]). The temporary loss of this amount of habitat is not considered a threat to the ESA-listed species because the loss is temporary and fish utilizing the habitat will be effectively captured and transported from the worksite to an appropriate location prior to dewatering.

Riparian vegetation removal resulting from project implementation may adversely affect fish habitat. Loss of riparian vegetation may reduce allochthonous inputs to the stream, potentially reducing primary productivity in affected reaches. Loss of up to three trees from individual project sites may affect long-term pool quantity and quality as woody debris provides essential functions in streams including the formation of habitats. Additionally, the removal of vegetation decreases streambank stability and it is resistance to erosion. The proposed action requires that all trees felled to accommodate project completion will be incorporated into the rehabilitation of the site; thus, current levels of large woody debris should not be adversely affected. Removal of up to three trees per project is also not expected to result in more than a negligible effect on future large woody debris recruitment potential. Any riparian vegetation removed will be stockpiled and transplanted back to the riparian area during site rehabilitation to hasten recovery processes. Since riparian vegetation is expected to recover quickly at most project sites, and vegetation removal is expected to be minimal, any reductions in allochthonous material input is expected to be inconsequential immediately following project completion. Although conservation measures attempt to minimize stream side disturbance resulting from diversion ditch construction, additional safeguards may be necessary to maintain bank stability adjacent to temporary diversion channels.

The intended purpose of the programmatic action is to remove fish passage barriers, resulting in long-term restoration of the project location. By completely removing stream crossings and restoring stream channels or by replacing stream crossings with stream simulation crossings, there will be a substantial increase in available habitat that is currently unavailable or underutilized. The stream simulation design method is intended to mimic natural stream processes and features evident at each crossing location. The stream simulation methods provide for fish passage by simulating natural stream conditions, substrate, instream structure, and flows. The stream simulation methods also allow for the movement of stream sediments and large wood downstream, providing the necessary materials to maintain habitat features and ecosystem processes above and below the treated crossings. Thus, stream simulation is expected to improve or restore riparian and floodplain function and physical stream processes at treated sites.

Maintenance actions are believed to provide long-term benefits to species and habitats by removing an imminent threat of crossing failure (catastrophic and incremental) and their associated habitat-related adverse impacts. The extent to which each crossing removal, replacement, or maintenance activity will benefit ESA-listed fish will depend on the current state of impairment, PDT's ability to implement the design criteria and objectives on the ground, and the capacity of the populations in question to exploit newly accessible habitats.

Although some temporary and short-term negative effects to the amount of available habitat are likely to occur as a result of this action, NMFS believes that the proposed design criteria adequately avoids or minimizes the potential extent, severity and duration of effects. Further, any temporary and short-term effects are expected to result in a long-term beneficial effect by increasing the quantity of available habitat within the action area.

2.4.4.5. Explosive Related Disturbance

During the site excavation phase it may be necessary to remove large rock or excavate bedrock in order to achieve the desired depth for the new crossing. Betonamit is a noiseless, shock-free, non-toxic substance that may be used to break rocks via expansive pressure within the dewatered stream channel. This is the material of choice and is likely to be used as a first choice for rock excavation. Its use is not anticipated to have any adverse effects to ESA-listed fish.

Where betonamit is not effective, explosive blasting within the dewatered area is proposed for this consultation. Explosive blasting has the potential to harm or kill rearing or spawning fish and incubating eggs. This activity will occur within the dewatered channel where ESA-listed fish exposure to chemicals, noise, vibrations or debris from blasting or betonamit use is not expected due to design criteria. Conducting all blasting within the dewatered channel and allowing for an adequate buffer width as adapted from Wright and Hopky 1998 (Appendix C) should adequately prevent pressure, toxicity, and vibration effects that may harm ESA-listed fish near the project area. Extension of the dewatered channel solely to accommodate larger charge weights is not proposed by this consultation in order to assure dewatering effects remain consistent with those described previously.

2.4.5. Summary of Effects on ESA-listed Fish

To effectively complete a jeopardy analysis, NMFS converted the number of juvenile fish impacted to the number of adult equivalents that may be lost from each population under the proposed action. The following assumptions were used to convert the juvenile numbers presented in Table 11 to a conservative number of adults that may be lost from the population each year during the life of the programmatic consultation (10 years). NMFS has assumed a reasonably conservative estimate of 50% parr-to-smolt survival for spring/summer Chinook salmon (Keifer and Lockhart 1994). Applying Table 11 values for the number of spring/summer Chinook salmon parr that are likely to be killed annually (407), the programmatic action is estimated to result in approximately 203 fewer spring/summer Chinook salmon smolts being produced from the ESU each year. Smolt-to-adult returns are estimated as 0.87% for spring/summer Chinook salmon. Applying this percentage to the calculated number of lost smolts, it is reasonable to assume that the programmatic action would be expected to result in 1.8 fewer adult spring/summer Chinook salmon returning to the action area on an annual basis. For steelhead, fry-to-parr survival is conservatively estimated at 50% (Herb Pollard, Fishery Biologist, NMFS, Pers. Comm. 2005), and parr-to-smolt survival is assumed to be 50% (Keifer and Lockhart 94), resulting in 103 fewer steelhead smolts annually. To calculate the adult reduction to the population, NMFS applied a 0.8% smolt-to-adult survival rate (FWS 1998) that results in less than one (0.83) fewer adult steelhead returning to the action area each year the project is in place.

Increased suspended sediment from project construction activities could cause sublethal effects to all fish located downstream of each project area. Turbidity levels will peak at their highest levels downstream of dewatered work areas, affecting juvenile Chinook salmon and steelhead up to 600 feet downstream of dewatered work areas. As previously discussed, approximately 24,166 spring/summer Chinook salmon, 5,598 steelhead parr, and 11,196 steelhead fry may be affected by the increased turbidity levels to some degree. These individuals are likely to experience a temporary (<2 hour) reduction in feeding rates, and increased occurrences of avoidance responses, abandonment of cover, or alarm reactions. Immediately following channel rewatering and lasting for approximately 1.5 hours, sediment levels will peak nearly instantaneously and steadily improve. The highest sediment intensities may result in major physiological stress and moderate habitat degradation and impaired homing ability. These effects may be overstated as fish are expected to migrate away from the highest turbidity levels, seeking more favorable conditions downstream. As sediment levels improve, the effects decrease from moderate physiological stress to increased rates of coughing and respiration rates to minor physiological stress. All these effects can be considered to 'harm' fish exposed to these conditions and temporarily degrade fish habitat rearing capacity for the 1.5 hours of exposure. Fish will then be exposed to sediment levels that elicit a behavioral response for up to 22 additional hours. No lethal take would be expected to occur as a result of sediment exposure. Conservative estimates of fish densities and implementation of effective conservation measures is expected to result in both fewer fish actually harmed and lower levels of actual harm.

No lethal take of sockeye salmon is anticipated to occur. Therefore, the proposed action will not affect the survival and recovery potential of Snake River sockeye salmon. Even though the estimated loss of two spring/summer Chinook salmon and one steelhead per year is measurable, NMFS does not believe it is likely to appreciably reduce the likelihood of survival or recovery of the Snake River spring/summer Chinook ESU or the Snake River Basin steelhead DPS because the projected loss is small in comparison to the total population and ESA-listed species numbers. The projected number of lost adults will not jeopardize any of the 21 Snake River spring/summer Chinook salmon populations or the 17 steelhead populations in the Snake River. Since the projects are anticipated to be well distributed across the action area, no one population will be exposed to the loss of more than one individual adult spring/summer Chinook salmon or adult steelhead and most will not result in the loss of any adult fish. Additionally, habitat improvements and the increased availability of fish habitat within the action area are expected to benefit the affected populations over the long-term.

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). Lethal take associated with work area isolation is expected to amount to no more than a few individual juveniles (see Table 11). NMFS believes these numbers are too low to influence population abundance (especially when adult equivalents under baseline conditions are considered). Similarly, small to intermediate reductions in juvenile population density in the action areas, caused by individuals moving out of the construction area to avoid short-term physical effects of the proposed action, are expected to be transitory and are not expected to alter long-term juvenile survival rates. Because adult salmon and steelhead are larger and more mobile than juveniles, and conservation measures reduce their exposure, it is unlikely that any will be killed or injured during work area isolation. With due diligence for the full range of conservation measures outlined above, it is unlikely that physical habitat changes caused by construction events at any single construction site associated with the proposed activity, or even any likely combination of such construction sites in proximity, will cause delays severe enough to reduce spawning success and alter population growth rate, or cause straying that might otherwise alter the spatial structure or genetic diversity of populations. Thus, it is unlikely that the direct biological effects of construction associated with the proposed action will affect the characteristics of salmon or steelhead populations.

At the ESA-listed species level, direct 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). As described above, it is unlikely that the direct biological effects of construction associated with the proposed action will affect the characteristics of salmon or steelhead populations; therefore, it is also unlikely that salmon or steelhead will be affected at the ESA-listed species level.

An incremental change in the likelihood of survival and recovery for the ESA-listed species considered in this consultation due to the proposed action cannot be quantified. However, based on the effects described above, it is reasonably likely that the proposed action will have a large, widespread and long-term net benefit of increasing the potential for survival and recovery of the ESA-listed species discussed in this Opinion.

2.4.6. Effects on Critical Habitat

NMFS designates critical habitat based on physical and biological features that are essential to the listed species. Essential features for designated critical habitat include substrate, water quality, water quantity, water temperature, food, riparian vegetation, access, water velocity, space, and safe passage. Critical habitat is widespread throughout the action area. The action area provides freshwater spawning, rearing and migration habitat for Snake River spring/summer Chinook salmon, Snake River Basin steelhead, Snake River fall Chinook salmon, and Snake River sockeye salmon. However, no stream crossing structure replacement and removal activities associated with the programmatic action are expected to be implemented within designated critical habitat for Snake River fall Chinook salmon. This is because such habitat only occurs along the lower Snake River, lower Clearwater River, and lower North Fork Clearwater River in Idaho where any river crossings would far exceed the parameters of the stream crossing structure replacement and removal activities involved in this consultation and Opinion.

Designated critical habitat for Snake River sockeye salmon in Idaho includes all mainstem rivers segments and tributary streams that comprise this species' migratory habitat. Most of the mainstem rivers segments that serve as Snake River sockeye salmon migratory habitat and have been designated as critical habitat for this species will not be involved stream crossing structure replacement and removal activities associated with the programmatic action. Therefore, no adverse effects to these critical habitats resulting from stream crossing structure replacement and removal activities are expected. Designated critical habitat for Snake River sockeye salmon that is located in the upper Salmon River subbasin may be involved in some stream crossing structure replacement and removal activities associated with the programmatic action. The extent and severity of any adverse effects to designated critical habitat for Snake River sockeye salmon, Snake River spring/summer Chinook salmon, and Snake River steelhead located in the upper Salmon River subbasin is described below.

The critical habitat essential features associated with the freshwater spawning, rearing and migratory PCEs potentially affected by this action are: water quality, substrate, forage, riparian vegetation, access (barriers), and floodplain connectivity.

2.4.6.1. Water Quality

Water quality in the action areas may be temporarily degraded due to increased turbidity from construction activities. This could negatively affect juvenile feeding until the channel and structures are fully stabilized. Removal/replacement of undersized crossings will likely reduce chronic sediment delivery and channel scouring thus reducing sediment levels and improving water quality over the long-term. Operation of heavy equipment in or near the stream channel elevates the risk for accidental fuel and oil contamination of the aquatic environment within the action area although design criteria in the proposed action will reduce the risk to discountable levels. In the long term, the action area's water temperature may also improve, as problematic sediment sources are stabilized, and riparian structure and function improve.

2.4.6.2. Substrate

Temporary pulses of sediment and turbidity plumes are expected to cause small increases in downstream sediment deposition (increased surface fines), negatively affecting substrate in the short term. However, any deposited sediments liberated during project activities are expected to be entrained during the next channel-adjusting discharge. Increased surface fines are not likely to persist beyond 6 months. Due to design criteria to avoid redds and limit the sediment introduced and thus deposited, this temporary increase is not expected to be significant. Further, these sediment levels are considered to be negligible in relation to the annual sediment load during peak discharge. Removal/replacement of undersized culverts should reduce chronic sediment delivery and eliminate adverse channel adjustments associated with undersized crossings (downcutting or deposition). Additionally, the long-term risk of culvert failures and associated channel scouring events will be decreased with project implementation.

2.4.6.3. Cover/Shelter

Cover/shelter may be slightly and temporarily negatively affected due to increases in turbidity and sediment during project construction activities. Overhead cover provided by riparian vegetation is not expected to change in the short term since the amount of riparian vegetation that could be removed is considered insignificant in the context of subwatersheds. Use of riprap within project sites may incrementally reduce the rearing quality of habitat at the sites for an approximate distance of 38 feet per project. Site rehabilitation efforts will encourage riparian recovery over the long term. Pool habitat quality is not expected to be impaired by project activities.

2.4.6.4. Food

Increases in turbidity and sediment deposition may temporarily reduce macroinvertebrate communities within the turbidity plume downstream of (<600 feet) individual project sites. However, working during the low water work period and dewatering the work site prior to conducting the majority of ground disturbing activities are expected to minimize both the magnitude and duration of effects on salmonid food sources. Also, increased stability of the stream channel due to stream simulation designs and reduced chronic sediment loads may positively affect macroinvertebrate communities in the affected watersheds over the long term.

2.4.6.5. Riparian Vegetation

Removal of stream crossings should increase the potential riparian vegetation and improve riparian function. Although stream simulation replacement culverts will continue to restrict riparian function at crossing locations, improved channel stability is likely to improve riparian function downstream of sites. Clearing of vegetation within individual project work sites is expected to have a short-term localized reduction in subwatershed riparian composition and function. Rehabilitation efforts conducted as part of the proposed action should ensure that riparian function is restored or improved in the long term.

2.4.6.6. Access

Upstream passage at project sites will continue to he impaired at project sites during construction activities. However, following completion of individual projects, passage will be restored at treated sites. This is an overall improvement to this PCE.

2.4.6.7. Floodplain Connectivity

Floodplain connectivity will be improved at stream crossing removal sites but may continue to be impaired at sites where crossing replacement occurs. Stream simulation design is likely to improve channel function at replacement and removal sites, and floodplain connectivity may be improved where drastically undersized culverts previously existed.

In summary, implementation of the proposed action is expected to cause some short-term impairment to PCEs in the action area due to temporary sediment impacts to substrate and salmonid food sources. However the proposed action should also provide long-term improvements to some critical habitat PCEs within the action area. Specifically, the essential features of water quality, substrate, forage, riparian vegetation, access (barriers) and floodplain connectivity should all experience some beneficial effects of programmatic implementation. Decreased maintenance levels, reduced risk of crossing failures and improved hydrologic function at individual sites will reduce sediment inputs, and improve water quality and substrate condition within rearing and spawning habitats. Removing barriers will increase access to fish habitat and provide additional productivity that benefits forage species as well as ESA-listed fish. Removal of some stream crossings should improve local riparian and floodplain processes. The conservation value of existing critical habitat is likely to improve as a result of programmatic stream crossing replacement and removal activities.

An incremental change in the conservation value of designated critical habitats within the action area due to the proposed action cannot be quantified. Based on the effects described above, it is reasonably likely that the proposed action will have small, local, negative impacts on the conservation value of critical habitats from the time of project completion until the next peak discharge (<6 months). While designated critical habitats for Snake River spring/summer Chinook salmon and Snake River steelhead may have small, local, and temporary blockages to migratory movement of these species, no such interruption to migratory movement of Snake River sockeye salmon is expected within designated critical habitat for this endangered species. Immediately following project completion and into the long-term, the conservation value of affected critical habitats should be improved with improved passage conditions, increased floodplain function, reduced channel instability (downcutting) and improved riparian condition.

2.5. Cumulative Effects

'Cumulative effects' are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02). Cumulative effects that reduce the ability of an ESA-listed species to meet their biological requirements in the action area may increase the likelihood that the effects of the proposed action on the ESA-listed species or its habitat will result in jeopardy to that listed species or in destruction or adverse modification of designated critical habitat.

Between 2000 and 2010, the population of the State of Idaho increased by 21.1%[12]. While the proposed action does not include all counties in Idaho, the statistics are thought to reasonably portray growth expectations within the action area. Thus, NMFS assumes that future private and state actions will continue within the action area, increasing as population density rises. As the human population in the action area continues to grow, demand for agricultural, commercial, or residential development is also likely to grow. The effects of new development caused by that demand are likely to further reduce the conservation value of the habitat within the action area.

Although quantifying an incremental change in survival for the ESA-listed species and in the conservation role of critical habitat considered in this consultation due to cumulative effects is

[12] U.S. Census Bureau, State and County Quickfacts, State of Idaho. http://quickfacts.census.gov/qfd/