United States Department of the Interior

FISH AND WILDLIFE SERVICE

Washington Fish and Wildlife Office
510 Desmond Dr. SE, Suite 102
Lacey, Washington 98503

APR 26 2011

In Reply Refer To:
13410-2010-F-0488

Memorandum

To: Superintendent, Mount Rainier National Park
Ashford, Washington

From: Manager, Washington Fish and Wildlife Office
Lacey, Washington

Subject: Biological Opinion for the Carbon River Access Management Plan

This document transmits the Fish and Wildlife Service's Biological Opinion based on our review of the proposed Carbon River Access Management Plan to be implemented in Mount Rainier National Park, Pierce County, Washington. We evaluated effects on the threatened northern spotted owl (*Strix occidentalis caurina*), marbled murrelet (*Brachyramphus marmoratus*), bull trout (*Salvelinus confluentus*), and designated bull trout critical habitat in accordance with section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 et seq.). Your July 29, 2010 request for formal consultation was received on August 2, 2010.

This Biological Opinion is based on information provided in the June 28, 2010 Biological Assessment and on other information and correspondence shared between our respective staff. Copies of all correspondence regarding this consultation are on file at the Washington Fish and Wildlife Office in Lacey, Washington.

If you have any questions about this memorandum, the attached Biological Opinion, or your responsibilities under the Act, please contact Vince Harke at (360) 753-9529 or Carolyn Scafidi at (360) 753-4068.

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Endangered Species Act – Section 7 Consultation

BIOLOGICAL OPINION

U.S. Fish and Wildlife Service Reference: 13410-2010-F-0488

Carbon River Access Management Plan
Mount Rainier National Park
Pierce County, Washington

Agency:

National Park Service

Consultation Conducted By:

U.S. Department of the Interior
Fish and Wildlife Service
Washington Fish and Wildlife Office
Lacey, Washington

Ken S. Berg, Manager

4-26-2011
Date

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LIST OF ACRONYMS

Act	Endangered Species Act of 1973
ATVs	All-Terrain Vehicles
BA	Biological Assessment
CFR	Code of Federal Regulations
CHU	Critical Habitat Units
dB	Decibels
DSA	Demographic Study Area
ELJs	Engineered Logjams
FR	Federal Register
FWS	U.S. Fish & Wildlife Service
GIS	Geographic Information System
GMP	General Management Plan
HCP	Habitat Conservation Plan
MP	Milepost
NMFS	National Marine Fisheries Service
NPS	National Park Service
NTUs	Nephelometric Turbidity Units
Opinion	Biological Opinion
Park	Mount Rainier National Park
PCEs	Primary Constituent Elements
RCW	Revised Code of Washington
RM	River Mile
RPMs	Reasonable and Prudent Measures
SOSEAs	Spotted Owl Special Emphasis Areas
Spotted Owl	Northern Spotted Owl
U.S.C.	United States Code
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
WAC	Washington Administrative Code
WDFW	Washington Fish and Wildlife
WDNR	Washington Department of Natural Resources
WDOE	Washington Department of Ecology

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Introduction

This document transmits the Fish and Wildlife Service's (FWS) Biological Opinion (Opinion) based on our review of the proposed Carbon River Access Management Plan located in Mount Rainier National Park (Park), Pierce County, Washington, and its effects on federally listed species and designated critical habitat in accordance with section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 et seq.). This Opinion is based on information provided in the July 29, 2010 Biological Assessment (BA), and on other information and correspondence as noted. The following list is a summary of the federally listed resources and effect determinations documented in the BA:

Species Name (Scientific Name)	Federal Status	Effect Determination
Bull trout (*Salvelinus confluentus*)	FT	**LAA**
Bull trout critical habitat	Designated/ Proposed	**LAA**
Canada lynx (*Lynx canadensis*)	FT	NE
Gray wolf (*Canis lupus*)	FE	NE
Grizzly bear (*Ursus arctos horribilis*)	FT	NE
Marbled murrelet (*Brachyramphus marmoratus*)	FT	**LAA**
Marbled murrelet critical habitat	Designated	NE
Northern spotted owl (*Strix occidentalis caurina*)	FT	**LAA**
Northern spotted owl critical habitat	Designated	NE
Puget Sound steelhead (*Oncorhynchus mykiss*)	FT	**LAA**
Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*)	FT	NLAA
Puget Sound Chinook salmon critical habitat	Designated	NLAA
Dolly Varden (*Salvelinus malma*)	FP	NE
Fisher (*Martes pennanti*) (West Coast DPS)	FC	NE
Bald Eagle (*Haliaeetus leucocephalus*)	BGEPA	NE
Definitions: LAA = "may affect, likely to adversely affect" NLAA = "may affect, not likely to adversely affect" NE = "no effect"	FT = Federal Threatened FE = Federal Endangered FP = Federal Proposed FC = Federal Candidate DPS = Distinct Population Segment BGEPA = Bald and Golden Eagle Protection Act	

In the BA, the National Park Service – Mount Rainier National Park determined the proposed action "may affect, and is likely to adversely affect" both designated and, at the time, proposed bull trout critical habitat, , northern spotted owls (spotted owls), and marbled murrelets. Effects to these listed resources are addressed in this Opinion.

The Park determined the proposed action would have "no effect" on the gray wolf, grizzly bear, and Canada lynx. There is no requirement for the FWS to concur with a "no effect" determination. Therefore, the "no effect" determination remains with the Park and consultation on these species is not required.

As indicated above, the BA addresses effects to federally listed Pacific salmon species under the jurisdiction of the National Marine Fisheries Service. Effects to these species are addressed in a separate consultation document completed by the National Marine Fisheries Service.

CONSULTATION HISTORY

Informal consultation between the FWS and the Park was initiated by the Park in February 2007 with an interagency site visit to view the flood-damaged areas along the Carbon River Road. Meetings and correspondence between the Park and the FWS regarding this project have continued since that time, including FWS staff participation in the Park development of alternatives for the proposed action and culminated with the joint preparation of the BA in 2010.

In an email dated June 28, 2010, FWS biologist Vince Harke transmitted the final BA document to Roger Andrascik at the Park. The effect determination in the BA for the spotted owl was listed as "may affect, not likely to adversely affect," based on information provided through surveys of the project area in 2008 and 2009.

On July 12, 2010, Mason Reid, Wildlife Ecologist at the Park notified V. Harke that a new pair of spotted owls had been located in the Carbon River valley. Based on the proximity of the new spotted owl location to the proposed action, the effect determination for spotted owl was changed to "may affect, likely to adversely affect" via email correspondence on July 15, 2010, with the acknowledgement that a supplement to the BA would be updated to reflect the new information.

In a letter dated July 29, 2010, the Park submitted the BA to the FWS with a letter requesting formal consultation for effects to bull trout, bull trout critical habitat, marbled murrelet, and spotted owl. The letter acknowledged the new information concerning the spotted owl and the need for a revised supplemental spotted owl analysis.

On September 7, 2010, Karen Thompson at the Park notified V. Harke that the Park had developed a revised project design for flood protection structures near the Park entrance, and that the Park Superintendent had made the decision to move forward with construction of two temporary rock barb structures during the fall of 2010. The rock barb structures are described as part of the proposed action in the BA. K. Thompson provided an addendum to the BA for the rock barb construction via email on September 21, 2010. The two rock barbs were installed at the Maintenance Area during September 30 to October 13, 2010. The barbs were constructed on a dry gravel bar.

On September 24, M. Reid submitted via email a supplemental BA that replaced the spotted owl analysis and effect determinations documented in the June 28, 2010 Carbon River BA. The supplemental BA made the determination that the Carbon River Access Management Plan "may affect, and is likely to adversely affect" the spotted owl, based on the new owl territory located in July 2010. Formal consultation was initiated concurrent with the submission of this supplemental BA on September 24, 2011.

On December 15, 2010, Roger Andrascik requested via email that the proposed backcountry campground on the Wonderland Trail identified in Alternative 5 of the Carbon River Access Management Plan Environmental Assessment be included as part of the proposed action, and included in this consultation. Mr. Andrascik also noted that the Park had identified January 14, 2011 as the date the Park Superintendent was to sign the Decision Notice for the Carbon River Access Management Plan. Mr. Andrascik requested a draft of the terms and conditions, conservation measures, and any monitoring requirements associated with the project prior to January 14, 2011. On January 13, 2011, the FWS issued a draft Incidental Take Statement with terms and conditions and monitoring requirements to the Park.

BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

Purpose and Need for the Proposed Action

The proposed Carbon River Access Management Plan has been prepared in accordance with the National Park Service Organic Act (1916) (16 U.S.C. 1) and the 1970 National Park Service General Authorities Act (as amended in 1978). The Park has also prepared an Environmental Assessment for the proposed action, in accordance with the National Environmental Policy Act of 1969 and its implementing regulations (40 CFR Parts 1500-1508); National Park Service Management Policies (2006); National Park Service Director's Order 12 and Handbook; Conservation Planning, Environmental Impact Analysis, and Decision-making (DO-12); Section 106 of the National Historic Preservation Act of 1966 as amended, and its implementing regulations (36 CFR Part 800), related guidance and all applicable Executive Orders.

The Carbon River Road provides visitor access to the Carbon River valley located in the northwest corner of Mount Rainier National Park. The road extends for 5 miles from the Park entrance to the Ipsut Creek campground, and provides access to several Park trails, including the popular Wonderland Trail and the Carbon Glacier. In November 2006, extreme flooding damaged sections of the Carbon River Road, altering the course of the Carbon River and Ipsut Creek, and removing several sections of the existing roadway. About 1.06 miles of the road is severely damaged, with another one mile of road surface damaged from the flooding. After the flood, the Park "scratched out" several unimproved trail segments immediately adjacent to washed out sections of the road to provide public and administrative access to the area. Since the 2006 flood, the road has been closed to public vehicle access at the Park entrance, and public use of the road has been restricted to hiking and biking.

The Carbon River in this area forms a braided channel that is highly dynamic and has been aggrading at an accelerated rate over the past decade. Carbon River Road, which in some areas is lower than the adjacent Carbon River channel, has been damaged by flooding many times over its history, and increasingly so over the last few decades. The 2006 flood was the largest recorded at the downstream Fairfax stream gauge. As a result of long-term flooding effects, the Park's General Management Plan (GMP) Record of Decision (NPS 2002: 3) states that the Park would eventually "close the Carbon River Road to private vehicles when there is a major washout of the road and convert the Ipsut Creek Campground to a walk-in/bike-in camping area." The 2006 fall flooding event is considered a major washout.

The GMP also calls for the preservation of the Carbon River Road corridor so as to have no adverse effect on the Mount Rainier National Historic Landmark District (NPS 2002: 255). Although the GMP calls for closure of the Carbon River Road to private vehicles following a major washout, it also provides for continued use by administrative vehicles and conversion of the road to a hike and bike trail.

In planning for the future of the area, the Park desires to preserve year round sustainable public access to the northwest corner of the Park and to the unique and popular natural, historical and

recreational features of the Carbon River Valley. The Carbon River Access Management project will define the nature and extent of public and administrative access to the Carbon River area, including for hikers, bicyclists, vehicles, camping, parking and trails.

The Environmental Assessment for the Carbon River Access Management Plan identifies and evaluates a range of alternatives for this project. The alternatives range from no action (which maintains the current situation) to reconstructing the road up to milepost (MP) 4.4, or abandoning the road and constructing a new Wilderness bypass trail. The proposed action is described in the Environment Assessment as Alternative 2 which would maintain an improved hiking and biking trail in the historic Carbon River Road corridor.

Project Location

The Carbon River Access Management project is located in Mount Rainier National Park, Pierce County, Washington. The project area is located in the upper Carbon River watershed, which is a major tributary to the Puyallup River (Figure 1). The legal description of the project area is summarized in Table 1:

Table 1. Summary of townships and sections. Carbon River Access Management area, Pierce County, Washington, Willamette Meridian.

Township	Range	Sections	County
17 North	07 East	1, 2, 3, 4	Pierce
17 North	08 East	5, 6, 7, 8	Pierce
18 North	07 East	33, 34, 35, 36	Pierce

Action Area – Upper Carbon River Watershed

The action area is defined as all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action (50 CFR § 402.02). In delineating the action area, we evaluated the farthest reaching physical, chemical, and biotic effects of the action on the environment. The Carbon River Access Management project action area includes both terrestrial and aquatic habitats. For the purposes of this analysis, the project action area includes the Carbon River valley from the Thompson Property (identified as a helicopter staging area) located approximately two miles west of the Park entrance up to the Ipsut Creek Campground. To delineate the action area, we plotted a general flight corridor for helicopters over the Carbon River from the Thompson Property up to Ipsut Campground. We then mapped a one mile zone along the flight corridor to represent the general area in which project noise (from helicopters) will extend, and also includes all terrestrial and aquatic habitat areas that may be affected by the project (Figure 1).

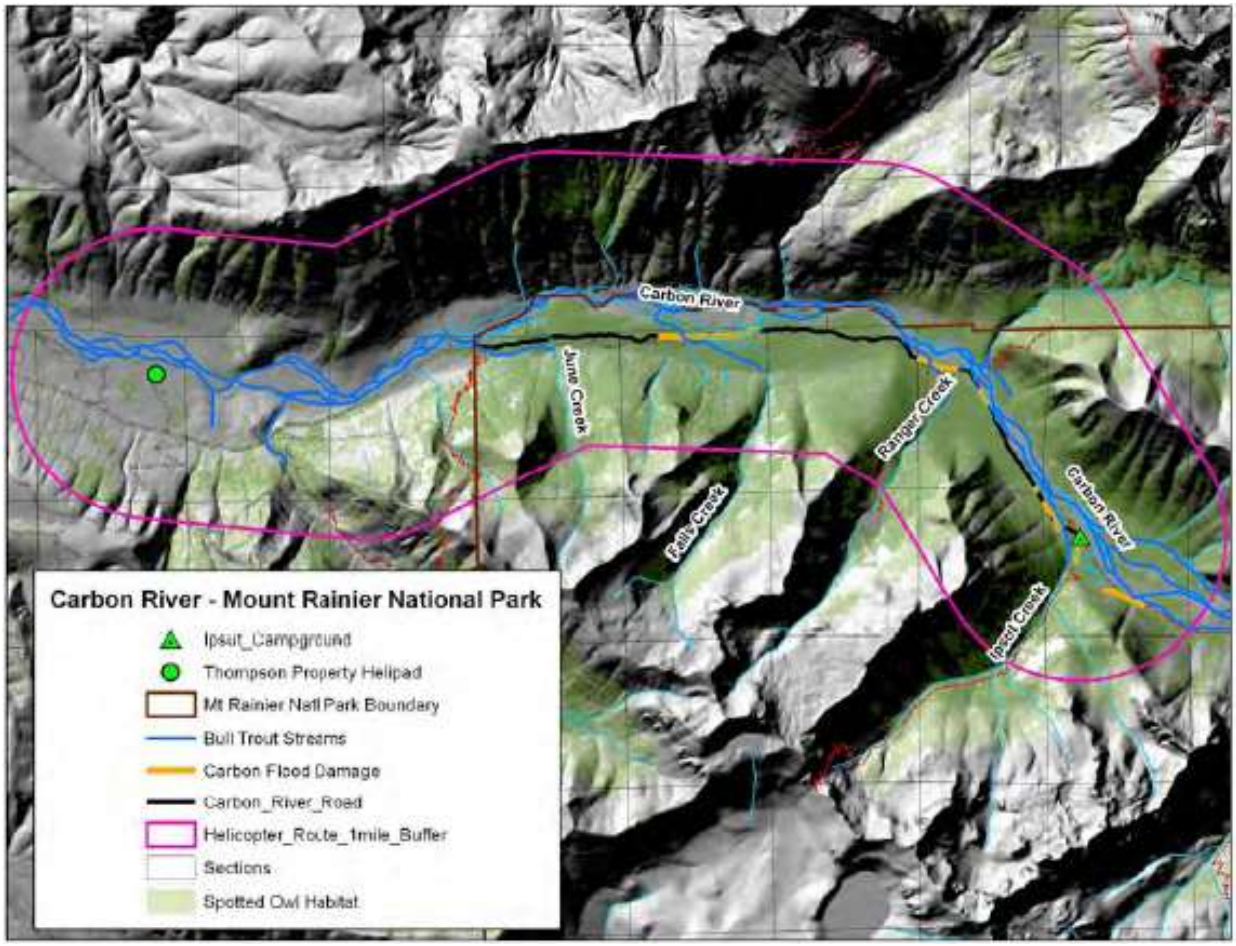

Figure 1. Project action area in the upper Carbon River watershed.

The project action area includes the Carbon River, and adjacent upland areas located on National Park, National Forest, and private lands. The Carbon River is a glacial fed tributary of the Puyallup River basin that contributes approximately 30 percent of the Puyallup River flow. Flowing approximately 32 miles from the Carbon and Russell Glaciers on Mt. Rainier, the Carbon River has nineteen tributary streams and has been considered to represent the largest and most productive habitat available for natural salmonid production in the Puyallup River basin (Kerwin 1999, p. 49). The project action area is located in the upper Carbon River watershed, from approximately river mile (RM) 22 at the Thompson Property up to the Ipsut Creek area at approximately RM 29.

The damaged segment of the Carbon River Road lies on the south side of the Carbon River, west of the Carbon Glacier. The road is constructed on old river terraces within the potential channel migration zone of the Carbon River. Forest vegetation in the action area ranges from early-seral shrub/alder forest within the active Carbon River channel, to late-successional and old-growth forest which occupies much of the floodplain adjacent to the Carbon River in the Park. Old-growth forest age in the project area ranges from 300 to 600 years. Common forest plant associations in the upper Carbon River valley include western hemlock and Pacific silver-fir series (NPS 2010, p. 127). The forest type is characterized by mixed forests of western red cedar

(*Thuja plicata*), western hemlock (*Tsuga heterophylla*), Pacific silver fir (*Abies amabilis*), Douglas-fir (*Pseudotsuga menziesii*), Alaska yellow cedar (*Chamaecyparis nootkatensis*), and noble fir (*Abies procera*). This vegetation association is the most extensive type in the Park. Mature forests of this type occupy areas lacking extremes of temperature and moisture. Common understory shrubs include vine maple (*Acer circinatum*), Sitka alder (*Alnus sinuata*), Sitka mountain ash (*Sorbus sitchensis*), devil's club (*Oplopanax horridus*), and Cascade huckleberry (*Vaccinium deliciosum*) (NPS 2010, p. 127).

Federally Listed Species in the Action Area

The following federally listed species and/or designated critical habitat are known to occur in the project action area:

Threatened Species:	Bull trout (*Salvelinus confluentus*)
	Marbled murrelet (*Brachyramphus marmoratus*)
	Northern spotted owl (*Strix occidentalis caurina*)
Designated:	Bull trout critical habitat

In the BA, the Park determined that the proposed action "may affect, and is likely to adversely affect" these species. Effects to these species will be addressed in this Opinion.

Overview of the Proposed Action

Under the proposed action, the Carbon River Road would be open to public vehicle access from the entrance (MP 0.0) to the Old Mine Trailhead located at MP 1.22. Public access beyond the Old Mine Trailhead turnaround would be via an improved hiking/bicycling trail (10 ft. wide) within or adjacent to the Carbon River Road up to the Ipsut Creek Campground and Wonderland Trailhead (MP 5.05). Major sections of the Carbon River road remain passable and will be maintained for use as a trail. An improved trail would be constructed to bypass the washed-out sections of the road. Trail sections would be hardened with a gravel surface. Because the designated Wilderness boundary is located 100 ft. on either side of the centerline of the existing Carbon River Road, the bypass trail segments will be located within 100 ft. of the existing Carbon River Road alignment.

The width of the improved trail would safely accommodate hikers and bicyclists and occasional administrative vehicles, including all-terrain vehicles (ATVs) or light trucks to transport supplies and materials. Over time, the two lane roadway now extant in some sections would be converted to the multiuse trail. There would be no conversion of the roadway unless current or future damage to it precluded maintaining it. For some time to come, the Carbon River corridor would include sections of former roadway connected by new sections of improved multiple-use trail. As additional parts of the Carbon River Road are washed out in subsequent flooding, they too would be modified and reconstructed as part of the proposed trail.
Other elements of this proposal include improving parking areas at the Park entrance and at the Carbon River Maintenance Area. An expanded vehicle turnaround would be provided at Old Mine Trailhead. Park entrance and maintenance facilities will be upgraded and relocated. Some culverts on the Carbon River Road will be removed to restore fish passage and natural

hydrologic functions. Trail bridges would be constructed to replace the culverts. Erosion protection measures, such as Engineered logjams (ELJs), will be constructed at key locations to protect Park facilities and undamaged sections of the Carbon River Road. Camping opportunities will be maintained at Ipsut Creek, and day-use picnic opportunities will be maintained at the Park entrance, Chenuis Creek trailhead, and at the Ipsut Campground. The historic Ipsut Creek Patrol Cabin will be relocated to a new location in the Ipsut Campground.

Project Elements

Parking Areas

Visitors would continue to park their vehicles in the small entrance parking area (which contains parking for approximately 12 vehicles) and in overflow areas along the road (parallel parking for 30 vehicles) up to the Carbon River Maintenance Area for approximately 0.25 mile. Parking would also likely continue to occur in undesignated road shoulder areas outside the current Carbon River entrance. Additional parking area will be made available in the former Carbon River Maintenance Area for 20 vehicles. Overflow parking outside the entrance would be discouraged. The Old Mine Trailhead parking area would be converted to become a vehicle turnaround area. The turnaround area would accommodate passenger vehicles and would include a designated passenger drop-off / pick-up area.

Carbon River Entrance Facilities

The existing ranger station would be removed. The area formerly occupied by the building would be reconfigured and replaced with formal parking and picnicking. A small visitor contact station would be constructed on the south side of the road. If replacement was warranted, the vault toilets would be relocated from the north side of the road to the south side of the road. The Carbon River Entrance Arch would be reconstructed. In addition, a toll booth and small visitor contact station would be constructed on the south side of the road near the entrance to replace some functions now served by the existing Ranger Station.

Carbon River Maintenance Area

All buildings and structures, except the historic Civilian Conservation Corps garage would be removed and replaced with formal parking and picnicking. Pending funding, the historic Civilian Conservation Corps garage would be relocated to the Thompson property. An interpretive exhibit would be placed at the former Carbon River Maintenance area and interpretive exhibits at the entrance to explain changes that have occurred in the area.

Carbon River Road and Trail Facilities

The Carbon River Road would be retained between the entrance and the Old Mine Trailhead (a distance of 1.2 miles). This intact section of two-lane road would be reconstructed and maintained to historic road standards, with a crown and side ditches. Surfacing between the entrance and the Old Mine Trailhead would be compacted, crushed gravel.

Public vehicles would be allowed to drive this section of road up to a turnaround provided, but would not be able to park at this location or along the narrow, winding road back toward the entrance because of poor sight distance and potential damage to large, old growth trees. The turnaround would allow drop-off and pick-up of passengers but the driver would need to return to the maintenance area, entrance or beyond to park and then rejoin their group afterwards.

Between the Old Mine Trailhead and Ipsut Creek, the road would be converted to an improved trail. An improved trail would be constructed to bypass the washed-out sections of the road. The improved trail will be up to 10 ft. wide and constructed of imported rock spalls compacted and overlain with imported $^{5}/_{8}$ in crushed gravel, suitable for hiking and most bicycles. The trail will allow for administrative access via ATV-type vehicles to expedite trail maintenance, law enforcement and emergency access. All administrative operations would initially or eventually include more use of helicopters, particularly for emergencies.

The trail sub base for the majority of new trail construction (through or around washout areas) would utilize large native rock of assorted sizes to create a substantial base. The amount of rock fill needed for the trail construction is not yet determined, but is estimated to be hundreds of cubic yards (cy). New stringer bridges, with rock filled gabion basket abutments, would be built over streams and low spots prone to future flooding. There are three specific wash out sections where the base is mostly silt and sand with very little native rock with which to build a sub base. Wide, flat rock filled gabion mattresses will be installed through these sections to provide the necessary sub base for the trail. These sections are: 1) a 440 foot section beginning at MP 1.56; 2) a 50 foot section beginning at MP 1.74; and 3) a 630 foot section beginning at MP 1.78.

Trail construction and maintenance would comply with Americans with Disabilities Act standards to the greatest extent possible from the Carbon River entrance to Ipsut Creek Campground, but may not be fully Americans with Disabilities Act accessible. Handicapped visitors with small electric motorized wheelchairs would be allowed to use the trail as conditions permit. Over time, however, as more flooding occurs and conditions worsen throughout the corridor accessibility may gradually worsen. The intent will be to maintain a formal improved trail throughout the corridor for as long as possible, but over time some reroute sections may become informal unimproved trail.

A total of approximately 1 mile of by-pass trails will be constructed at 3 different locations. The longest by-pass section is located at Falls Creek, with approximately 2,600 ft. of by-pass trail needed, and the Ipsut Creek washout (1,000 ft. of trail needed). By-pass trail construction at Falls Creek will occur at a distance of 10 to 50 ft. from the bank of the Falls Creek / Carbon River side channel.

Additional repairs will be needed along intact road sections to repair surface scouring at Ranger Creek and other locations as needed. Most trail improvements will occur within the existing "scratched out" by-pass trail sections that have been in place since 2007, although some minor realignments may be necessary to reduce the risk of trail failure and improve trail safety. Trail realignments will be designed to minimize impacts to forest vegetation and large trees. Some limited live tree removal will be needed, as well as removal of downlogs, stumps, and understory

vegetation to facilitate trail alignments (Table 2). Blasting may be needed to remove stumps in some locations. Additional trees may be identified for removal as the project is developed.

Table 2. Summary of live tree removal needed for trail realignments.

Carbon Road/Trail MP	Tree removal: small trees < 16 in diameter	Tree removal: large trees ≥ 16 in diameter
Falls Creek Washout – MP 1.45 to 1.95	W. hemlock - 10 trees Silver fir – 1 tree Red alder – 1 tree	1 - 18" W. hemlock 1 – 16" W. hemlock 1 – 16" W. redcedar 1 – 24" W. redcedar
MP 4.47 Washout – MP 4.47 to 4.57	W. hemlock - 5 trees	none
Ipsut Creek Washout MP 4.6 to 4.8	W. hemlock - 3 trees Silver fir – 2 trees	1 - 18" W. hemlock 1 – 18" Silver fir
Total trees	22 small trees	6 large trees

Note: Additional trees may be identified for removal as the project is implemented. This estimate is based on current trail design survey notes compiled in March 2010.

Future unimproved trail would be constructed of native soil and rock and native and imported wood, where needed. Where needed, over time, sections of raised trail or boardwalk could also be constructed. In washout areas, a structural permeable design (to allow water passage) would likely serve as the base of the trail.

Rock Hauling and Storage

The project will require the use of imported rock. Both coarse rock material and crushed rock will be used to for this project. Rock for the project will originate from a private quarry located near Enumclaw, and will be hauled via dump truck to the Park maintenance area. Rock storage will occur at the maintenance area and the Old Mine Trailhead area. The haul route from Enumclaw to the Park entrance is all located on paved State and County highways. All-Terrain Vehicles with trailers will be used to haul rock to trail construction sites from the Old Mine Trailhead.

Stream Crossings

Road culverts between the Entrance and the Old Mine Trailhead would continue to be maintained. Culverts in this section of the road do not cross fish-bearing streams. From MP 1.2 up to Ipsut Creek campground there are 23 culverts. Most of these are cross drain culverts that do not connect to stream channels. Several culverts were washed out during the flood and are now embedded in stream banks or in debris jams. A total of 10 trail bridge crossings have been identified along the corridor. There are 6 crossings over fish-bearing streams, including large culverts at Falls Creek and Ranger Creek (Table 3). All culverts on fish bearing streams now present barriers to fish passage. The Falls Creek culvert is located in an abandoned stream channel and is completely filled with stream sediment and no longer functions as a culvert. The Falls Creek culvert no longer crosses an active fish bearing stream, but is included here because of its location on the edge of the Falls Creek – Carbon River side channel. The concrete bridge

at Ipsut Creek (MP 4.85) is not included in the list of fish stream crossings, as this bridge crosses the former Ipsut Creek stream channel that is now abandoned. Under the proposed action, the bridge will remain in this location for use as a trail bridge.

Culverts on fish bearing streams will be excavated and removed to improve fish passage and natural hydrologic function in these streams. Trail crossing structures such as log-stringer bridges will be constructed to replace corrugated metal pipes. Culvert removal and replacement work will occurring during summer low-flow periods when some streams are completely dry or have minimal flow levels. Culverts will be removed using a small excavator. Culvert pipe will be cut into sections and hauled out using ATVs or small trucks, or sections may be hauled out with a helicopter.

Culvert removal in flowing streams (e.g. Ranger Creek) will require project-area dewatering and fish removal prior to excavating the pipe. Instream excavation will occur during the Washington Department of Fish and Wildlife (WDFW) approved season for in-water work (July 16 to August 15).

For a complete list of all project criteria to minimize impacts associated with stream crossings and heavy equipment use, refer to the Avoidance and Minimization Measures.

Table 3. Summary of stream crossings proposed over fish-bearing streams in the Carbon River corridor.

Carbon Road/Trail MilePoint	Stream Name	Existing Structure	Replacement Structure	Fish habitat/ comments
1.468	Falls Creek trib. #1	24 in corrugated metal pipe (cmp) partially buried.	Remove culvert, replace with 4-stringer bridge, 15 ft. long. Install grade-control check dam upstream of crossing.	Seasonally dry tributary, presumed rearing for habitat for bull trout/ steelhead
1.496	Falls Creek trib. #2	24 in cmp, partially buried.	Remove culvert, replace with 4-stringer bridge, 15 ft. long. Install grade-control check dam upstream of crossing.	Seasonally dry tributary, presumed rearing for habitat for bull trout/ steelhead
1.644	Falls Creek, new stream channel location.	Existing trail bridge over the new Falls Creek stream where it enters the road washout.	Existing trail bridge will be replaced in the new trail alignment. Replace with a 4-stringer bridge, 35 ft. long with gabion basket abutments.	May be seasonally dry in some years. Documented bull trout rearing habitat – proposed bull trout critical habitat. Presumed rearing habitat for steelhead.
1.680 – Not a fish-bearing stream-crossing	Falls Creek historic crossing location, now filled with gravel.	11' x 6' cmp, 33 ft. in length. Structure is completely filled with gravel, non-functional.	Remove culvert, back-fill trench with coarse rock and re-grade site to existing trail alignment and elevation.	Excavation site intersects with the new Falls Creek/Carbon River side channel. May be seasonally dry. Bull trout presence documented in new side channel up to this culvert location.
3.142	Ranger Creek	12' x 7.6' cmp, 30 ft. in length. Structure has a 1 ft. drop at culvert outfall, creating a partial barrier to fish passage. The bankfull width is about 22 ft. wide above the culvert.	Remove culvert. Construct steel I-beam bridge, 40 ft. long, 10 ft. wide with concrete footings.	Documented bull trout spawning and rearing, steelhead rearing habitat. Designated as bull trout critical habitat. Culvert removal will restore fish access to 0.5 miles of high quality spawning and rearing habitat.
3.586	Unnamed tributary at Chenuis Creek trailhead.	9.6' x 6.6' cmp, 39 ft. in length. Structure has a 3 ft. drop at the culvert outfall, and is a total barrier to fish passage. Large sediment deposit above the culvert, bankfull width above the culvert is about 15 ft. wide.	Remove culvert. Construct steel I-beam bridge, 30 ft. long, 10 ft. wide with concrete footings.	Documented bull trout presence at the culvert outlet. Culvert removal will restore fish access to 0.25 miles of high quality spawning and rearing habitat.
4.802	Ipsut Creek, new stream channel location resulting from 2006 flood.	Current log-trail bridge over stream is 6' x 40'. Bankful width at this crossing is about 30 ft.	Install a new 8 ft. x 50 ft. log stringer bridge, on elevated footings.	Documented bull trout spawning and rearing. Designated as bull trout critical habitat.

Erosion Protection Measures

The Carbon River shoreline along the south bank of the river from the Park entrance upstream to the Ipsut Creek confluence is approximately 4.77 miles in length. Bank erosion analysis completed by the Park indicates significant bank erosion in the road washout areas over the past decade. The Park will build or contract out to be built several erosion prevention structures along approximately 1,630 linear ft. of the Carbon River channel at 7 different locations. Additional bank protection structures are proposed at Falls Creek and Ipsut Creek (Table 4). Several of the structures (logjams or crib-wall structures) would be installed along the bank of Carbon River, others structures will be built into the road or trail. Appendix 1 provides location maps and conceptual designs for each proposed structure. All structures installed in the river will use accumulations of logs, rootwads, and large wood to create structures that maintain important fish habitat features and use natural fluvial processes to achieve the desired bank protection. The wood will be harvested from within the Carbon River floodplain as directed by Park biologists. No trees in the Park would be felled to be used in the structures. If additional wood is needed the Park will purchase wood from local sources and haul the logs to the project site. River cobbles will be excavated from exposed gravel bars in the main Carbon River channel to use as ballast in the logjam structures. In channel excavation with heavy equipment will occur in isolation from flowing water, and will only occur during the approved season for in-water work. In some locations the Carbon River would have to be temporarily diverted around a work site so construction could take place in the dry. For a complete list of all project criteria to minimize impacts associated with instream excavation and heavy equipment use, refer to the Avoidance and Minimization Measures.

Several different types of bank protection structures are proposed. The Park solicited conceptual designs and recommendations from Geomax Engineering, Inc. and Entrix, Inc. consultants. The bank protection structures are not intended to prevent flooding; rather, they are intended to change the character of potential flood damage from deep scouring and head-cutting to sheet flow, quickly diverted off the road or to minimize wide-scale bank erosion along the river side of the road. Neither consultant had recommendations that could sustainably alter the character of flooding in the Falls Creek washout area because this area is lower than the adjacent river bed. The following types of structures are proposed:

Rock Barbs

Barbs are low-elevation structures that are projected into the channel from a bank and angled upstream to redirect flow away from the bank and to control erosion. Barbs function similarly to weirs in that flow spills over the barb toward the center of the channel, reducing the water velocity near the bank. Barbs also increase channel roughness, which dissipates energy, reduces channel-bed shear stress and interrupts sediment transport (ISPG 2003:6-23). Due to uncertainty about project funding, two rock barb structures are proposed at the maintenance area, with the intention that the rock used for the structure could later be recycled as ballast in ELJs at the same location.

Engineered Logjams

Engineered logjams are collections of large wood that redirect flow and provide stability to an eroding streambank or downstream gravel bar. Engineered logjams are used to realign a channel or redirect flow away from a streambank to protect it from erosional forces. They are also used to increase channel roughness to reduce flow velocities and shear stress along eroding banks. Large-woody-debris jams create a hydraulic shadow, a low-velocity zone for some distance downstream that allows sediment to settle out and stabilize. By locating a logjam along an eroding bank, the bank downstream of the jam becomes a deposition zone rather than an erosion zone. The deposition zone tends to become vegetated and continues to grow in volume over time. Engineered logjams as a bank-protection treatment are still considered experimental, but they are becoming increasingly popular as bank protection because they integrate fish-habitat restoration with bank protection (ISPG 2003:6-31). Engineered logjams are proposed at the Park entrance and maintenance area (Table 4). Refer to Appendix 1 for a conceptual design drawings of ELJs.

Log Crib walls and Log/Rock Roughened Toes

Log crib walls are structures built of logs laid horizontally and separated by smaller wooden spacers. Cribwalls are essentially vertical retaining walls constructed of stacked logs and back-filled with rock. Log cribwalls are typically applied as bank protection on steep slopes. They are often installed where floodplain encroachment has occurred, and a near-vertical structure is required to protect an eroding streambank. As part of construction, the existing bank is usually excavated where the cribwall will be placed to minimize channel confinement at the site and the log cribwall should be extended below the anticipated depth of scour in the adjacent channel (IPSG 2003: 6-99).

Log / rock roughened toes are structural features that prevent erosion at the toe of a streambank. The toe refers to that portion of the streambank that extends from the channel bottom up to the lower limit of vegetation or to a distinct break in slope between the top of the bank and the streambed. Log toes can provide the foundation for upper-bank treatments such as reinforced or re-sloped banks. Log toes are generally constructed of logs and gravel fill between logs, but may also include components made of large woody debris to provide additional habitat value. Log toes may also incorporate large rock or rip-rap material to provide added protection. Log toes differ from log cribwalls in two primary ways: 1) log toes are not structural retaining walls, and 2) the top elevation of log toes does not exceed the lower limit of vegetation on the bank (IPSG 2003: 6-79).

Due to equipment limitations to access areas beyond the Falls Creek washout, the Park is proposing to use gabion baskets as a substitute for rip-rap in the construction of log/rock roughened toe structures. In this application, the Park is proposing to use river rock excavated from the Carbon River channel to fill gabion baskets to construct roughened toe bank protection structures in the washouts above Falls Creek (Table 4). Refer to Appendix 1 for proposed locations and conceptual design drawings.

Drop Structures, Check Dams, and Roughness Trees

Drop structures are low-elevation weirs (or check-dams) that span the entire width of the channel. They are designed to spill and direct flow away from an eroding bank, dissipate and redistribute energy and provide grade stabilization. Drop structures are commonly used in degrading channels to restore the channel bed to a more stable profile and elevation. They can also act as grade-control structures. Drop structures are typically constructed with logs and rock, and the configuration of the structure may vary from straight weirs, upstream-oriented chevron weirs, or arch configurations (ISPG 2003:6-31). Roughness trees are logs with rootwads or whole trees that are placed parallel to an eroding streambank to reduce bank erosion. When positioned properly, roughness trees reduce bank erosion, trap sediment, and allow the establishment of vegetation, which ultimately results in the stabilization of actively eroding banks (ISPG 2003:6-61).

The Park is proposing to install a series of drop structures in the Falls Creek washout, which is now functioning as the Falls Creek stream channel and as an active side channel of the Carbon River. The Falls Creek structures will use both roughness trees and drop structures to reduce bank erosion and scour along the south bank of the channel adjacent to the proposed trail location. All drop structures will be constructed with low notches with a maximum drop height of 8 inches to maintain fish passage. For a complete list of all project criteria to minimize impacts associated with instream structures refer to the Avoidance and Minimization Measures. Drop structures are proposed at Falls Creek, and in other tributary streams to control stream gradient (Table 4). Refer to Appendix 1 for conceptual design drawings and location maps.

Rock and Log-filled Road Humps

Road or trail humps will be constructed in several locations along the access route. These structures are designed to divert surface flow off of the road surface and minimize road surface scour during flood events. The basic concept is to construct a ditch in the road and then fill the ditch with logs or large rock that will deflect surface flow and road scour if the road is overtopped by floodwaters. Road humps are proposed at several locations along the Carbon River road/trail corridor (Table 4). Refer to Appendix 1 for conceptual design drawings and location maps.

Table 4. Summary of erosion control structures proposed for the Carbon River Road/Trail. Refer to Appendix 1 for location maps and a more detailed description and conceptual drawings of the proposed structures.

Carbon Road / Trail MP	General location	Structure type	River/stream channel directly affected (below the bankfull channel width)	Fish Habitat/Comments
0.0	Park entrance - south bank of Carbon River braided channel complex	Potential site for (2) ELJs (60' x 20')	1,200 ft^2 / 60 linear ft. Carbon River channel will be occupied by each logjam. The construction foot print is estimated to be 2x the structure area = 4,800 ft^2 /240 linear ft.	Yes - below OHWM along south bank of Carbon River – near confluence of June Creek and main Carbon River – wet site, requires water diversion. – Potential steelhead, Chinook, bull trout spawning habitat.
0.15	Maintenance area - south bank of Carbon River braided channel complex	(2) Rock barb deflectors to potentially be replaced later in time with (2) ELJs (60' x 60' each)	3,600 ft^2 / 60 linear ft. in Carbon River channel will be occupied by each logjam. The construction foot print is estimated to be 2x the structure area = 14,400 ft^2 /240 linear ft.	Yes – below OHWM along south bank of Carbon River – may be seasonally dry.
0.20 – 1.45	Carbon River Road between Maintenance area and Falls Creek washout	(5 to 9) Rock/log core road humps.	No direct instream construction work is indicated in this area.	No fish stream crossings are indicated in this section of the road.
1.45 – 1.95	Falls Creek washout	Approx. (26) instream log drop structures	2,600 linear ft. of Falls Creek / Carbon River side channel – approx. 1 log structure per 100 ft. of stream channel. 2 additional drop structures may be installed on Falls Creek tributaries.	Yes – proposed bull trout critical habitat, rearing habitat for bull trout, steelhead
2.95	Bedrock knob area between Falls Creek and Ranger Creek – Described as an expanding floodplain scour channel.	Approx. (4) instream log drop structures	400 linear ft. of floodplain scour channel adjacent to road – approx. 1 structure per 100 linear ft. of channel.	Unknown. The channel is seasonally dry; connectivity to Carbon River is not described.
3.459	Washout at milepost 3.46	Gabion log / rock roughened toe structures 15' x 240'	3,600 ft^2 /240 linear ft. of Carbon River channel – would be filled with logs/rock/ and gabion baskets. River rock excavation for gabions is estimated at 1,300 CY.	Yes – below OHWM along south bank of Carbon River– may be seasonally dry.

Table 4 continued. Summary of erosion control structures proposed for the Carbon River Road/Trail. Refer to Appendix 1 for location maps and a more detailed description and conceptual drawings of the proposed structures.

Carbon Road / Trail MP	General location	Structure type	River/stream channel directly affected (below the bankfull channel width)	Fish Habitat/Comments
3.58	Hanging culvert tributary at Chenuis Trailhead	Approx.(3) instream log drop structures	Large accumulation of sediment above culvert (650 CY). Drop structures needed to control head cutting at culvert removal site. 300 linear ft. of stream channel – approx. 1 log structure per 100 ft. of stream.	Yes - access to channel is currently blocked by hanging culvert at Chenuis trailhead. Culvert removal will provide fish access to approx. 0.25 miles of high quality spawning and rearing habitat for bull trout.
3.76	Road surface scour at milepost 3.76	Rock/log core road humps.	Approximately 100 ft. of road surface scour damage.	No – located on the edge of the active floodplain, but above the OHWM. Dry site, no water diversion needed
3.93	Road washout at milepost 3.93	Gabion log / rock roughened toe structures 15' x 200'	3,000 ft^2 /200 linear ft. of Carbon River channel – would be filled with logs/rock/ and gabion baskets. River rock excavation for gabions is estimated at 1,084 CY.	Yes – below OHWM along south bank of Carbon River – may be seasonally dry
4.47	Road washout at milepost 4.47	Log crib wall or gabion log / rock roughened toe structures 15' x 380'	5,700 ft^2 /380 linear ft. of Ipsut Creek channel – would be filled with logs/rock/ and gabion baskets to construct log crib wall. River rock excavation for gabions is estimated at 2,060 CY.	Yes – below OHWM along south bank of Carbon River – near confluence of Ipsut Creek and Carbon River. Sensitive site for river gravel excavation due to close proximity with Ipsut Creek – may be seasonally dry

Table 4 continued. Summary of erosion control structures proposed for the Carbon River Road/Trail. Refer to Appendix 1 for location maps and a more detailed description and conceptual drawings of the proposed structures.

Carbon Road / Trail MP	General location	Structure type	River/stream channel directly affected (below the bankfull channel width)	Fish Habitat/Comments
4.62	End of the intact road below the Ipsut Creek scour.	Buried groin structure.	No direct instream construction work is indicated in this area. Structure may eventually be exposed by flood erosion.	No – Buried groin structure would be located about 60 ft. back from the Ipsut Creek – Carbon River channel.
4.65	Threatened trail segment adjacent to lower Ipsut Creek at MP 4.65	Potential site for a gabion log / rock roughened toe structure adjacent to trail location. 15' x 130'	Structure estimated at 1950 ft^2 / 130 linear ft. – toe-roughened structure to protect trail location. River rock excavation for gabions is estimated at 704 CY.	Yes – below OHWM along lower Ipsut Creek – wet site, requires water diversion. Bull trout spawning/ rearing habitat, potential steelhead spawning/ rearing habitat.
4.8	Ipsut Creek diversion	Stream diversion site that would divert lower Ipsut Creek into a former channel location and reduce risk to this section of trail.	Diversion out of current channel would result in dewatering about 800 ft. of stream. Diversion to old channel would rewater about 650 ft. of abandoned channel.	Yes – below OHWM along lower Ipsut Creek – Diversion would result in net loss of 150 ft. of spawning /rearing habitat. Fish capture and removal from dewatered channel required.

Excavation of Gravel from the Carbon River

Several thousand yards of river rock will be excavated from exposed bars in the main Carbon River channel for use in the construction of ELJs, and other bank protection structures. The total amount of gravel needed is estimated at over 5,500 cy for bank protection structures in washed out road sections. The in channel excavation area for river gravels is currently estimated at approximately 1.14 acres distributed across 4 sites. Excavation of river gravels is limited to that needed for the construction of bank protection structures. Excavation is limited to dry, exposed gravel bars, and cannot exceed the depth of the adjacent water level in the river. For a complete list of all project criteria to minimize impacts associated with instream excavation and heavy equipment use, refer to the Avoidance and Minimization Measures.

Carbon River Road and Facility Obliteration/Restoration

There would be no active restoration of the Carbon River Road not encompassed by the proposed trail. The width of the historic road corridor would be retained where possible, including the existing canopy width and roadside vegetation. Cross-drain culverts would be retained, while culverts over streams will be removed and replaced with trail bridges. Other road characteristics, including the crown and side ditches would likely be lost over time due to the inability to get heavy equipment into the area to maintain these.

Ipsut Creek Campground and Proposed Wonderland Trail Backcountry Campground

Ipsut Creek Campground would be rehabilitated as a hike-in/bike-in backcountry camp with 15 individual sites and three group sites. Thirteen sites would be removed and restored. The three group sites would either be within the campground in combined sites or would be located in the former Ipsut Creek Trailhead Parking Area. Vault toilets would be removed and replaced with backcountry toilets. This will entail flying in a pump and tank with a helicopter so the vaults can be pumped before being dismantled. All asphalt, bumper-stops, buildings, some picnic tables and campsites, and most signs would be removed. The Ipsut Creek Bridge would be retained as long as it is viable for public trail use and doesn't impede hydrological conditions. If either of these two occurred, it would be removed. The former chlorinator building and amphitheater storage shed would also be removed. Bear-proof food storage containers would be added in the campground. The Ipsut Creek Patrol Cabin, which was deconstructed following the 2006 flood, would be reconstructed in a new location on higher ground near Ipsut Creek Campground in the former Ipsut Creek Trailhead Parking Area.

Ipsut Creek campground will continue to be managed as a hike-in/bike-in campground until such time as flood damage in the area results in a total closure of the campground. The Park has also proposed to develop a new backcountry campground (with four individual sites and one group site) located approximately 0.5 miles south of the existing Ipsut Creek campground along the Wonderland Trail. For this analysis, we assume the proposed new campground will occupy about 1 acre. In the near-term the new hike-in Wilderness campground will serve as an alternative campsite for people hiking the Wonderland Trail. In the long-term, the Ipsut Creek campground will be closed, and the proposed new campground would provide the only campsite for Park visitors in this area.

New Facilities Outside the Park Boundary

If possible, a new parking area would be identified and constructed outside the Carbon River Entrance on land intended for the boundary expansion or via agreement with Park partners. Upon acquisition of boundary expansion lands, planning will begin for relocation of drive-in camping and administrative facilities outside the Carbon River Entrance. All future developments associated with a potential boundary expansion will be evaluated in a separate analysis, and are not addressed further in this consultation.

Helicopter Use

A large, double-rotor helicopter (such as a Boeing Vertol 107 II or a Chinook 47-D) will be used to fly equipment into and out of the Ipsut Creek campground area. Flight staging areas will occur at the Thompson Property (located approximately 2.2 miles west of the Park), the Maintenance Area, and Ipsut Creek campground. A helicopter will also be used to fly-in logs or equipment for the construction of bank protection structures in the washout areas. The flight corridor for project activities would occur over the Carbon River channel for approximately 7 miles from the Thompson Property up to Ipsut Creek Campground. For a complete list of all project criteria to minimize impacts associated with helicopter use, refer to the Avoidance and Minimization Measures.

Work Activities and Project Equipment

A variety of equipment and tools are needed to complete this project. Large dump trucks will be needed to haul rock and gravel for road repairs from the entrance to MP 1.22. Trail construction will require the use of small dump trucks or ATVs to haul rock, tools, supplies, and personnel into work sites. Multiple trips per day will be required over a work season that could extend from late March into November. A tracked excavator will be needed remove culverts and place erosion control structures. Chainsaws will be needed to clear down logs and vegetation for trail realignments, and for erosion control structures. Helicopters will be used to fly equipment into and out of the project area. All of this equipment generates loud noises that could disturb or displace wildlife from the project area.

Table 5 is a summary list of the various types of equipment likely to be used and the approximate sound levels (decibels) (dB) associated with each. Sound levels are generally reported in dBA which refers to the A-weighted dB scale which represents the normal range of human hearing. Table 6 provides a summary of the estimated noise contours used to calculate the area affected by project generated noise.

Table 5. Summary list of various equipment and typical noise levels that will be used for the Carbon River access management project.

Equipment	Typical noise level (dBA)	Distance from source	Reference
ATV 4 x 4	75-89	50 ft.	1
Backhoe	78-80	50 ft.	2
Chainsaws – various models	77-88	50 ft.	3
Chainsaw – Stihl 038 model	91	50 ft.	4
Chainsaw – Stihl 044 model	83-88	50 ft.	5
Chainsaw – Stihl 025 model	78	50 ft.	6
Concrete Saw	90	50 ft.	2
Concrete Mixer Truck	79-85	50 ft.	2
Dozer	82-85	50 ft.	2
Dump Truck	76-84	50 ft.	2
Excavator	81-85	50 ft.	2
Generator	81-82	50 ft.	2
Grader	89-92	50 ft.	7
Grapple (on backhoe)	85-87	50 ft.	2
Jackhammer	85-89	50 ft.	2
Loader	79-80	50 ft.	2
Pick-up Truck	55-75	50 ft.	2
Portable Pump	77-81	50 ft.	2
Rock Drill	81-85	50 ft.	2
Roller	80-85	50 ft.	2
Helicopter – Boeing Vertol 107-II (Double-rotor, 10,000 lb. lift capacity commonly used for logging operations)	91-97	195 ft.	8
Helicopter – Chinook 47-D (Double-rotor military helicopter, 20,000 lb. lift capacity).	93-98	394 ft.	9

References:

1. Martin et al. 2005 – California Off-Highway Vehicle Noise Study, Table 4.1 – EPA F-76 Test results for ATVs (Note: All but one of the ATVs tested at 75-79 dB at 50 ft.).
2. FHWA 2006 – Highway Construction Noise Handbook – Table 9.1 – Default noise emission reference levels.
3. NPC 2005 – Chain saw noise levels - based on reported values of 106-117 dB at the operator, and adjusted for a "soft site" attenuation of -7.5 dB for every doubling of distance from source.
4. USFWS 2003, p. 273 – Sound measurements for chainsaws - Olympic Natl. Forest Programmatic Biological Opinion. Based on a maximum sound level of 90.8 dB for the Stihl 038 at 50 ft. The peak sound reading for this saw was 104.2 dB at 50 ft.
5. NPS 2009a – Sound measurements for chainsaws - based on reported values of 112-117 dB at the operator, and adjusted for a "soft site" attenuation of -7.5 dB for every doubling of distance from source.
6. Delaney and Grubb 2001 (p.25). Typical chainsaw noise at 15 m was 77.8 dBA for a Stihl 025.
7. Delaney and Grubb 2004 (p.41). Sound recordings of road maintenance equipment. Based on reported values of 83.3 to 85.9 dBA for road graders at a distance of 30m in a forest setting.
8. USFS 2008 – Sound measurements for helicopters during logging operations.
9. Newman et al. 1984 – Noise measurement flight test for Boeing Vertol 234/Chinook 47-D.

Table 6. Estimated noise contours for various project activities.

Type of Equipment	Approximate sound level at 1 m (3.28 ft.) from source	Typical sound level at 50 ft. from source	Approximate distance to 92 dB contour	Approximate distance to 70 dB contour	Approximate distance to near ambient levels (45 dB)
Road Grader[1]	120 dB	91 dB	45 ft.	340 ft.	~2,900 ft.
Chainsaws, (large models), loud end of spectrum[2]	117 dB	88 dB	33 ft.	260 ft.	~2,100 ft.
Heavy Equipment (Excavators, Dump Trucks)[3]	115 dB	85 dB	26 ft.	210 ft.	~1,700 ft.
Portable pumps, ATVs, Loaders[4]	110 dB	81 dB	18 ft.	130 ft.	~1,200 ft.
Helicopter[5] – Boeing Vertol 107-II (Double-rotor, 10,000 lb. lift capacity commonly used for logging operations)	n/a	n/a	450 ft.	>3,000 ft.	>10,000 ft.
Helicopter[6] – Chinook 47-D (Double-rotor military helicopter, 20,000 lb. lift capacity)	n/a	n/a	800 ft.	>3,000 ft.	>10,000 ft.

Note: All values are approximate based on a "soft-site" attenuation rate of -7.5 dB for every doubling of distance from the source (USFWS 2003, p. 276).

[1] Based on sound measurements reported in Delaney and Grubb 2004.
[2] Based on sound measurements reported in NPS 2009a, NPC 2005, and USFWS 2003.
[3] Based on sound measurements reported in FHWA 2006.
[4] Based on sound measurements reported in FHWA 2006 and Martin et al. 2005 (ATVs).
[5] Based on sound measurements reported in USFS 2008, which used a -6 dB standard attenuation rate.
[6] Based on sound measurements reported in Newman et al. 1984, and analysis presented in USFWS 2009 (Greenwater BiOp).

Project Schedule and Duration

The project work and activities associated with the Carbon River access management project will occur over a period of 3 or 4 work seasons depending upon funding. The work season identified by the Park for this project begins in mid-March and extends into mid-November. Project implementation is expected to occur from late summer 2010 through 2013 or 2014.

The following dates are significant for evaluating effects to listed species in this BA:

- *April 1 to August 5* – is the marbled murrelet early nesting season and is a critical period for disturbance at nest sites. Project work that occurs during this period is likely to adversely affect marbled murrelets.

- *August 6 to September 15* – is the late marbled murrelet nesting season. Potential disturbance to murrelets can be minimized with daily operating restrictions during this period. Project work that occurs during this period is not likely to adversely affect marbled murrelets.

- *September 16 – April 1* – is the winter non-nesting season for murrelets. Project work that occurs during this period has no effect to marbled murrelets.

- *July 16 to August 15* – is the approved season (31 days) for in-water work with heavy equipment in the upper Carbon River and its tributaries. This restriction is not applicable at project sites that are seasonally dry from July to October.

- *July 9 to August 22* – is the extended season (45 days) for in-water work associated with the installation of bank protection structures along the main Carbon River.

Project Implementation Schedule

The general sequencing of the project under Alternative 2 is expected to take 3 to 4 work seasons. The actual dates for implementation may change from this general outline, depending upon project funding. Projects that require in-water excavation with heavy equipment or water crossings with heavy equipment are constrained to the approved season for in-water work to minimize impacts to listed fish species.

2011 work season (approximately March 15 to November 15):

- Remove buildings at the Park Entrance and Maintenance areas.
- Ipsut Creek Campground area decommissioning.
- Install road humps and regrade the Carbon River Road to the Mine Trailhead.
- Construct Mine Trailhead turnaround and vehicle parking.
- By-pass trail construction through the Falls Creek washout.
- Install check dams, drop structures, roughness trees at Falls Creek washout, Magirl Channel, and Bedrock Knob.
- Install ELJs at Park Entrance and Maintenance Areas.
- Reconstruct trail surface in damaged sections of road and install road humps between Falls Creek and Chenuis Trailhead area.

2012 work season:

- Install toe-roughened gabions / log cribwalls structures through road washouts located between the Falls Creek and the Ipsut Creek Campground.
- Reconstruct trail sections through or around washouts.
- Reconstruct trail surface in damaged sections of road and install road humps in intact sections of road between Chenuis Trailhead and Ipsut Creek.

2013 work season:

- Excavate large culverts at Ranger Creek, Chenuis Trailhead, and Falls Creek
- Construct trail bridges to replace large culverts
- Construct new trail bridge at Ipsut Creek

Project work is may carry over into 2014 as well, depending on the funding and implementation. Table 7 provides a summary of the estimated project schedule.

Table 7. Summary of the 2011 proposed work schedule. All dates are approximate and subject to change pending project funding availability and site conditions encountered during implementation.

General Area / MP	Project Activity	Expected work dates	Estimated duration	Equipment needed
Park entrance to Ipsut Campground MP 0.00 to 4.99	Continue current management: Open Carbon Road / Trail for public access after winter season, includes down fall removal, cleaning water bars, trail bridge repairs, cleaning water bars and ditches, minor by-pass trail reconstruction as needed, depending on flood damage.	Mar 15 – April 15	10 to 30 days depending upon flood damage	ATVs Chainsaws Dump truck Excavator Road Grader
Mine Trailhead and Falls Creek washout MP 1.2 0 to 1.95	By-pass trail construction along the Falls Creek washout – constructing and placing gabion baskets for trail base using material imported to Falls Creek and transported to sites with ATVs	April 15 – July 15	30 days	ATV's Chainsaws Front end loader, Dump truck
Falls Creek washout MP 1.45 0 to 1.95	Install drop structures (check dams) and roughness trees in the Falls Creek / Carbon River side channel	July 16 – August 15	20 days	ATVs Chainsaws Excavator Power winch
Bedrock Knob (MP 2.9) Magirl Channel MP 3.4)	Install drop structures (check dams) in the Magirl Channel / Carbon River side channel	July 16 – August 15	10 days	ATVs Chainsaws Excavator Power winch
Park entrance MP 0.00 Maintenance Area MP 0.15	Install (2) ELJs at the Park entrance – wet site requires water diversion. Install (2) ELJs at the maintenance area.	July 9-Aug 22	45 days + upland staging activities may occur prior to and after these dates	Excavator Front end loader Portable pump 7- Dump truck Log Truck
Falls Creek washout (MP 1.45) to Road washout at MP 3.93	Remove culverts and install new trail bridges in Falls Creek area (except the large abandoned culvert on old Falls Creek channel). Reconstruct trail surface in damaged sections of road and install road humps between Falls Creek to 1st major washout above Chenuis Trailhead area.	July 16 – Nov 15	30 days	ATVs Excavator Front end loader Portable pump- Dump truck

Table 7 continued. Summary of the **2012** proposed work schedule. All dates are approximate and subject to change pending project funding availability and site conditions encountered during implementation.

General Area / MP	Project Activity	Expected work dates	Estimated duration	Equipment needed
Park entrance to Ipsut Campground MP 0.00 to 4.99	Continue current management: Open Carbon Road / Trail for public access after winter season, includes down fall removal, cleaning water bars, trail bridge repairs, cleaning water bars and ditches, minor by-pass trail reconstruction as needed, depending on flood damage.	Mar 15 – April 15	10 to 30 days depending upon flood damage	ATVs Chainsaws Dump truck Excavator Road Grader
Chenuis Trailhead to Ipsut Creek MP 1.2 0 to 1.95	Reconstruct trail surface in damaged sections of road and install road humps between Chenuis Trailhead and Ipsut Creek.	April 15 – July 15	30 days	ATV's Chainsaws Front end loader, Dump truck
Chenuis Trailhead to Ipsut Creek	Install toe-roughened gabions / log crib wall structures through (4) road washouts located between Falls Creek and the Ipsut Creek Campground.	July 9 – August 22	20 to 30 days for each site. 45 days + upland staging activities may occur prior to and after these dates	ATVs Chainsaws Excavator Helicopter (?)

Table 7 continued. Summary of the **2013** proposed work schedule. All dates are approximate and subject to change pending project funding availability and site conditions encountered during implementation.

General Area / MP	Project Activity	Expected work dates	Estimated duration	Equipment needed
Park entrance to Ipsut Campground MP 0.00 to 4.99	Continue current management: Open Carbon Road / Trail for public access after winter season, includes down fall removal, cleaning water bars, trail bridge repairs, cleaning water bars and ditches, minor by-pass trail reconstruction as needed, depending on flood damage.	March 15 – April 15	10 to 30 days depending upon flood damage	ATVs Chainsaws Dump truck Excavator Road Grader
Chenuis Trailhead Hanging Culvert MP 3.586	Remove culvert, replace with trail bridge. Install drop structures in stream channel above crossing. Requires site dewatering protocol.	July 16 – August 15	10 days	ATV's Chainsaws Excavator
Ranger Creek Culvert	Remove culvert, replace with trail bridge. Requires site dewatering and fish removal protocol.	July 16 – August 15	10 days	ATVs Chainsaws Excavator
Falls Creek Culvert MP 1.68	Remove culvert, back-fill trench with coarse rock and re-grade site to existing trail alignment and elevation. May require site dewatering or sediment control due to intersection with the active Carbon River side channel.	July 16 – August 15	10 days	ATVs Chainsaws Excavator
Ipsut Creek Trail bridge MP 4.8	Replace existing trail bridge with new trail bridge.	July 16 – August 15	10 days	ATVs Chainsaws Excavator

Avoidance and Minimization Measures

The following list of protective measures would be implemented throughout the duration of the project to minimize effects to listed species and water quality.

Actions to minimize disturbance to nesting murrelets
(Source: USFWS 2003)

- Felling of large trees in suitable nesting habitat for marbled murrelets will not occur during the marbled murrelet nesting season (April 1 – September 15). Tree felling is not permitted from April 1 through September 15 to protect nesting murrelets, eggs, and young in stands that are identified as suitable murrelet nesting habitat. Large trees are defined as conifers with a diameter-at-breast-height of 16 inches or greater.

- All project activities located will only occur two hours after official sunrise, and will cease 2 hours prior to official sunset during the murrelet nesting season (April 1 to September 15)[1]. This restriction avoids potential disruption to murrelets during their daily peak activity periods for feeding and incubation exchanges.

- Blasting activities will not occur between April 1 and August 5. This restriction avoids potential disruption of murrelets during their early nesting season, to protect incubation and brooding of hatchlings.

- All food items would be stored inside vehicles, trailers, or trash dumpsters except during actual use to prevent unnatural attractants to crows, jays, and other wildlife which have been identified as predators of murrelet eggs and young.

[1]A typical conservation measure is to avoid all construction activities during the murrelet early nesting season (04/01 to 08/05). This measure has not been included here because the Park has determined that compliance with this measure is not feasible for Alternative 2 due to the need to comply with in-water work seasons.

Actions to minimize disturbance to nesting spotted owls:
(Source: USFWS 2007)

- Felling of large trees in suitable nesting habitat for spotted owls will not occur during the spotted owl nesting season (March 15 – September 15). Tree felling is not permitted during the nesting season to protect nesting spotted owls, eggs, and young in stands that are identified as suitable nesting habitat. Large trees are defined as conifers with a diameter-at-breast-height of 16 inches or greater.

- Blasting activities will not occur between March 15 and July 30. This restriction avoids potential disruption of spotted owls during their early nesting season which includes incubation and brooding of hatchlings.

Actions to minimize impacts to bull trout and steelhead
(Sources: USFWS 2007, WDFW and USFS 2005)

Follow the appropriate WDFW guidelines for the timing of in-water work. Such guidelines are intended to avoid in-water work during periods when salmonid eggs and fry incubate within stream gravels, and include the following:

- In-water work is restricted to the period of **July 16 to August 15** for all Carbon River tributaries streams such as Ranger Creek (WAC-110-206).

- The extended in-water work season for the mainstem Carbon River is **July 9 to August 22.** This applies to work associated with placement of ELJs or other bank protections structures along the Carbon River.

- Projects which require in-water excavation with heavy equipment (i.e., culvert removal and placement of ELJs) will follow the approved work-site isolation, dewatering, and fish removal protocol described below.

- Fish within construction sites that will be dewatered or isolated from the main waterbody shall be captured and safely moved from the job site. Fish capture and transportation equipment shall be available on the job site during all in-water activities.

- Any pump used for diverting water from a fish bearing waterbody shall be equipped with a fish guard to prevent passage of fish into the pump. The pump intake shall be screened with 3/32 in or smaller mesh. Screen maintenance shall be adequate to prevent injury or entrapment to juvenile fish and shall remain in place whenever water is withdrawn from the waterbody through the pump intake.

Exceptions:

In-channel work below the ordinary high-water line may occur outside the specified in-water work period in areas that are dry during the proposed work period. Many side-channels and other fish-bearing streams within the Carbon River floodplain are seasonally dry from mid-summer into the fall months.

Extended in water work season for installation of Engineered Logjams:

The Park has identified the need for an extension to the in-water work season in order to construct ELJs near the Park entrance. Based on a review of this request by WDFW, USFWS, and NMFS, the agreed upon extension for this work is July 9 to August 22 for project work in the Carbon River (G. Piazza, WDFW pers. comm. 04/08/2010, J. Walters, NMFS, pers. comm. 04/08/2010). This extension minimizes potential impacts to bull trout or Chinook which may be staging to spawn in project areas in late August. This extension does not apply for in-water work in Carbon River tributaries such as Ranger Creek and Ipsut Creek.

Fish Passage Criteria for Instream Structures
(Sources: SHRG 2004 – *Stream Habitat Restoration Guidelines* and WAC-110-070)

Hydraulic drop is the difference in elevation between the water surface upstream and downstream of the structure. To maintain fish passage for juvenile salmonids, the following hydraulic drop criteria apply:

Drop structures or grade-control structures: The maximum hydraulic drop for instream structures is 0.7 ft. (8 inches). This drop height can be achieved by placing notches in structures, or by setting the structure at an angle such that the desired drop height is achieved. The maximum hydraulic drop criteria must be satisfied at all flows between the low and high flow design criteria.

Recommended weir spacing should be no closer than the net drop divided by the channel slope (for example, a one-foot high weir in a stream with a two-percent gradient will have a minimum spacing of 50 ft. (1/0.02)).

Fish Removal and Dewatering Protocol
(Source: USFWS 2007)

The following procedures will be used to isolate and dewater sites which require in-water work with heavy equipment. All fish capture, removal, and handling activities shall be conducted by an experienced fisheries biologist or technician.

1. Isolate the Construction Site and Remove Fish

Install block nets at up and downstream locations and leave in a secured position to exclude fish from entering the project area. Leave nets secured to the stream channel bed and banks until fish capture and transport activities are complete.

If block nets or traps remain in place more than one day, monitor the nets and or traps at least on a daily basis to ensure they are secured to the banks and free of organic accumulation and to minimize fish predation in the trap.

Fish Capture Alternatives:

Collect fish by hand or dip nets, as the area is slowly dewatered.

Seining – Use seine with mesh of such a size to ensure entrapment of the residing fish.

Minnow traps – Traps will be left in place overnight and in conjunction with seining.

Electrofishing – Prior to dewatering, use electrofishing only where other means of fish capture may not be feasible or effective.

The protocol for electrofishing includes the following:

If fish are observed spawning during the in-water work period, electrofishing shall not be conducted in the vicinity of spawning adult fish or active redds.

Only Direct Current or Pulsed Direct Current shall be used.

Conductivity <100: use voltage ranges from 900 to 1100. Conductivity from 100 to 300: use voltage ranges from 500 to 800. Conductivity greater than 300: use voltage to 400.

Begin electrofishing with minimum pulse width and recommended voltage and then gradually increase to the point where fish are immobilized and captured. Turn off current once fish are immobilized.

Do not allow fish to come into contact with anode. Do not electrofish an area for an extended period of time. Remove fish immediately from water and handle as described below. Dark bands on the fish indicate injury, suggesting a reduction in voltage and pulse width and longer recovery time.

Fish Handling and Release

Fish must be handled with extreme care and kept in water the maximum extent possible during transfer procedures. A healthy environment for the stressed fish shall be provided—large buckets (five-gallon minimum to prevent overcrowding) and minimal handling of fish.

Place large fish in buckets separate from smaller prey-sized fish. Monitor water temperature in buckets and well-being of captured fish. As rapidly as possible (especially for temperature-sensitive bull trout), but after fish have recovered, release fish upstream of the isolated reach in a pool or area that provides cover and flow refuge. Document all fish injuries or mortalities and include in annual report.

2. Dewater the Construction Site

Upstream of the isolated construction area, divert flow around the construction site with a coffer dam (built with non-erosive materials) and an associated pump or a by-pass culvert. Diversions constructed with material mined from the streambed or floodplain is not permitted. Small amounts of instream material can be moved to help seal and secure diversion structures.

Pumps must have fish screens with 3/32 in or smaller mesh. Dissipate flow energy at the bypass outflow to prevent damage to riparian vegetation or stream channel. If diversion allows for downstream fish passage (i.e., is not screened), place diversion outlet in a location to promote safe reentry of fish into the stream channel, preferably into pool habitat with cover.

When necessary, pump seepage water from the de-watered work area to a temporary storage and treatment site or into upland areas and allow water to filter through vegetation prior to reentering the stream channel.

3. Rewater the Construction Site

Upon project completion, slowly re-water the construction site to prevent loss of surface water downstream as the construction site streambed absorbs water and to prevent a sudden increase in stream turbidity. Monitor downstream during re-watering to prevent stranding of aquatic organisms below the construction site.

Pumping equipment must be staged away from the rivers; except for the pump hose, which may extend down to the edge of the rivers. Pump intakes must be screened with 3/32 in or smaller mesh on the end of pump hose to filter-out aquatic organisms. This screen should be cleaned of debris periodically.

Place a spill containment enclosure around the pump and or generator to contain gas, oil or other fluids.

<u>Minimize Heavy Equipment Impacts to Aquatic and Riparian Habitats</u>
(Sources: USFWS 2007, WDFW and USFS 2005)

- Establish staging areas (used for construction equipment storage, vehicle storage, fueling, servicing, hazardous material storage, etc.) at least 150 ft. away from streams in a location and manner that will preclude erosion into or contamination of streams or wetlands.

- All equipment used for instream work shall be cleaned and leaks repaired prior to entering the project area. Remove external oil and grease, along with dirt and mud prior to construction. Thereafter, inspect equipment daily for leaks or accumulations of grease, and fix any identified problems before entering streams or areas that drain directly to streams or wetlands.

- Heavy equipment used for in-water work will use bio-degradable hydraulic fluids.

- If the project includes excavation of the streambed or banks, those work areas shall be isolated from flowing waters to protect water quality and minimize turbidity.

- All equipment shall be cleaned of all dirt and weeds before entering the project area to prevent the spread of noxious weeds.

- Equipment used for instream or riparian work shall be fueled and serviced in an established staging area located at least 150 ft. away from streams. When not in use, vehicles shall be stored in the staging area.

- Minimize the number and length of stream crossings and access routes through riparian areas. Stream crossings and access routes should be at right angles.

- Heavy equipment will follow planned routes of access, will travel across dry, un-wetted substrates to the extent possible, and will only cross wetted channels at designated locations.

- Existing roadways or travel paths will be used whenever reasonable. Minimize the number of new access paths to minimize impacts to riparian vegetation and functions.

- Project operations must cease under high flow conditions that inundate the project area, except for efforts to avoid or minimize resource damage.

- Initiate rehabilitation of all disturbed areas in a manner that results in similar or better than pre-work conditions through spreading of stockpiled materials, seeding, and/or planting with locally native seed mixes or plants. Planting shall be completed no later than spring planting season of the year following construction.

Minimize Water-Quality Contamination from Concrete and Treated Wood
(Sources: WDFW and USFS 2005)

- Fresh concrete, concrete by products, or other chemical contaminants shall not be allowed to enter waterbodies. Structures containing concrete shall be sufficiently cured to prevent leaching prior to contact with the waterbody.

- Treated wood used for bridges or other structures shall meet or exceed the standards established in the most current edition of "*Best Management Practices For the Use of Treated Wood in Aquatic Environments*" developed by the Western Wood Preservers Institute..

Project Criteria for Culvert or Trail Bridge Placements:
(Sources: USFWS 2007, WDFW and USFS 2005, WAC-220-110-070)

- Structure types may include closed-bottomed culverts, open-bottomed arch or box culverts, or bridges.

- The structure width shall never be less than the bankfull channel width. The stream width inside the culvert or between bridge footings shall be equal to or greater than the bankfull width.

- Culverts in fish-bearing streams shall be designed, installed, and maintained to provide passage for all fish species and all life stages that are likely to be encountered at the site.

- Stream crossing structures (culverts or bridges) must accommodate a 100-year flood flow while maintaining sediment continuity (similar particle size distribution) within the culvert as compared to the upstream and downstream reaches.

- Culvert removal or placement sites shall be dewatered or isolated from flowing waters to protect water quality and minimize turbidity.

- Culvert removal or replacement projects in fish-bearing streams will only occur during the approved in-water work season (July 16 – August 15).

- Structures containing concrete must be cured or dried before they come into contact with stream flow.

- Bridge abutments must be placed outside the bankfull channel width.

- Embedment – If a closed culvert is used, the bottom of the culvert shall be buried into the streambed not less than 20 percent and not more than 50 percent of the culvert height. For open-bottomed arches and bridges, the footings or foundation shall be designed to be stable at the largest anticipated scour depth. Substrate and habitat patterns within the culvert should mimic stream patterns that naturally occur above and below the culvert. Coarser material may be incorporated to create velocity breaks during high flows, thereby improving fish passage, and to provide substrate stability.

- Grade Control Structures – Grade control structures are permitted to prevent headcutting above or below the culvert or bridge. Grade control typically consists of boulder structures that are keyed into the banks, span the channel, and are buried in the substrate. Grade-control structures must accommodate fish passage for all species and life stages of fish present.

- When removing woody debris from the road-crossing inlet, place the debris downstream of the road crossing.

<u>Project Criteria for Permanent Culvert or Bridge Removal</u>
(Sources: USFWS 2007, WDFW and USFS 2005, WAC-220-110-070)

- All fill material and man-made structures shall be removed from stream channels. The natural stream channel profile shall be restored. Bottom width opening of the fill removal at stream channel crossings shall be equal to, or greater than, the natural bankfull channel width.

- Streambanks shall be shaped to blend in to the existing natural banks upstream and downstream from the crossing removal.

- Streambed substrates shall mimic the natural streambed characteristics upstream and downstream of the crossing removal. Large woody material and/or large rocks may need to be placed within the crossing removal site to accomplish this objective.

- The toe of the excavation shall be stabilized with large wood, appropriately sized rock, and/or vegetation as necessary to prevent excessive erosion of the new streambanks.

- When removing culverts on fish-bearing streams, construction sites shall be dewatered or isolated from flowing waters to prevent generation of sediment and minimize turbidity.

- Dewatering is not required for culvert or ford removals on non-fish bearing streams unless substantial excavation of stream channel or culvert bedding materials will be required after the existing culvert or structure is removed.

Project Criteria for In-channel Gravel Removal
(Source: WAC-110-140)

Limited excavation of river gravels and cobbles for project fill is permitted. Gravel excavation is limited to dry gravel bars within the main Carbon River channel only. The following technical provisions apply to gravel removal projects:

- Gravel removal from a watercourse shall be limited to removal from exposed bars and shall not result in a lowering, over time, of the average channel cross-section profile through the project area or downstream.

- Gravel removal from the Carbon River will only occur during the approved in-water work season (July 9 – August 22).

- An "excavation line" shall be established. "Excavation line" means a line on the dry bed, at or parallel to the water's edge. The excavation line should be established at a distance that will avoid excavation disturbance within the wetted channel. The excavation line may change with water level fluctuations.

- An "excavation zone" shall be defined as the area between the "excavation line" and the bank or the center of the bar. The "excavation zone" shall be identified by boundary markers placed by the applicant and approved by the department prior to the commencement of gravel removal.

- Excavation shall begin at the excavation line and proceed toward the bank or the center of the bar, perpendicular to the alignment of the watercourse.

- Bed material shall not be removed from the water side of the excavation line.

- Equipment shall not enter or operate within the wetted perimeter of the watercourse, except at designated equipment crossing sites.

- Gravel may be removed within the excavation zone from a point beginning at the excavation line and progressing upward toward the bank or the center of the bar on a minimum two percent gradient. It may be necessary to survey the excavation zone upon completion of the gravel removal operation to ensure the two percent gradient is maintained and that no depressions exist.

- The depth of gravel excavation from exposed bars is limited to the depth of the adjacent water level.

- No excavation of gravels from within wetted channels is allowed.

- At the end of each work day the excavation zone shall not contain pits, or potholes, or depressions that may trap fish as a result of fluctuation in water levels.

- The upstream end of the gravel bar shall be left undisturbed to maintain watercourse stability water-ward of the ordinary high water line.

- Large woody material shall be retained water-ward of the ordinary high water line and repositioned within the watercourse. Other debris shall be disposed of so as not to reenter the watercourse.

- Equipment shall be inspected, cleaned, and maintained to prevent loss of petroleum products water-ward of the ordinary high water line.

Project Criteria for Moving In-channel Large Wood for use in Engineered Logjams

- Only logs that are isolated and no portion of the log is buried on dry gravel bars in the Carbon River braided channel zone may be moved for use in logjams.

- No logs that are interacting with the wetted channel width may be moved, except within the construction footprint of a project site.

- Equipment shall not enter or operate within the wetted perimeter of the watercourse, except at designated equipment crossing sites, and will only occur during the approved in-water work season for the Carbon River (July 9 – August 22).

ANALYTICAL FRAMEWORK FOR THE JEOPARDY AND ADVERSE MODIFICATION DETERMINATIONS

Jeopardy Determination

In accordance with policy and regulation, the jeopardy analyses in this Opinion rely upon four components: (1) the Status of the Species, which evaluates the species range-wide condition, the factors responsible for that condition, and its survival and recovery needs; (2) the Environmental Baseline, which evaluates the condition of the species in the action area, the factors responsible for that condition, and the relationship of the action area to the survival and recovery of the species; (3) the Effects of the Action, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the species; and (4) Cumulative Effects, which evaluates the effects of future, non-Federal activities in the action area on the species.

In accordance with policy and regulation, the jeopardy determination is made by evaluating the effects of the proposed Federal action in the context of the species current status, taking into account any cumulative effects, to determine if implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of both the survival and recovery of the species in the wild.

The jeopardy analyses in this Opinion emphasize consideration of the range-wide survival and recovery needs of the species and the role of the action area in the survival and recovery of the species. It is within this context that we evaluate the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the jeopardy determination.

Adverse Modification Determination

This Opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statutory provisions of the Act to complete the following analysis with respect to critical habitat.

In accordance with policy and regulation, the adverse modification analysis in this Opinion relies on four components: 1) the Status of Critical Habitat, which evaluates the range-wide condition of designated critical habitat for the species in terms of primary constituent elements (PCEs), the factors responsible for that condition, and the intended recovery function of the critical habitat overall; 2) the Environmental Baseline, which evaluates the condition of the critical habitat in the action area, the factors responsible for that condition, and the recovery role of the critical habitat in the action area; 3) the Effects of the Action, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the PCEs and how that will influence the recovery role of affected critical habitat units; and 4) Cumulative Effects, which evaluates the effects of future, non-Federal activities in the action area on the PCEs and how that will influence the recovery role of affected critical habitat units.

For purposes of the adverse modification determination, the effects of the proposed Federal action on a species critical habitat are evaluated in the context of the range-wide condition of the critical habitat, taking into account any cumulative effects, to determine if the critical habitat range-wide would remain functional (or would retain the current ability for the PCEs to be functionally established in areas of currently unsuitable but capable habitat) to serve its intended recovery role for the species.

The analysis in this Opinion places an emphasis on using the intended range-wide recovery function of a species' critical habitat and the role of the action area relative to that intended function as the context for evaluating the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the adverse modification determination.

STATUS OF THE SPECIES: Spotted owl (*Strix occidentalis caurina*)

Summary of species status and biology

The spotted owl was listed as a threatened species in 1990 because of widespread loss of suitable habitat across the species range and the inadequacy of existing regulatory mechanisms to conserve the species (55 FR 26114 [June 26, 1990])). Many populations of spotted owls continue to decline, especially in the northern parts of the species' range, where populations have declined by as much as 40 to 60 percent since 1990. Over the past decade it has become

apparent that competition from the barred owl (*Strix varia*) poses a significant threat to the spotted owl. Past habitat loss and current habitat loss are also threats to the spotted owl, even though loss of habitat due to timber harvest has been greatly reduced on Federal lands for the past 2 decades (USFWS 2008).

Spotted owls are long-lived, non-migratory birds that establish territories that they defend against other owls. Spotted owls range across their territories over the course of the year hunting for prey. In western Washington, spotted owls prey almost entirely on northern flying squirrels (*Glaucomys sabrinus*) and other small mammals (Forsman et al. 2001). Spotted owls are mostly nocturnal, although they also forage opportunistically during the day. Spotted owl territories are large and encompass thousands of acres of forest habitat. Suitable spotted owl habitat is generally mature or old-growth forest that has a moderate to high canopy closure; a multi-layered, multi-species canopy dominated by large overstory trees; numerous large snags and down logs; and sufficient open space below the canopy for owls to fly through (Thomas et al. 1990). Forests with these characteristics provide nesting and roosting sites for spotted owls and support the highest densities of northern flying squirrels (Carey 1995).

In the Washington Cascades, an average spotted owl territory encompasses over 6,000 acres (USFWS 1992). For management purposes, a 1.8-mile radius circle is used to map spotted owl territories. Within the annual home range there is a core area of concentrated habitat use during the nesting season (Bingham and Noon 1997). The core area contains the nest tree, alternate roosting sites, and the nest patch, which is roughly a 70 acre area surrounding the nest site that is heavily used by juvenile spotted owls prior to dispersal (Miller 1989, p. 19). For management purposes, a nest patch is represented by a 300-meter radius circle (USFWS et al. 2008). Spotted owl monitoring has indicated that established spotted owl territories are fairly stable, and that some territories may be occupied by different pairs of spotted owls over many years (Forsman et al. 1984, p. 19). The actual nest-tree used within a territory may change from year to year, but alternate nest trees are usually located within the same general core area (equal to a 0.7-mile radius around an established activity center) (Forsman et al. 1984, p. 32).

At Mount Rainier, the spotted owl nesting season extends from March 15 through September 30. The nesting season is divided into early and late seasons. The early nesting season is defined as March 15 to July 31. Early nesting season behavior includes nest site selection, egg laying, incubation, and brooding of nestlings to the point of fledging (Forsman et al. 1984, pp. 32-38). The late nesting season extends from August 1 through September 30. During this period, the juvenile spotted owls have left the nest and are able to fly short distances, but they remain close to the nest site and depend upon the adults for feeding. By late summer, the adults are rarely found roosting with their young and usually only visit the juveniles to feed them at night (Forsman et al. 1984, p. 38). Juvenile owls typically disperse away from their natal sites in late September or early October, and become non-territorial “floaters” for 2 to 5 years before they acquire their own territories (Forsman et al. 2002, p. 2). The survival rate for fledglings is low, with approximately 50 to 80 percent of juvenile owls dying due to starvation or predation during their first year (Miller 1989, Forsman et al. 2002). Recent demographic modeling indicates only about 10 percent of juvenile spotted owls survive to be recruited into the breeding population (Glenn et al. 2010). Because spotted owls are long-lived birds with relatively low reproductive output with low survival rates for juvenile owls, it may take several years of nesting for a pair to

successfully replace themselves in the breeding population. The spotted owl's long reproductive life span allows for some eventual recruitment of offspring, even if recruitment does not occur each year (Franklin et al. 2000).

The rangewide spotted owl population is distributed across the landscape in local clusters or subpopulations that function as a metapopulation with some demographic exchange between the subpopulations (Courtney et al. 2004, p. 8-4). All conservation strategies developed for the spotted owl recognize the importance of maintaining large blocks of suitable habitat to support clusters of spotted owl territories and by providing for demographic exchange (dispersal) between these local populations (Courtney et al. 2004, p. 8-4). The factors that influence spotted owl demography are not fully understood, but habitat quality and quantity, annual weather patterns, and the presence of barred owls are all factors that affect spotted owl survival, reproduction, and local population trends (Anthony et al. 2006, Glenn et al. 2010).

Spotted owl demography studies use estimates of fecundity (reproduction) and apparent survival to determine if populations are increasing, stationary, or decreasing. In the 11 demography study areas distributed across the range of the spotted owl, populations are declining in 7 areas, and are currently stable in 4 areas. Stable populations occur in portions of southern Oregon and northern California, while the populations in Washington and northern Oregon are all declining at a rate of 3 to 7 percent per year (Forsman et al. in press, cited in USFWS 2010a, p. 90). An overall decline in apparent survival rates (the probability that an owl will survive from one year to the next) is the most significant factor driving the declining population trends across the range of the species (Forsman et al. in press, cited in USFWS 2010a, p. 90).

For a detailed account of spotted owl biology, life history, threats, demography, and conservation needs, refer to Appendix 2 (Status of the Species - Spotted Owl).

ENVIRONMENTAL BASELINE: Spotted Owl

Regulations implementing the Act (50 CFR 402.02) define the environmental baseline as the past and present impacts of all Federal, State, or private actions and other human activities in the action area. Also included in the environmental baseline are the anticipated impacts of all proposed Federal projects in the action area that have undergone section 7 consultation, and the impacts of State and private actions which are contemporaneous with the consultation in progress. The action area for this proposed action is depicted in Figure 1. We will initially address conditions at the physiographic province and Park scales to provide an appropriate context for the environmental baseline.

Western Washington Cascades Physiographic Province

For analysis and conservation planning purposes, the range of the spotted owl is divided into 12 physiographic provinces that reflect the physical, biological, and environmental factors that shape broad-scale landscape features and natural plant communities (Thomas et al. 1990, p. 61). In the 2010 draft revised recovery plan for the spotted owl, the FWS identified the physiographic provinces as individual recovery units essential for the survival and recovery of spotted owls (USFWS 2010a, p. 37). In Washington, there are four physiographic provinces, including the

Olympic Peninsula, the Western Washington Lowlands, the Western Washington Cascades, and the Eastern Washington Cascades.

The Park is located in the Western Washington Cascades province. Federal lands in the province include over 1.1 million acres of suitable spotted owl habitat, which represents about 15 percent of all suitable owl habitat on Federal lands. Approximately 78 percent of the owl habitat on Federal lands in the province is located in conservation reserves. The spotted owl recovery team identified several threats to spotted owls within the Western Washington Cascades province, including fragmented distribution of spotted owl habitat and local populations, and the potential for isolation of spotted owls within the province from populations in adjacent provinces (USFWS 1992, p. 45). Barred owls are common in the Western Washington Cascades (Herter and Hicks 2000, Pearson and Livezey 2003), and competition with barred owls poses a significant and complex threat to the spotted owl (USFWS 2010a, p. ix).

Status of Spotted Owls in Mount Rainier National Park

The Park contains approximately 80,000 acres of suitable spotted owl habitat (Myers 2009). Spotted owl habitat extends up to an elevation of about 4,800 ft. in the Park. Surveys for spotted owls have been conducted annually in the Park since 1997 as part of an ongoing spotted owl demography study (Herter et al. 2008, Myers 2009). In 2010, there were 34 spotted owl sites surveyed in the Park. Spotted owls were detected at 16 sites (12 pairs, 3 singles, and 1 undetermined), and nesting pairs were documented at 7 sites in the Park (Bagnall 2010). In 2009, spotted owls were detected at 13 sites in the Park, including 7 pair sites, but there were no nesting attempts documented (Herter 2009). It is common for spotted owls to nest in alternating years, with most nesting attempts occurring in even years, and relatively few nesting attempts documented in odd years (Anthony et al. 2006). Not all suitable habitat in the Park is surveyed for spotted owls. Approximately 10 percent of the suitable habitat in the Park is not surveyed during annual monitoring, and additional owl pairs may be present in these areas.

The Park constitutes approximately 40 percent of the Rainier Spotted Owl Demographic Study Area (DSA). The spotted owl population in the north half of the Rainier DSA has declined significantly and now over half of the spotted owls remaining in the DSA (including most of the breeding pairs) are located within the Park (Herter et al. 2009). In the Rainier DSA, annual fecundity has been stable or is increasing, but apparent survival has declined, resulting in a decreasing population trend. The most recent demographic analysis indicates the population has declined at a rate of 7 percent per year since 1992 (Forsman et al. in press, cited in USFWS 2010a, p. 90). The result is that the current population in the Rainier DSA has declined by as much as 40 to 60 percent compared to the initial population that was present in 1992. Competition with barred owls is implicated as the primary cause for this decline (Herter et al. 2008). Barred owls have now been detected at 90 percent of spotted owl sites monitored in the Park (Bagnall 2010). Barred owls were first detected in the Park in 1986, and by 2006 there were 37 probable barred owl territories identified in the Park (Myers 2009). Despite the apparent high densities of barred owls in the area, low numbers of spotted owls continue to persist and successfully reproduce in the Park.

Status of Spotted Owls in the Action Area – Carbon River

The upper Carbon River valley contains approximately 12,300 acres of suitable spotted owl habitat, including over 7,200 acres of habitat within the Park (60 percent). Spotted owl habitat in the Carbon River valley extends up to an elevation of approximately 4,500 ft., and is somewhat topographically isolated from habitat in adjacent river valleys. Within the Park boundary, spotted owl habitat is relatively pristine, with minor habitat loss (< 25 acres) associated with existing Park developments (i.e., roads, trails, and campgrounds) that occurred after the Carbon River Road was established in early 1900's. Outside the Park, much of the forested area on private and National Forest lands has been previously harvested, resulting in the fragmentation and loss of most of the historic suitable spotted owl habitat outside the Park boundary. Barred owls have been documented in the Carbon River valley incidentally during spotted owl surveys (Bagnall 2010), but the numbers and location of active barred owl territories is unknown.

Spotted owl monitoring efforts have documented five spotted activity centers in the Carbon River valley, including three active territories in the Park, and two historic spotted owl territories (one located in the Park, and one located just north of the Park in the Mt. Baker-Snoqualmie National Forest but not monitored since 1998 (Herter et al. 2008) (Figure 2). Spotted owl occupancy in the action area has been inconsistent in recent years. No spotted owls were detected in the Carbon River valley in 2008. In 2009, a new pair of spotted owls was detected at Ipsut Creek, and a single male spotted owl was detected near Green Lake (Herter et al. 2009). In July 2010, a new pair of spotted owls with 2 juveniles was detected in the vicinity of Falls Creek/June Creek area. As of 2010, there are now 3 active spotted owl sites within the Park in the Carbon River valley – at Ipsut Creek, Green Lake, and June Creek (Bagnall 2010).

Conservation Role of the Action Area for Spotted Owls

Although spotted owl habitat in the Park is restricted to a relatively narrow band around the perimeter of Mount Rainer, this habitat currently supports a small breeding population of spotted owls and is considered essential for the long-term conservation of the species. Habitat within the Park is important for both spotted owl demographic support and dispersal connectivity within the Washington Cascades. In the spotted owl recovery plan, the FWS identified suitable spotted owl habitat in the Park as part of a network of "Managed Owl Conservation Areas" in western Washington. The Managed Owl Conservation Areas represent areas which the FWS considers essential for spotted owl recovery (USFWS 2008, p. 13).

EFFECTS OF THE PROPOSED ACTION: Spotted Owl

Direct Effects to Spotted Owls

Potential Disturbance to Spotted Owls from Project Noise and Activity

The use of helicopters, excavators, chainsaws, and other motorized equipment will introduce increased levels of sound and human activity into the project area over the course of four work seasons. Project work will coincide with the spotted owl nesting season (March 15 – Sept 30), and will continue into the fall months after the nesting season. Noise and activities associated

with road and trail construction, as well as construction of bank erosion protection structures, has the potential to disturb spotted owls in the project area. The response of spotted owls to project noise and activities is not well defined and is variable between individuals. Spotted owl responses to noise disturbance range from no apparent reaction, to an alert response where the owls are attentive for the duration of the activity, to a flush response (Delaney et al. 1999, p.68). Significant disturbance occurs when noise or project activity causes a spotted owl to become so agitated that it flushes away from an active nest during incubation or aborts a feeding of nestlings in the early spotted owl nesting season (March 15 – July 30 at Mt. Rainier) (USFWS 2003, p. 273). Such events are considered significant because they have the potential to result in reduced hatching success, fitness, or survival of juveniles. Specific thresholds for significant disturbance include:

(a) *Nesting spotted owls that are exposed to noise that is greater than or equal to 92 dB at an active nest site during the early nesting season*. This sound threshold is based primarily on two studies. Awbrey and Bowles (1990, p. 21) suggest that noise begins to disturb (i.e., cause an alert response, but not flight) most raptors at around 80-85 dB, and that the threshold for flight response is around 95 dB. Mexican spotted owls (*Strix occidentalis lucida*) exposed to helicopter noise elicited alert responses (i.e., head turning towards noise) when helicopters were an average of 0.25 mile (400 m) away, but owls did not flush from their roosts until the noise from helicopters exceeded 92 dB and occurred within a distance of less than 344 ft. (105 m) (Delaney et al. 1999 pp. 66-68).

(b) *Nesting spotted owls that are exposed to ground-based activities with motorized equipment within a distance of approximately 65 yards (60 m) from an active nest site during the early nesting season.* This distance threshold is based on two studies. Delaney et al. (1999) reported that Mexican spotted owls exposed to chainsaw noise flushed when chainsaws were operated within a distance of 344 ft. (105 m) and the sound level for chainsaws was greater than 46 dB (Delaney et al. 1999 pp. 66-68). However, only 2.8 percent (1 of 36) of the chainsaw trials at distances greater than 60 m resulted in a flush response, but over 70 percent of chainsaw trials at distances less than or equal to 60 m resulted in a flush response. The sound levels associated with the chainsaw tests were in the range of 54 to 61 dB at 197 ft. (60 m). Delaney and Grubb (2003, p. 22) reported that a spotted owl flushed in response to motorcycles passing within a distance of 220 ft. (67 m). The sound levels reported for motorcycles (61-82 dB at 50 to 65 ft.), are comparable to or less than sound levels reported for many types of motorized equipment.

It is important to note that not all spotted owls exposed to chainsaw or motorcycle noise in these studies flushed, and that spotted owls that were previously exposed to helicopters or chainsaw noise were less likely to flush during subsequent exposures, suggesting some birds have the ability to tolerate or habituate to such disturbances (Delaney et al. 1999, p. 69).

Spotted owls also did not flush from nests during incubation or brooding of nestlings, suggesting that spotted owls are reluctant to leave the nest during the early stages of the breeding cycle (Delaney et al. 1999 p. 71; Delaney and Grubb 2003, p. 22). However, the researchers in the Mexican spotted owl study did not challenge incubating spotted owls with chainsaw noise at

distances of less than 60 m due to the high flush rates observed for non-nesting birds exposed to chainsaw noise at less than 60 m (Delaney et al. 1999, p. 65). Considering the limited evidence available for spotted owls, we have determined that 60 m (65 yards) is a reasonable distance to assume a flush response may occur from ground-based, motorized activities.

Exposure of spotted owls to project noise

We used a Geographic Information System (GIS) to evaluate potential exposure of spotted owls to project noise (Figure 2). Based on the estimated sound attenuation contours and the disturbance thresholds described above, we calculated potential disturbance zones within the project area. For ground-based motorized activities along the Carbon River Road/Trail, we mapped a 65-yard disturbance zone along either side of the road from the Park entrance to Ipsut Creek Campground. For helicopter use, we mapped an 800-ft noise disturbance zone based on an estimated 92 dB sound contour for the Chinook 47-D. For more information on estimated sound levels for project equipment, refer to Tables 6 and 7 in the *Description of the Proposed Action*.

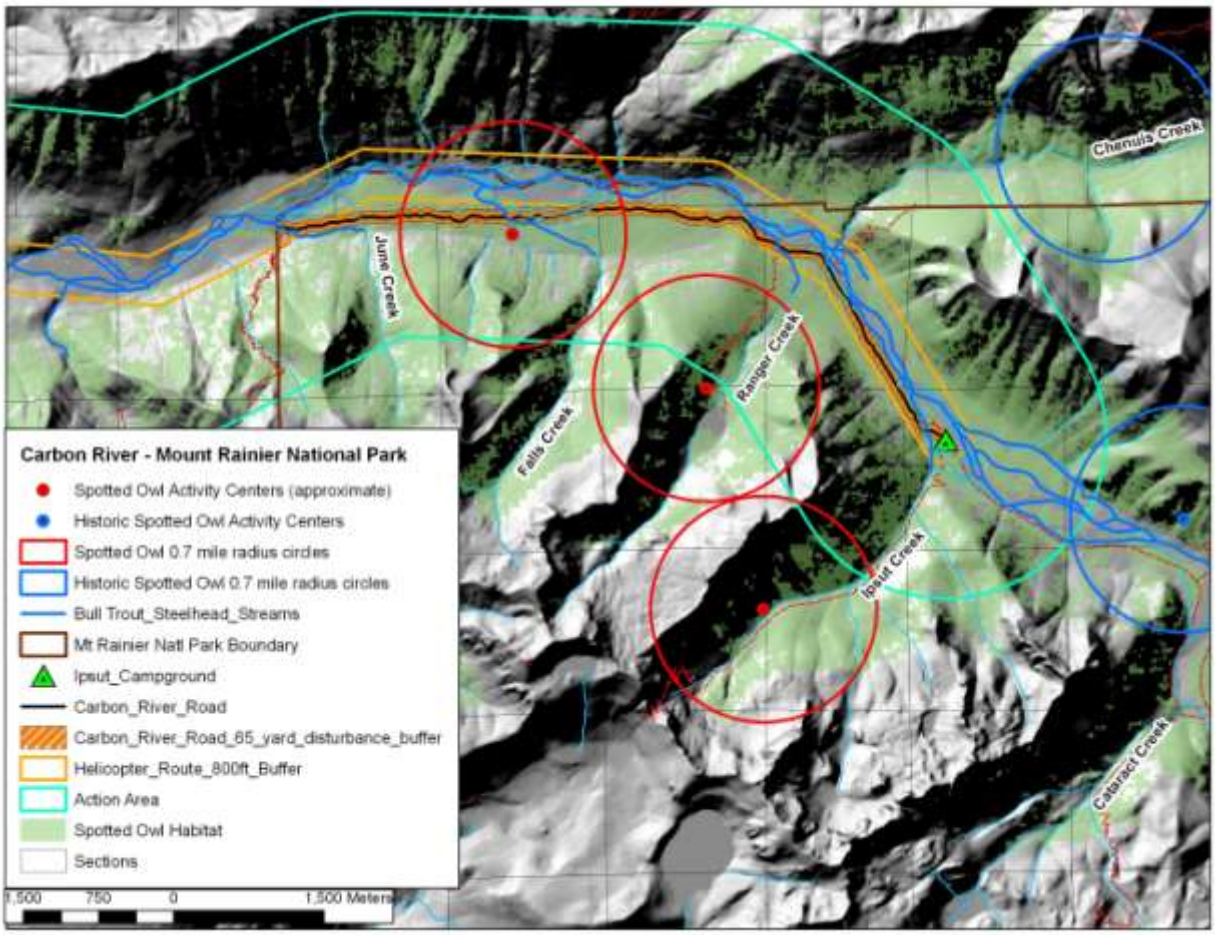

Figure 2. Overlap of project noise contours with spotted owl 0.7-mile radius core areas.

Use of Motorized Equipment along the Carbon River Road/Trail

Based on the disturbance thresholds described above, we mapped a 65 yard "disturbance" zone along either side of Carbon River Road/Trail to represent the area where spotted owls may be flushed by the use of motorized equipment. The 65-yard disturbance zone exceeds the estimated 92 dB sound contour for all project equipment except helicopters and blasting (Tables 6 and 7, above). For each mile of the road, there is approximately 48 acres located within the 65 yard disturbance zone. The total area associated with the disturbance zone along the Carbon River Road/Trail is approximately 240 acres, but only about 180 acres are actually forested and provide suitable spotted owl habitat. These areas will be subjected to construction noise and activity of varying degrees on a daily basis over 3 to 4 years from late March through mid-November.

Disturbance to Nesting Spotted Owls during the Early Nesting Season (March 15 – July 30).

As described in the *Description of the Proposed Action*, trail reconstruction through the Falls Creek area will occur during the spring and summer months of 2011 and will coincide with the early spotted owl nesting season. Construction activities (including trail construction and placement of bank protection logs along a 0.5-mile section of trail) are expected to last for approximately 4 to 6 weeks. Construction activities will be restricted to daylight hours only, and will not occur during dawn and dusk periods, when spotted owls are most active.

The spotted owl site in closest proximity to the trail is the June Creek activity center, which is located south of the Carbon River Road/Trail in the vicinity of the Falls Creek washout. The actual nest site for this pair is unknown, but the adult female and 2 juveniles were observed roosting in the forest canopy only about 160 yards south of the road, indicating that the nest tree or the 70 acre "nest patch" could occur within the 65-yard disturbance zone along the Carbon River Road. Because spotted owls do occasionally choose alternate nest locations within their core areas, we used the 0.7 mile-radius core area circle to represent the areas where potential spotted owl nesting sites are most likely to occur. Due the high degree of overlap of the June Creek core area circle with the Carbon River Road, we assume that the June Creek spotted owl pair is likely to be exposed to construction noise and activity during the early nesting season

Considering that the nest site location for this owl pair is unknown and can change from year to year, we assume that noise and visual disturbance associated with the Falls Creek trail construction could result in flushing a spotted owl adult or juvenile away from its nest or result in reduced or disrupted feeding of the nestlings. Flushing from a nest site is considered a significant disruption of normal behavior because flushing a nesting owl increases the risk of predation or premature fledging. We presume that any disturbances that cause adult or juvenile spotted owls to flush will increase predation risk. A flush response may create the likelihood of injury by increasing the risk of predation, e.g., through the advertisement of the nest's location, advertisement of the adult and juvenile, or the premature departure of a nestling from a nest. Predation mortality of juvenile spotted owls by great horned owls (*Bubo virginianus*) and northern goshawks (*Accipiter gentilis*) is well documented (Forsman et al. 1984; Forsman et al. 2002).

Female spotted owls may be more directly affected by human disturbance than are males. Since female spotted owls attend the nest, egg and nestling survival depend largely on their behavior (Swarthout and Steidl 2003, p. 312). Survival rates of juvenile spotted owls are low with predation and starvation being the most common sources of mortality (Forsman et al. 1984, Forsman et al. 2002). Any reduction in nestling vigor either through reduced energy intake, reduced parental care, or a combination of both may make fledged juveniles more susceptible to these sources of mortality (Swarthout and Steidl 2003, p.312).

For this analysis, we assume that construction of the trail through the Falls Creek washout (scheduled for 2011) will occur during one nesting season, so the adverse effects to spotted owls are limited to one nesting season over the 4-year implementation of the entire project. After construction of the Falls Creek section, the only activity that will occur in the vicinity of this nest site will be recreational and administrative access along the trail.

The effect of noise and visual disturbance to nesting spotted owls is uncertain, but we do not expect an outright nest failure to occur as a result of the disturbance, or the abandonment of the territory by the adult pair of spotted owls. In the Delaney et al. (1999) study of noise disturbance and Mexican spotted owls, none of the owls exposed to noise abandoned their nests, and there was no difference in the reproductive success between experimental and control groups. Individuals that had previously experienced chainsaw or helicopter noise did not flush during subsequent exposures, indicating that the spotted owls in this study were capable of tolerating subsequent exposures to noise disturbances without a flush response. Daily operating restrictions that restrict work activities to daylight periods only will reduce the duration and frequency of disturbance impacts by avoiding work during night and dawn/dusk periods when spotted owls are most active.

Disturbance to Nesting Spotted Owls during the Late Nesting Season (August 1 – September 30).

The late nesting season extends from August 1 through September 30. In the late nesting season, juvenile spotted owls have fledged and are able to thermoregulate, fly short distances, and are no longer completely dependent upon the adults for daily feedings (Forsman et al. 1984, p. 38). A flush response from either an adult or juvenile at this stage of development is not likely to reduce the juvenile owls' fitness or ability to survive. Therefore the biological effect of potential noise disturbance that occurs during the late nesting season is considered to be insignificant.

Disturbance to Foraging Spotted Owls

The Carbon River Road/Trail corridor occurs within the potential 1.8 mile radius home ranges of three active spotted owl territories. Over the course of the 4 years of project implementation, it is likely that individual spotted owls that are foraging or roosting in close proximity to the road may occasionally be flushed away from a foraging perch or a roosting site by project noise and activity. Such flush responses that occur away from an active nest site are considered to be insignificant, because the owls are simply moving away from the source of disturbance, rather than being forced to flush away from an active nest site.

The Park has included a daylight operating restriction for project implementation which restricts project work to daylight hours only from April 1 to September 15. Spotted owls are primarily nocturnal, and forage for prey almost exclusively at night, with peak activity levels occurring after sunset and prior to sunrise (Forsman et al. 1984, p. 51). By avoiding project activity during these nocturnal periods, normal spotted owl foraging behaviors are not likely to be significantly disrupted by project activities along the Carbon River Road/Trail.

Disturbance from Helicopters

The Park identified four sites where helicopters will be used to transport equipment and materials: the Ipsut Creek Campground and road washouts at MP 3.43, MP 3.93, and MP 4.47. The duration of helicopter use over the 4 years of project implementation is relatively brief, and is estimated as multiple flights at each site for a period of 1 to 2 days. For this assessment, we assume the Park will contract a Chinook 47-D, which is a double-rotor helicopter with a 20,000 lb. lift capacity. The Chinook 47-D is a very loud helicopter with an estimated 92 dB sound contour at 800 ft. (Table 6). Based on the 92 dB disturbance threshold described above, we expect any spotted owls located within an 800 ft. -radius of the helicopter flight path and drop sites would likely flush in response to helicopter noise.
We used GIS to map 800 ft. disturbance zones to indicate areas that would be exposed to helicopter noise levels of 92 dB or greater (Figure 2). Based on the current distribution of known occupied and historic spotted owl nest sites in the project area, we do not expect any spotted owl nest sites to occur within the 800 ft. – helicopter disturbance zone along the Carbon River Road/Trail. At the June Creek owl site, the helicopter disturbance zone occurs largely along the open Carbon River channel, with relatively little overlap into the adjacent forest. As with ground-based activities along the Carbon Road/Trail corridor described above, there is a potential for individual spotted owls that are foraging or roosting within the helicopter disturbance areas to be temporarily displaced by noise disturbance. However, due to the short duration and minor scope of this disturbance, we considered the effects to spotted owls to be insignificant, with no implications for impaired fitness, survival, or reproductive capability.

At Ipsut Creek Campground, the helicopter disturbance zone slightly overlaps the 0.7 mile-radius core area circle for the Ipsut Creek spotted owl site. There is a potential for noise disturbance to occur if the spotted owls at this territory select an alternate nest tree near the campground. Helicopter flights at Ipsut Campground will be scheduled to occur after September 15. Helicopter use that occurs during the latter half of the spotted owl breeding season (Aug. 1 – Sept. 30) would not significantly disrupt nesting spotted owls. In the late nesting season, juvenile spotted owls have fledged and are able to thermoregulate, fly short distances, and are no longer completely dependent upon the adults for daily feedings (Forsman et al. 1984, p. 38). A flush response from either an adult or juvenile at this stage of development is not likely to reduce the juvenile owls' fitness or ability to survive. Therefore the biological effect of potential noise disturbance that occurs during the late nesting season is considered to be insignificant.

Blasting for Trail Realignments

The Park has identified several locations along the Carbon River Road/Trail that may require blasting to remove stumps for trail alignments. The noise associated with blasting is highly variable and depends on size of the charge and the material being blasted. The FWS identified blasts of 2 lbs. or less to have a disturbance radius of 120 yards (USFWS 2003, p.282). Based on sound measurements taken during a previous project, the noise from a rock blasting project was reported as approximately 88 dB at 500 ft. (NPS 2008). For this project, all blasting activities will be scheduled to occur after August 6. Based on the timing of blasting activities and the current distribution of known occupied and historic spotted owl nest sites in the project area, the effects of blasting to spotted owls would be insignificant.

Recreational Use in the Carbon River Corridor

The Carbon River corridor currently receives over 30,000 visitors per year. Visitor use may increase over time as access in the corridor is improved. Visitor uses include hiking, camping, and picnicking along trails and at the Ipsut Creek campground. Most visitors stay on or close to Park trails, so the potential for visitors to encounter spotted owls is limited to those instances when spotted owls may be roosting near a trail. Swarthout and Steidl (2001) studied flush responses of Mexican spotted owls in constricted canyons in the Utah desert in which hikers walked close to roosting spotted owls. They found that 95 percent of flushes by adult and juvenile spotted owls occurred within distances of 24 m and 12 m, respectively, of the hikers, and that a 55-m buffer "would eliminate virtually all behavioral responses of owls to hikers" (p. 312). In this study, spotted owls were apparently much more sensitive to the presence of hikers than what is generally reported for spotted owls. This may be due to the narrow canyon setting in which the study was completed, where the spotted owls were apparently threatened by the close approach of hikers. Spotted owl researchers in the Pacific Northwest report that most spotted owl roosts and virtually all nest sites are located high enough in the forest canopy that spotted owls rarely flush even when someone walks directly under a roost or nest site (USFWS 2003, p. 279). Spotted owls can be flushed by hikers that approach within 20 to 30 ft. when the owls are roosting close to the ground, but such instances are uncommon (USFWS 2003, p. 279).

Considering the current distribution of known occupied and historic spotted owl nest sites in the project area, we do not expect that Park visitors will be hiking directly under active spotted owl nest trees. As with ground-based activities along the Carbon Road/Trail corridor described above, there is a potential for individual spotted owls that are foraging or roosting near trails or campgrounds to be flushed by the close approach of hikers. Flushing a spotted owl from a roost site is considered to be insignificant with no implications for impaired fitness, survival, or reproductive capability.

Indirect Effects to Spotted Owls

<u>Effects to spotted owl habitat from trail realignments</u>

Trail realignments along the Carbon River Road/Trail corridor may indirectly affect spotted owls by removing key habitat elements such as large trees and snags, and understory vegetation. Trail

construction activities would result in removal of approximately 28 trees dispersed across 3 different trail sections (Table 2). The total area of vegetation loss associated with trail realignments is estimated at less than 0.5 acre dispersed across 3 sites. Because spotted owls occupy large territories that encompass thousands of acres of forest habitat, the loss of scattered individual trees within a stand of suitable habitat is considered to be an insignificant habitat modification, because the affected stands would continue to provide suitable habitat for spotted owls roosting and foraging behaviors.

Effects of Interrelated or Interdependent Actions

One inter-related action associated with the Carbon River Access Management project will be the future need to remove hazard trees in the vicinity of campgrounds, trailheads, and visitor parking areas. The Park completed a Hazard Tree Management Plan in 2006. In accordance with the Management Plan, hazard trees may only be felled during the period of October 1 through March 14. This seasonal restriction avoids hazard tree removal during the nesting season for spotted owls. Therefore, potential disturbance or injury to spotted owls from hazard tree removal is not anticipated (USFWS 2006, pp. 5-9).

Once the Carbon River Access Management project has been completed, there will be a need to continue active management of the road and trail system. Trail maintenance includes activities such as clearing logs and debris from the trail, maintaining drainage features, and repairing trail surfaces. These activities can occur throughout the year, but generally occur during the summer and fall months. As described above, there are approximately 180 acres of suitable spotted owl habitat associated with the disturbance zone immediately adjacent to the Carbon River Road. These acres will be exposed to periodic noise and activity associated with routine trail maintenance actions. The Park generally plans maintenance projects to avoid the spotted owl nesting season, and restricts activities to mid-day hours only. Considering the limited timing and duration associated with periodic removal of logs from the trail, we assume the effects of routine trail maintenance activities will be insignificant.

It is highly likely that flood damage will continue to occur along the Carbon River corridor, which will require continued trail and road reconstruction efforts. Any future road or trail reconstruction projects are considered future Federal actions that will be subject to consultation under section 7 of the Act and are not considered to be part of this proposed action.

CUMULATIVE EFFECTS: Spotted Owl

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

<u>Forest Practices</u>

In the Carbon River action area, there is a mix of non-Federal timber land and National Forest lands located adjacent to the Park. National Forest lands on the adjacent Mt. Baker-Snoqualmie

National Forest in the Carbon River valley are designated as Late-Successional Reserves, or as Wilderness. Non-federal lands in the action area are managed primarily for timber production, but almost all forest that was potential spotted owl habitat on these lands has been previously harvested. Private timber harvest in the area must comply with the Washington Forest Practices Act (RCW 76.09) as well as the Washington Administrative Code with respect to the Washington Forest Practices Rules (WAC 222).

In the absence of a federally-approved Habitat Conservation Plan (HCP) or a State-approved special wildlife management plan, suitable spotted owl habitat on non-Federal lands is only protected by the Washington Forest Practices Rules in State-designated Spotted Owl Special Emphasis Areas (SOSEAs). Within SOSEAs, the Forest Practices rules provide protection for occupied suitable spotted owl habitat. However not all suitable spotted owl habitat on non-Federal lands is included within designated SOSEAs. Under the Washington Forest Practices Rules, a landowner in Washington could be in full compliance with the Washington Forest Practices Rules and have some risk of causing adverse impacts to spotted owls if their forest practices activity resulted in the loss of occupied spotted owl habitat.

Non-federal lands in the Carbon River action area occur are not located within a SOSEA, or in an area with a federally-approved HCP for spotted owls. Outside of SOSEA boundaries, there are no restrictions on the harvest of suitable spotted owl habitat. Therefore, a landowner could harvest timber (habitat) without a pre-harvest survey, potentially resulting in the loss of a spotted owl site center or suitable habitat within an occupied spotted owl territory. In the upper Carbon River valley, virtually all suitable spotted owl habitat that existed on non-Federal lands has been previously harvested. The small patches of suitable habitat that remain on these lands are primarily associated with potentially unstable slopes or stream riparian areas, which are protected under the Washington Forest Practices Rules. Based on the limited amount of suitable habitat remaining on private lands in the action area, we conclude that the risk to spotted owls for adverse cumulative effects associated with forest practices is very low, and are therefore not anticipated.

Climate Change

During the next 20 to 40 years, the climate of the Pacific Northwest is projected to change significantly with associated changes to forested ecosystems (Littell et al. 2009, p.15). Predicted changes include warmer, drier summers and warmer, wetter autumns and winters, resulting in diminished snowpack, earlier snowmelt, and an increase in extreme heat waves and precipitation events (Salathe et al. 2009). Initially, the Pacific Northwest is likely to see increased forest growth region-wide over the next few decades due to increased winter precipitation and longer growing seasons; however, forest growth is expected to decrease as temperatures increase and trees can no longer benefit from the increased winter precipitation and longer growing seasons (Littell et al. 2009, p.15). Additionally, the changing climate will likely alter forest ecosystems as a result of the frequency, intensity, duration and timing of disturbance factors such as fire, drought, introduced species, insect and pathogen outbreaks, windstorms, ice storms, landslides, and flooding (Littell et al. 2009, p.14).

One of the largest projected effects on Pacific Northwest forests is likely to come from an increase in fire frequency, duration and severity. In general, wet western forests have short dry summers and high fuel moisture levels that result in very low fire frequencies. However, high fuel accumulations and forest densities create the potential for fires of very high intensity and severity when fuels are dry (Mote 2008, p.23). Westerling et al. (2006) looked at a much larger area in the western US including the Pacific Northwest, and found that since the mid-1980s, wildfire frequency in western forests has nearly quadrupled compared to the average of the period 1970-1986. The total area burned is more than six and a half times the previous level and the average length of the fire season during 1987-2003 was 78 days longer compared to 1978-1986 (Westerling et al. 2006, p.941). Littell et al. (2009, p.2) project that the area burned by fire in the Pacific Northwest will double by the 2040s and triple by the 2080s.

Potential changes in temperature and precipitation have profound implications for spotted owls. Wet, cold weather during the winter or nesting season, particularly the early nesting season, has been shown to negatively affect spotted owl reproduction (Olson et al. 2004, Dugger et al. 2005), survival (Franklin et al. 2000, Olson et al. 2004, Glenn et al. 2010), and recruitment (Franklin et al. 2000). Cold, wet weather may reduce reproduction and/or survival during the breeding season due to declines or decreased activity in small mammal populations so that less food is available during reproduction when metabolic demands are high (Glenn et al. 2010). Cold, wet nesting seasons may increase the mortality of nestlings due to chilling (Franklin et al. 2000) and reduce the number of young fledged per pair per year (Franklin et al. 2000, Glenn et al. 2010).

Drought or hot temperatures during the summer have also been linked to reduced spotted owl recruitment and survival (Franklin et al. 2000, Glenn et al. 2010). Drier, warmer summers and drought conditions during the growing season strongly influence primary production in forests, food availability, and the population sizes of small mammals (Glenn et al. 2010).

In summary, climate change is likely to further exacerbate some existing threats to the spotted owl such as the projected potential for increased habitat loss from drought related fire, tree mortality, insects and disease, and increases in extreme flooding, landslides and windthrow events in the short-term (10 to 30 years), as well as affecting reproduction and survival during years of extreme weather.

INTEGRATION AND SYNTHESIS OF EFFECTS: Spotted Owl

Effects to Spotted Owl Numbers, Reproduction, and Distribution

In accordance with policy and regulation, the jeopardy determination is made by evaluating the effects of the proposed Federal action in the context of the species current status, taking into account any cumulative effects, to determine if implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of both the survival and recovery of the species in the wild. The jeopardy analysis in this Opinion emphasizes consideration of the range-wide survival and recovery needs of the species and the role of the action area in the survival and recovery of the species. It is within this context that we evaluate the significance of the effects

of the proposed Federal action, taken together with cumulative effects, for purposes of making the jeopardy determination.

Summary of the Current Status and Conservation Needs of the Spotted Owl

Many spotted owl populations are declining, especially in the northern parts of the species' range, where populations have declined by as much as 40 to 60 percent since 1990 (USFWS 2010, p. 88). The factors that influence spotted owl demography are not fully understood, but habitat quality and quantity, annual weather patterns, and the presence of barred owls are all factors that affect spotted owl survival, reproduction, and local population trends (Anthony et al. 2006, Glenn et al. 2010).

Over the past decade it has become apparent that competition from the barred owl poses a significant threat to the spotted owl. Past habitat loss and current habitat loss are also threats to the spotted owl, even though loss of habitat due to timber harvest has been greatly reduced on Federal lands for the past 2 decades (USFWS 2010, p. ix). Conservation strategies for the spotted owl recognize the importance of maintaining large blocks of suitable habitat to support clusters of spotted owl territories and by providing for demographic exchange (dispersal) between these local populations (USFWS 2008, p. 13), and reducing impacts associated with barred owl competition (USFWS 2010, pp. 65-69).

Although spotted owl habitat in the Park is restricted to a relatively narrow band around the perimeter of Mount Rainer, this habitat currently supports a small breeding population of spotted owls and is considered essential for the long-term conservation of the species. Habitat within the Park is important for both spotted owl demographic support and dispersal connectivity within the Washington Cascades.

Summary of the Effects of the Proposed Action, and Cumulative Effects

Noise and activity associated with trail construction is expected to occur over a period of 3 to 4 years, and result in short-term disturbance (one season) to one pair of nesting spotted owls. The effect of this disturbance is expected to include a flush response during incubation or brooding of nestlings that creates the likelihood of injury by increasing the risk of predation or the premature departure of a nestling from a nest. We do not expect outright nest failure or the abandonment of the nest, because spotted owls in experimental studies have demonstrated an ability to tolerate short-term disturbances without nest abandonment or reproductive failure (Delaney et al. 1999, Delaney and Grubb 2003). Daily operating restrictions that restrict work activities to daylight periods will reduce potential disturbance effects by avoiding work during night and dawn/dusk periods when spotted owls are most active, but these restrictions do not entirely avoid the potential for disturbance during the early nesting season.

The effects of other potential stressors to spotted owls associated with vegetation removal and future public and administrative uses along the Carbon River Road/Trail are considered to be insignificant with no long-term adverse effects to spotted nesting, roosting, or foraging behaviors. Based on the limited amount of suitable habitat remaining on private lands in the

action area, we conclude that the risk to spotted owls for adverse cumulative effects associated with non-Federal forest practices is very low, and are therefore not anticipated.

The upper Carbon River valley has over 12,000 acres of suitable spotted owl habitat, including large stands of high-quality old-growth forest in the Park that currently support three active spotted owl territories and two historic spotted owl sites. Considering the minor habitat effects associated with the project and the short-term disturbance associated with trail construction, we do not expect a measurable reduction in spotted owl numbers, reproduction, or distribution at the scale of the action area, province, or listed range of the species.

Effects to Spotted Owl Survival and Recovery

In spotted owl demography studies, apparent survival is an estimate of the probability that an individual will survive from one year to the next (Anthony et al. 2006, p. 10). The annual survival rate of breeding adults is important because spotted owl population trends are most influenced by changes in adult survival (Anthony et al. 2006, p. 30, Forsman et al. in press, cited in USFWS 2010a, p. 90). The factors that influence annual survival rates are not fully understood, but habitat quality and quantity, prey species abundance, annual weather patterns, and the presence of barred owls all influence adult survival rates (Dugger et al. 2005, Anthony et al. 2006, Glenn et al. 2010). In the Rainer DSA, survival rates have declined (1992 – 2003), and the presence of barred owls in spotted owl territories appears to be the most apparent cause for the decline, because there have been only minor losses of habitat due to timber harvest or wildfire (Anthony et al. 2006, p. 33).

Under the proposed action, there would be no significant change in the amount or quality of suitable spotted owl habitat in the Park, and there would be no effects that would increase the potential for competitive interactions between barred owls and spotted owls. The essential conservation role of the Park to support long-term survival and recovery for spotted owls would not be reduced or diminished by the effects of the proposed action.

CONCLUSION: Spotted Owl

After reviewing the current status of the spotted owl, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the FWS's Opinion that the Carbon River Access Management Plan, as proposed, is not likely to jeopardize the continued existence of the spotted owl and is not likely to destroy or adversely modify designated critical habitat. Critical habitat for the spotted owl has been designated in the Washington Cascades, however, this action does not affect that area and no destruction or adverse modification of critical habitat is anticipated.

The Park's proposed programs and activities are not likely to jeopardize the continued existence of the spotted owl for the following reasons:

- The proposed action would not result in the loss of suitable spotted owl habitat.
- The essential conservation role of the Park lands within the Carbon River valley to

provide for spotted owl survival and recovery would not be reduced or diminished by this action.

The Carbon River Access Management Plan is consistent with the recovery strategy and recovery objectives identified in the spotted owl recovery plan (USFWS 2008) that is based upon the following biological principles: 1) the presence of large blocks of habitat to support clusters or local population centers of spotted owls, 2) habitat conditions and spacing between local populations of spotted owls to facilitate survival and movement, 3) habitat maintained across a variety of ecological conditions within the spotted owl's range to reduce risk of local or widespread extirpation.

Given the above analysis, we conclude that the adverse effects to spotted owls that would result from the proposed actions would not appreciably reduce the likelihood of survival and recovery of the spotted owl in the wild by reducing owl numbers, reproduction, or distribution, at the scale of the Park, the Western Washington Cascades physiographic province, or the range of the species.

STATUS OF THE SPECIES: Marbled Murrelet (*Brachyramphus marmoratus*)

Summary of species status and biology

The marbled murrelet (murrelet) was listed as a threatened species in Washington, Oregon, and northern California in 1992. The primary reasons for listing included extensive loss and fragmentation of old-growth forests which serve as nesting habitat for murrelets and human-induced mortality in the marine environment from gillnets and oil spills (57 FR 45328 [Oct. 1, 1992])). Although some threats such as gillnet mortality and loss of nesting habitat on Federal lands have been reduced since the 1992 listing, the primary threats to species persistence continue (75 FR 3424 [Jan. 21, 2010]). The murrelet population estimate for the Northwest Forest Plan area in 2009 was 17,791 (95 percent confidence interval: 14,631 – 20,952) (Pearson et al. 2010, p. ii). Surveys from 2000 to present have documented that murrelet populations throughout the listed range have continued to decline at a rate of 2.4 to 4.3 percent per year. This represents an overall population decline of 19 to 34 percent since 2000 (75 FR 3424:3425 [Jan. 21, 2010]).

Murrelets are small, diving seabirds that spend most of their life in nearshore marine waters foraging on small fish and invertebrates, but use old-growth forests for nesting. Murrelets nest in forested areas up to 52 miles inland from their saltwater foraging areas (Hamer 1995, p. 167). Nests occur primarily in large, old-growth trees, with large branches or deformities that provide a suitable nest platform. Murrelets do not build a nest, but rather create a nest depression in moss or litter on large branches (Nelson 1997). In Washington, the murrelet breeding season occurs between April 1 and September 15 (Hamer et al. 2003). For management purposes, the FWS defines the murrelet early nesting season as April 1 through August 5. Early nesting season behaviors include egg laying, incubation, and brooding of nestlings. The late nesting season is defined as August 6 through September 15. During the late season, murrelet chicks are left unattended at the nest site until they fledge, except during feedings by the adults, with all chicks fledging by mid-September (Hamer et al. 2003). Both parents feed the chick, which receives one to eight feedings per day (Nelson 1997). Most meals are delivered at dawn, while about a third of the food deliveries occur at dusk and intermittently throughout the day (Nelson and Hamer 1995a).

Nest site predation is suspected to be the principal factor limiting murrelet reproductive success. Losses of eggs and chicks to avian predators have been determined to be the most important cause of nest failure (Nelson and Hamer 1995b; McShane et al. 2004). Nest failure rates of 68 to 100 percent have been reported in some areas (75 FR 3424:3432 [Jan. 21, 2010]). The risk of predation by avian predators appears to be highest in close proximity to forest edges and human activity, where many corvid species (e.g., jays, crows, ravens) are in highest abundance (McShane et al. 2004).

The marbled murrelet recovery plan identifies 6 broad “Marbled Murrelet Conservation Zones” across the listed range of the species to geographically define recovery goals and objectives. In Washington, there are two conservation zones: Puget Sound (Conservation Zone 1) and Western Washington Coast Range (Conservation Zone 2) (USFWS 1997). Conservation Zone 1 includes all the waters of Puget Sound and most waters of the Strait of Juan de Fuca south of the U.S.-

Canadian border and extends inland 55 miles from the Puget Sound, including the north Cascade Mountains and the northern and eastern sections of the Olympic Peninsula. Forest lands in the Puget Trough have been predominately replaced by urban development and the remaining suitable habitat in Conservation Zone 1 is typically a considerable distance from the marine environment, lending special importance to nesting habitat close to Puget Sound (USFWS 1997). The murrelet population in Conservation Zone 1 has been declining over the past decade. The murrelet population in 2009 was estimated at 5,623 birds (95 percent confidence interval: 3,922 – 8,352) (Pearson et al. 2010, p. 4). Mount Rainier Park is located in Conservation Zone 1, and all murrelets nesting in the Park are considered to be part of the Conservation Zone 1 murrelet population.

For a more detailed account of murrelet biology, life history, threats, demography, and conservation needs, refer to Appendix 3 – Status of the Species: Marbled Murrelet.

ENVIRONMENTAL BASELINE: Murrelet

Status of Murrelets in Mount Rainier National Park

The Park has conducted surveys for murrelets in the Park annually since 1994. To date, murrelet presence has been documented within four watersheds: the Carbon, Mowich, Puyallup, and Nisqually River basins (NPS 2009b). Based on the presence of suitable murrelet nesting habitat and multiple detections indicating presence or occupancy behaviors, it is assumed that murrelets are nesting in these areas. However, because of the difficulty of detecting murrelet nests, no active nests have been located within the Park (NPS 2009b).

With the establishment of the Northwest Forest Plan in 1994, the range of the murrelet for management and conservation purposes was established at 55 miles inland from marine waters in Washington (Raphael et al. 2006, p.101). Essentially the entire Park, with the exception of a small area in the southeast corner of the Park, is located within the potential range of the murrelet. The murrelet potential nesting habitat maps produced by Raphael et al. (2006, p.119) indicate there is approximately 26,500 acres of potential murrelet nesting habitat in the Park extending up to an elevation of about 3,800 ft., which constitutes about 11 percent of the Park area.

Status of Murrelets in the Action Area – Carbon River

The upper Carbon River valley contains approximately 5,600 acres of suitable murrelet habitat, including over 3,900 acres of habitat within the Park (70 percent). Murrelet habitat in the Carbon River valley extends up to an elevation of approximately 3,800 ft. Within the Park boundary, murrelet habitat is relatively pristine, with minor habitat loss (< 25 acres) associated with existing Park developments (i.e., roads, trails, and campgrounds). Outside the Park, much of the forested area on private and National Forest lands has been previously harvested, resulting in the fragmentation and loss of much of the suitable murrelet habitat outside the Park boundary. Based on the work by Marzluff and Neatherlin (2006), we expect murrelets nesting in close proximity (within a 1 km radius) to Ipsut Creek campground may have a higher rate of nest predation due to the potential for increased corvid abundance adjacent to campgrounds.

The Park has conducted both audio-visual surveys (1994-2009) and ornithological radar surveys (2000 -2009) in the Carbon River valley (NPS 2009b, ABR 2009). These surveys have documented audio-visual observations of both murrelet presence and occupancy behaviors in the Carbon River corridor from Park entrance up to Ipsut Creek Campground (Figure 3). These survey data indicate the Carbon River valley likely supports the highest density of nesting murrelets in the Park.

Radar-surveys of murrelets can provide an index for the number of murrelets using a particular drainage, and the technique has been widely used in several different study areas (e.g., Rapheal et al. 2002). In the Carbon River, the number of murrelets detected entering the watershed was used as the index for murrelet abundance (ABR 2009). From the 2000 to 2009, the number of murrelets detected entering the upper Carbon River drainage with radar ranged from 2 to 30 birds, with a 10-year average of about 12.5 murrelets detected (ABR 2009). In 2009, the mean landward count of 9.5 murrelets generally fell in the low end of other mean radar counts at the Carbon River site (ABR 2009). The authors note that first ten years of data show a slight negative trend in radar counts of murrelets at the Carbon River site, but that given the high inter-annual variation in counts, it is premature to make definitive statements regarding murrelet trends in the Carbon River drainage until more years of data are collected (ABR 2009).

Conservation Role of the Action Area for Murrelets

The Park provides large, contiguous blocks of murrelet nesting habitat and supports reproductive pairs of murrelets. Because the most of the Park is designated Wilderness, high-quality murrelet nesting habitat within the Park is largely undisturbed by development or human presence. Murrelet nesting habitat within the Park is considered essential for the long-term conservation and recovery of murrelets (USFWS 1997, p.132).

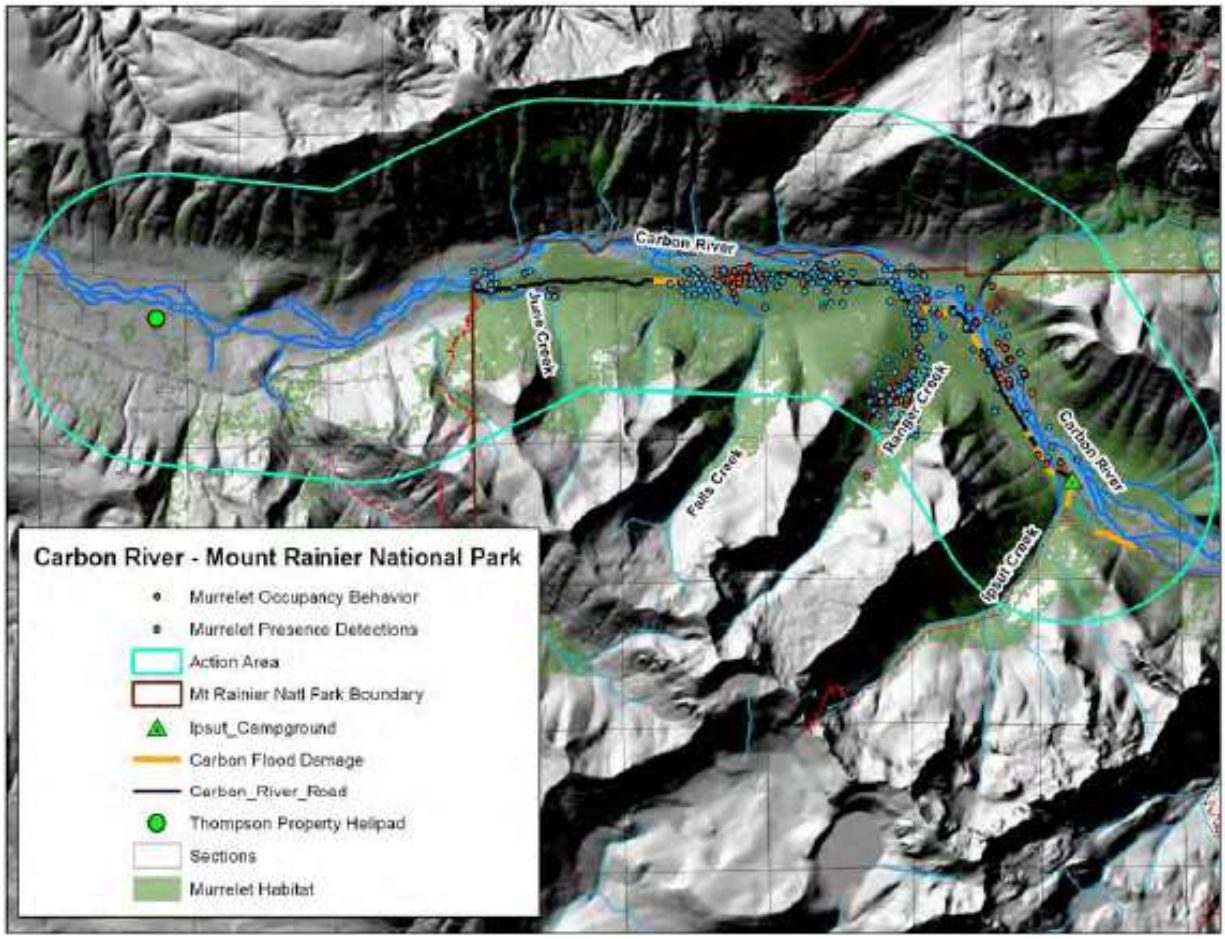

Figure 3. Murrelet nesting habitat and documented murrelet presence and occupancy detections in the upper Carbon River valley.

EFFECTS OF THE PROPOSED ACTION: Murrelet

Direct Effects to Murrelets

<u>Potential Disturbance to Individual Murrelets from Project Noise and Activity</u>

The use of helicopters, excavators, chainsaws, and other motorized equipment will introduce increased levels of sound and human activity into the project area over the course of 4 work seasons. Project work will coincide with the murrelet nesting season (April 1 – Sept. 15), and will continue into the fall months after the nesting season has passed. Noise and activities associated with road and trail construction, as well as construction of bank erosion protection structures have the potential to disturb murrelets nesting in the project area.

There is limited information concerning murrelet vulnerability to disturbance effects. In general, responses to noise disturbance at nest sites have been modifications of posture and on-nest behaviors without flushing or abandoning the nest (Long and Ralph 1998, USFWS 2003, Hebert

and Go lightly 2006). Significant disturbance occurs when noise or project activity causes a murrelet to become so agitated that it flushes away from an active nest site or aborts a feeding attempt during incubation or brooding of nestlings (USFWS 2003, p. 273). Such events are considered significant because they have the potential to result in reduced hatching success, fitness, or survival of juveniles. Specific threshold indicators for disturbance to murrelets include:

(a) *Nesting murrelets that are exposed to project noise that is greater than or equal to 92 dB at an active nest site during the early nesting season (April 1-August 5);or during dawn/dusk hours at any time during the nesting season*. There is no direct research on murrelets that indicates that very loud sounds will cause a murrelet to flush from a nest. The 92 dB threshold is derived from research on other bird species. Awbrey and Bowles (1990, p. 21) suggest that noise begins to disturb (i.e., cause an alert response, but not flight) most raptors at around 80-85 dB, and that the threshold for flight response is around 95 dB. Mexican spotted owls exposed to helicopter noise did not flush from their roosts until the noise from helicopters exceeded 92 dB, and the helicopters were within a distance of 105 m (Delaney et al. 1999 pp. 66-68). Brown (1990) subjected crested terns (*Sterna bargain*) to simulated aircraft noise and noted that at 95 dB, approximately 15 percent of birds were startled and about 8 percent of terns flushed. Based on these data, the FWS concluded that murrelets exposed to sound levels 92 dB or greater could flush from a nest (USFWS 2003, p. 275).

(b) *Nesting murrelets that are exposed to prolonged, ground-based activities with motorized equipment within a distance of 35 yards (32 m) from an occupied nest tree during the early nesting season; or during dawn/dusk hours at any time during the nesting season*. *Prolonged exposure is defined as more than 2 days.* This threshold is based primarily on information provided in Long and Ralph (1998), Hamer and Nelson (1998), USFWS (2003), and Hebert and Go lightly (2006).

Hebert and Go lightly (2006) monitored nesting murrelets exposed to chainsaw noise and the presence of people hiking on trails in Redwood National and State Parks in northern California. Chainsaw disturbance tests were conducted for 15 minute intervals at a distance of 25 m (82 ft.) from the base of occupied nest trees (n = 12). Murrelet nests were located in the upper forest canopy, with an average nest height of 51 m (167 ft.) above ground, and average nest tree height of 61 m (200 ft.) (p. 19).

Adult and chick responses to chainsaw noise, vehicle traffic, and people walking on forest trails resulted in no flushing and no significant increase in corvid presence (pp. 35-39). However, adults exposed to chainsaw noise spent more time with their head raised, and their bill raised up in a posture of alert, vigilant behavior. When undisturbed, adult murrelets spent 95 percent of the time resting or motionless. Many adult murrelets exposed to an operating chainsaw ultimately experienced complete nest failure, but the authors caution that the relationship, if any, between the disturbance trials during the incubation period, and fledging success was unclear. Overall reproductive success was similar for control (13 percent) and experimental nests (30 percent) (p. 37).

Murrelet chicks exposed to chainsaw noise also spent more time with their head raised, and their bill up during the disturbance trials, although compared to pre- and post-disturbance trials, the relationship was not statistically significant (p. 36). All three chicks exposed to chainsaw disturbance fledged (p. 29). Hebert and Golightly (p. 36) conclude that chainsaw noise disturbance lasting 10 to 15 minutes, at a distance greater than 25 m from the nest does not appear to induce long-term behavioral changes. None of the murrelets in this study were exposed to sound levels that approached 92 dB, so the results of this study do not confirm or refute the 92 dB threshold currently used by the FWS.

The relevance of the behavioral responses seen in adults tending nests is unknown, but the behavior is similar to an adult murrelet reaction to the presence of a nest predator (p. 35). Hebert and Golightly (2006) suggest that prolonged noise disturbance at nest sites could produce short term behaviors that have unknown consequences. It is reasonable to assume that a murrelet responding to a noise by moving or shifting position would increase the chance that it will be detected by a predator. Additionally, the energetic cost of increased vigilance to protracted disturbance could have negative consequences for nesting success (p. 37). Adult murrelets typically feed their chicks in the early morning, and occasionally in the evening. Operating chainsaws while an adult approaches a nest to feed a chick may cause sufficient disturbance to result in abortion or delay of the feeding. The abortion of a single feeding trip could deprive the chick of 25-50 percent of its daily energy and water intake, which could have a significant negative impact on fledging success (p. 38). In summary, Hebert and Golightly (2006, p. 40) recommend avoiding extended disturbance to incubating adults and avoiding disturbance to chicks at the time food deliveries are most likely to occur: which is early morning and late evening, although murrelets do occasionally deliver food during mid-day hours (Nelson 1997, p. 18).

The USFWS (2003) review of murrelet responses to disturbance concluded that the use of heavy equipment within 35 yards of a nest tree could cause a murrelet to flush (p. 277). This distance was derived from a reported instance of 2 murrelets flushing from a tree in response to people slamming car doors and talking loudly within a distance of 30 m of the tree (p. 277). Hamer and Nelson (1998, p. 9) noted that adult murrelets would abort feeding attempts or flush off the nest branch during attempted food deliveries when people on the ground were visible to the birds and within a distance of 15 to 40 m, or occasionally when vehicles passed directly under a nest tree.

Murrelet chicks appear to be much more difficult to disturb than adults, and there are no documented instances of a nestling murrelet falling due to sound or visual disturbance, including disturbances due to researchers climbing nest trees, handling young, and placing cameras close to young (USFWS 2003, p. 269). Based on this review, the FWS concluded that significant disturbance with a potential for injury for murrelets would only occur as a result of an adult murrelet flushing from the nest during incubation or brooding, or adults aborting a feeding of the chick (USFWS 2003, p. 274).

Overall, it appears that murrelets are not easily disrupted from nesting attempts by human disturbance except when confronted at or very near the nest itself. The study completed by Hebert and Golightly (2006) is the first experimental study that has monitored murrelet responses to disturbance events in a controlled manor. In this study, adult murrelets exposed to people operating chainsaws or groups of hikers passing nearby on Park trails did not flush from the nest. Murrelets have evolved several mechanisms to avoid predation; they have cryptic coloration, are silent around the nest, minimize movement at the nest, and limit incubation exchanges and chick feeding to occur during twilight hours (Nelson 1997). Hebert and Golightly (2006) suggest that flushing as a result of a disturbance or activity on the ground might not provide a benefit compared to the potential risk of exposure to predators. When confronted with the presence of potential predators, murrelets remain on the nest in alert or defensive postures (Hamer and Nelson 1998, Hebert and Golightly 2006) and do not flush unless confronted directly by a large predator such as a raven (Singer et al. 1991).

Based on the best available information concerning murrelet responses to disturbance associated with noise, activity, and human presence, we conclude the following:

1. Adult murrelets are most likely to exhibit a flush response while attempting to deliver food to the chick at dawn or dusk. Therefore, disturbance activities that occur in close proximity to occupied nests during dawn or dusk periods can cause adult murrelets to flush and abort a feeding attempt. *For the purpose of this analysis, we define close proximity as 35 yards for ground-based activities with motorized equipment, or the 92 dB sound contour for helicopters and blasting.*

2. Adult murrelets that are incubating an egg are not likely to flush from disturbance, *unless the birds are exposed to sounds 92 dB or greater*. Short-term ground-based disturbance events (such as operating a chainsaw for 15 minutes or less during mid-day periods) do not appear to cause any significant effect to murrelet adults or chicks.

3. The normal behavior of incubating adults is to rest and remain motionless during the day. Prolonged disturbance disrupts this normal behavior by causing the adults to remain vigilant and alert during a time when they are normally resting. *For the purpose of this analysis, prolonged exposure is defined as more than 2 days of activity in the same location during the early nesting season.* Adult murrelets exchange incubation duties approximately once every 24 hours at dawn (Nelson 1997). We assume that each adult can tolerate noise disturbance for a 1-day cycle without consequence to individual fitness or increased predation risk to the egg.

4. Murrelet chicks appear to be mostly unaffected by visual or noise disturbance. The greatest risk to murrelet chicks from disturbance is the potential for missed feedings, which occur primarily during dawn and dusk periods, but do occasionally occur during mid-day hours.

Exposure of Individual Murrelets to Project Noise Disturbance

The actual number of murrelets that will be exposed to disturbance effects and direct injury is difficult to establish. There are no reliable data from which to derive an average murrelet density estimate at the scale of a patch of occupied nesting habitat in the Carbon River valley. However, radar has been used to survey for murrelets at the watershed scale (McShane et al., 2004, pp. 4-60). Radar surveys conducted between 2000 and 2009 detected an average of 12.5 murrelets entering the Carbon River valley (annual mean range = 3 to 22 landward murrelets detected) (ABR, Inc., 2009).

Research in California demonstrated that radar surveys tended to overestimate the total number of breeding birds, because non-breeding murrelets can represent as much as 30 percent of the birds detected flying inland by radar (Peery et al., 2004, p. 352). Consequently, the authors suggest that inferences from radar counts of murrelets should be limited to indices of the size of the *potential* breeding population in a given year, and not to total breeding or regional population size. We believe radar survey data should not be used to make inferences about murrelet densities within selected habitat patches at a scale smaller than the watershed. Therefore, we elected to use acres of habitat affected by the action as a surrogate for the number of breeding murrelets likely to be exposed to the effects of the action.

We used GIS to evaluate the potential area of exposure of murrelets to project noise. Based on the estimated sound attenuation contours and the disturbance thresholds described above, we calculated potential disturbance zones within the project area (Figure 4).

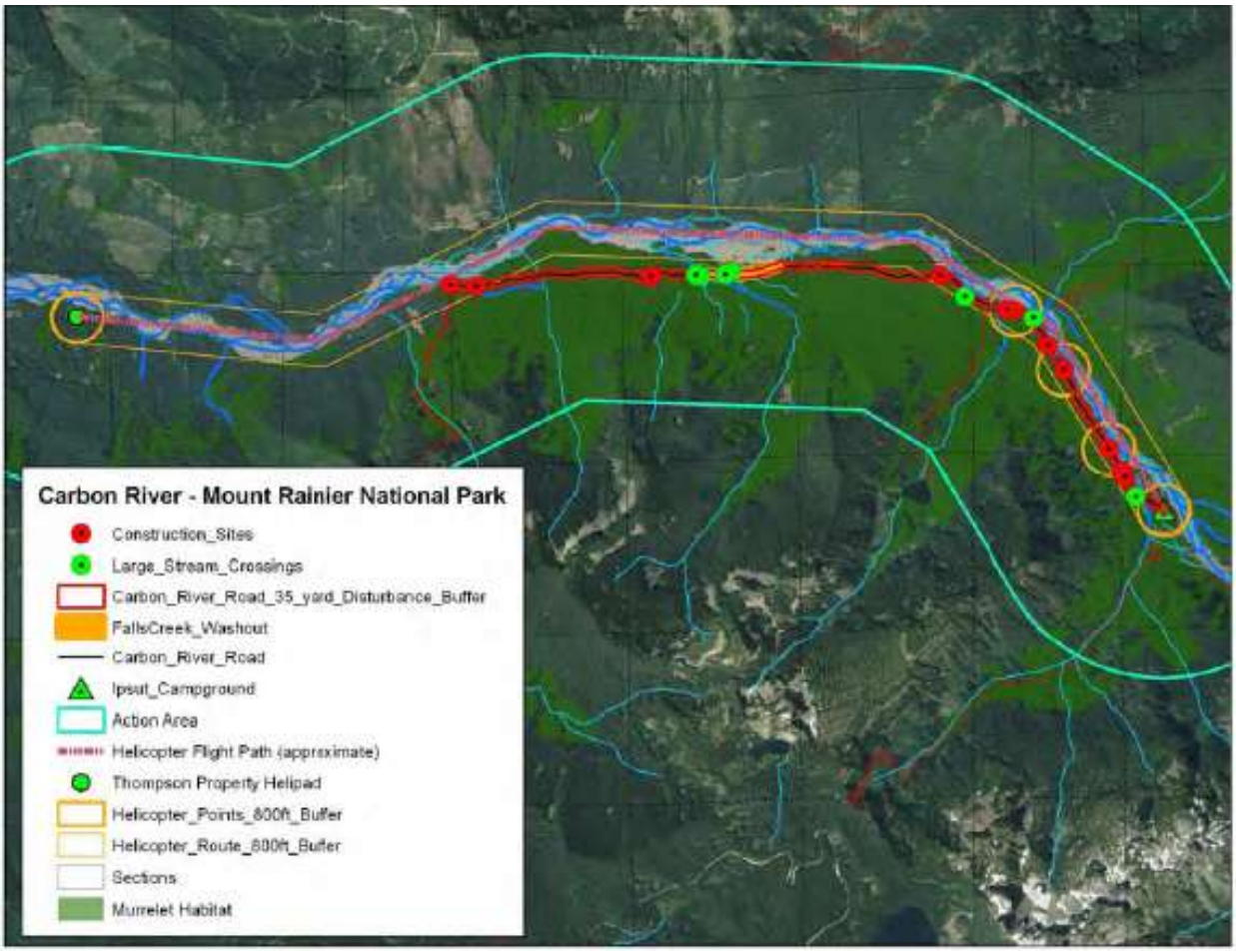

Figure 4. Overlap of project noise contours with murrelet nesting habitat in the project area. Large stream crossings, construction sites, and helicopter points are locations that will be subject to prolonged disturbance.

Disturbance to nesting murrelets from the use of motorized equipment along the Carbon River Road/Trail and bank protection structure construction sites.

Based on the disturbance thresholds described above, we mapped a 35-yard "disturbance zone" along either side of the Carbon River Road/Trail to represent the area where murrelets would most likely be disturbed due to their proximity to motorized equipment regardless of dB levels. The 35-yard disturbance zone exceeds the estimated 92 dB sound contour for all project equipment except helicopters and blasting (refer to Table 5, for a summary of equipment sound levels). For each mile of the road, there are approximately 25 acres located within the 35-yard disturbance zone. The total area associated with the disturbance zone along the Carbon River Road/Trail is approximately 128 acres, but only about 110 acres are actually forested and provide suitable murrelet nesting habitat.

Based on the documented history of murrelet occupancy behaviors in the upper Carbon River watershed, we assume that all suitable murrelet nesting habitat in the project area is occupied habitat. All murrelets associated with 110 acres of nesting habitat adjacent to the Carbon River

Road/Trail corridor will be subjected to noise and activity of varying intensity on a daily basis over the next 4 years from April 1 through September 15.

The Park has incorporated a daily activity schedule for the Carbon River project. Project work will only occur 2 hours after official sunrise, and will cease 2 hours prior to official sunset during the murrelet nesting season (April 1 to September 15). This restriction reduces the potential to disrupt murrelets during their daily peak activity periods for feeding and incubation exchanges, but it does not ensure that all murrelets will be protected from disturbance under all circumstances. Unrestricted activities that occur during the mid-day hours will likely result in the disruption of adult nesting behaviors, or result in aborted feedings or postponed feedings of hatchlings.

Adult murrelets typically incubate for a 24-hour period, then exchange duties with their mate at dawn. Hatchlings appear to be brooded by an adult for 1-2 days and are then left alone at the nest for the remainder of the rearing period, except during feedings. Both parents feed the chick, which receives 1-8 meals per day (Nelson 1997). Most meals are delivered early in the morning, while about a third are delivered at dusk and a few meals are sometimes scattered throughout the day (Nelson and Hamer 1995a, p. 62). Based on the data presented by Nelson and Hamer (1995a), over 90 percent of the feedings occur during the dawn/dusk daily peak activity periods.

Approximately 6 percent of feedings occur during mid-day hours from 9:00 am to 6:00 pm (Nelson and Hamer 1995a, p. 62), when activities are not restricted, so there is a potential for construction activities to result in some aborted feeding attempts during mid-day hours. We expect that the risk for disrupting a mid-day feeding is most likely to occur in locations where there is prolonged work (multiple days) at a site, because the duration of the activity is long enough that the likelihood for disrupting a mid-day feeding is not discountable. Based on our review of the murrelet disturbance literature, we conclude that Park trail crews and contractors that are travelling to and from work sites in vehicles, on ATVs, or on foot along the Carbon River corridor during mid-day hours are not likely to cause a murrelet to flush off a nest, or cause an adult murrelet to abort a food delivery to a chick, because the duration of these activities is brief and the likelihood of disrupting a mid-day feeding is considered to be discountable.

Due to timing constraints required for in-water work, most work at bank protection sites and major stream crossings will occur during the early murrelet nesting season. Based on our review of the murrelet disturbance literature, we expect that murrelets nesting in close proximity to these major construction sites will be exposed to prolonged disturbance that will result in a significant disruption of nesting behaviors, with implications for reduced individual fitness, reduced hatching success, and increased risk of nest predation for any murrelets nesting in close proximity to the construction sites. Project disturbance from these activities is anticipated to create a likelihood of injury by increasing the probability (risk) of nest predation. We do not expect disturbance effects will always result in nest failure. It is possible that some nesting murrelets exposed to disturbance will nest successfully. However, under a reasonable worst-case scenario, project disturbance would indirectly result in a failed nest. The acres of nesting habitat exposed to prolonged disturbance vary based on the project footprint and duration. The most intensive disturbance areas will be associated with construction of bank protection structures,

and construction of trail through the Falls Creek washout area. Due to the prolonged exposure to construction activities during the early nesting season, we expect all murrelets associated with 110 acres of nesting habitat adjacent to the Carbon River Road have an increased likelihood of nest failure as a result of project disturbance for a period of 3 to 4 years.

Noise and Visual Disturbances from Helicopter Operations

The Thompson Property will be used as a base for helicopter operations. There is no suitable murrelet nesting habitat indicated at this property, so we do not anticipate disturbance to murrelets associated with this site. The Ipsut Creek Campground and road washouts at MP 3.43, MP 3.93 and MP 4.47 are identified as helicopter drops sites for equipment and materials. Helicopter work at the Ipsut Campground will be scheduled to occur after the murrelet nesting season, so there would be no effect to murrelets from helicopter use at this site. Helicopter use at the road washouts will occur in July, during the early murrelet nesting season. The duration of helicopter use over the 4 years of project implementation is relatively brief, and is estimated as multiple flights at each site for a period of 1 to 2 days, for an estimated total of 3 to 6 days of helicopter use.

For this assessment, we assumed the Park will contract a Chinook 47D, which is a double-rotor helicopter with a 20,000 lb. lift capacity, and likely represents a reasonable worst-case scenario for assessing risks to murrelets. When delivering logs to a project site, helicopters will generally hover no closer than 250 ft. above ground level, due to the use of a 250 ft. long cable with grapple tongs to transport the logs. Transport flights between pick up and drop sites will generally be at 800 to 1,000 ft. above ground level for safety purposes (D. Horrax, Columbia Helicopters, pers. comm. 2010). The Chinook 47D is a very loud helicopter with an estimated 92 dB sound contour at approximately 800 ft. (Table 6). To estimate the area exposed to this level of helicopter noise, we plotted a general helicopter flight path over the Carbon River between the Thompson Property and Ipsut Creek Campground. We used GIS to map 800 ft. disturbance zones to indicate areas that would be exposed to helicopter noise levels of 92 dB or greater (Figures 4, 5). Within the general helicopter flight path there are approximately 400 acres of murrelet nesting habitat within the disturbance zone, and about 23 to 27 acres of murrelet nesting habitat are associated with each of the 3 helicopter drop sites located at the road washouts for a total of about 76 acres (Table 8).

Based on the 92 dB disturbance threshold described above, we expect any nesting murrelets located within an 800 ft.-radius of the helicopter flight path and drop sites would potentially flush off a nest in response to intense helicopter noise or the visual disturbance associated with a close over-canopy approach. As described above, a flush response during the early nesting season is considered to be a significant disruption of normal nesting behavior that creates a likelihood of injury with implications for reduced nesting success. Based on the documented history of murrelet occupancy behaviors in the upper Carbon River watershed, we assume that all suitable murrelet nesting habitat in the project area is occupied habitat. All murrelets associated with approximately 400 acres of nesting habitat adjacent to the Carbon River Road/Trail corridor will be subjected to helicopter noise disturbance for a period of 3 to 6 days during one nesting season (possibly 2012).

Potential for Injury or Mortality from Helicopter Rotor wash

Rotor wash is a column of high velocity air forced downward by a helicopters blade rotation. As rotor wash nears the surface, it spreads laterally as side-wash along the ground (Slijepcevic and Fogarty 1998, p. 1). Helicopter rotor wash can cause saplings, decaying trees, and loose debris from tree tops to fall, and can create hazardous conditions from dust and flying debris underneath the ship (WCB 2005, p. 19). The intensity of rotor wash is influenced by helicopter flight (height above ground and forward speed), helicopter mass, and rotor span (Slijepcevic and Fogarty 1998, p. 2). For example, a Bell 205A helicopter that is hovering at 50 ft. above ground level generates rotor wash wind speeds of approximately 60 mph at the surface. The same ship hovering at a 100 ft. above the ground would generate a rotor wash of approximately 35 mph at ground level (Slijepcevic and Fogarty 1998, p. 11).

Large helicopters, such as the Chinook-47D, can generate rotor wash in excess of 120 mph directly under the ship (www.globalsecurity.org, 2010). Based on discussions with a helicopter contractor that uses the Chinook 47D, we assume that helicopters will generally hover no closer than 250 ft. above ground level when delivering logs to project sites, due to the standard use of a 250 ft. long cable with grapple tongs to transport logs for river projects (D. Horrax, Columbia Helicopters, pers. comm. 2010). Because the intensity of rotor wash varies significantly based on mass, speed, and the height of a ship above ground level, we are not able to predict the severity of rotor wash generated from a Chinook 47D that is hovering at a height of 250 ft. Helicopter logging safety guidelines developed in British Columbia recommend a 300 ft. radius safety zone for timber fallers working underneath ships that are flying below 500 ft. above ground level (WCB 2005, p. 2). This safety zone is recommended to avoid exposing timber fallers to overhead hazards created by rotor-wash, and we believe it represents a reasonable worst-case approach to analyzing risk.

Therefore, to estimate the area exposed to hazardous rotor wash conditions, we plotted a 300 ft. radius circle around each drop site (6.49 acres per site) and then estimated the amount of murrelet habitat within each circle (Table 8, Figure 5). Because the helicopter drops sites are located along the bank of the Carbon River, only about half of the potential rotor wash area will actually affect murrelet nesting habitat. Based on these assumptions, we estimated there is about 10 acres of murrelet nesting habitat distributed across three sites that will be exposed to hazardous rotor wash conditions during the early nesting season. The forest along the Carbon River in the vicinity of the bank protection sites has an estimated dominant tree height of 150 – 200 ft. Therefore, if a ship is hovering at 250 ft. above ground level, the adjacent forest canopy could be exposed to rotor wash sufficient to break branches and physically damage trees. Because the intensity of rotor wash reduces significantly with increasing forward speed (Slijepcevic and Fogarty 1998, p. 2), we do not anticipate hazardous rotor wash conditions while the ship is in transit between pick up and drop sites.

Table 8. Summary of helicopter rotor wash and noise exposure associated with bank protections sites between Chenuis Falls Trailhead and Ipsut Creek.

Carbon Road/Trail MP	Murrelet nesting habitat within a 300 ft. radius (rotor wash zone) of helicopter drop points.	Murrelet nesting habitat within an 800 ft. radius (92 dB sound contour) of helicopter drop points.
MP 3.464	4 acres	23 acres
MP 3.939	3 acres	26 acres
MP. 4.470	3 acres	27 acres
Total disturbance acres	10 acres	76 acres

Notes: All habitat acres are approximate values derived from GIS data. A circle with a radius of 300 ft. = 6.49 acres. A circle with a radius of 800 ft. = 46.1 acres.

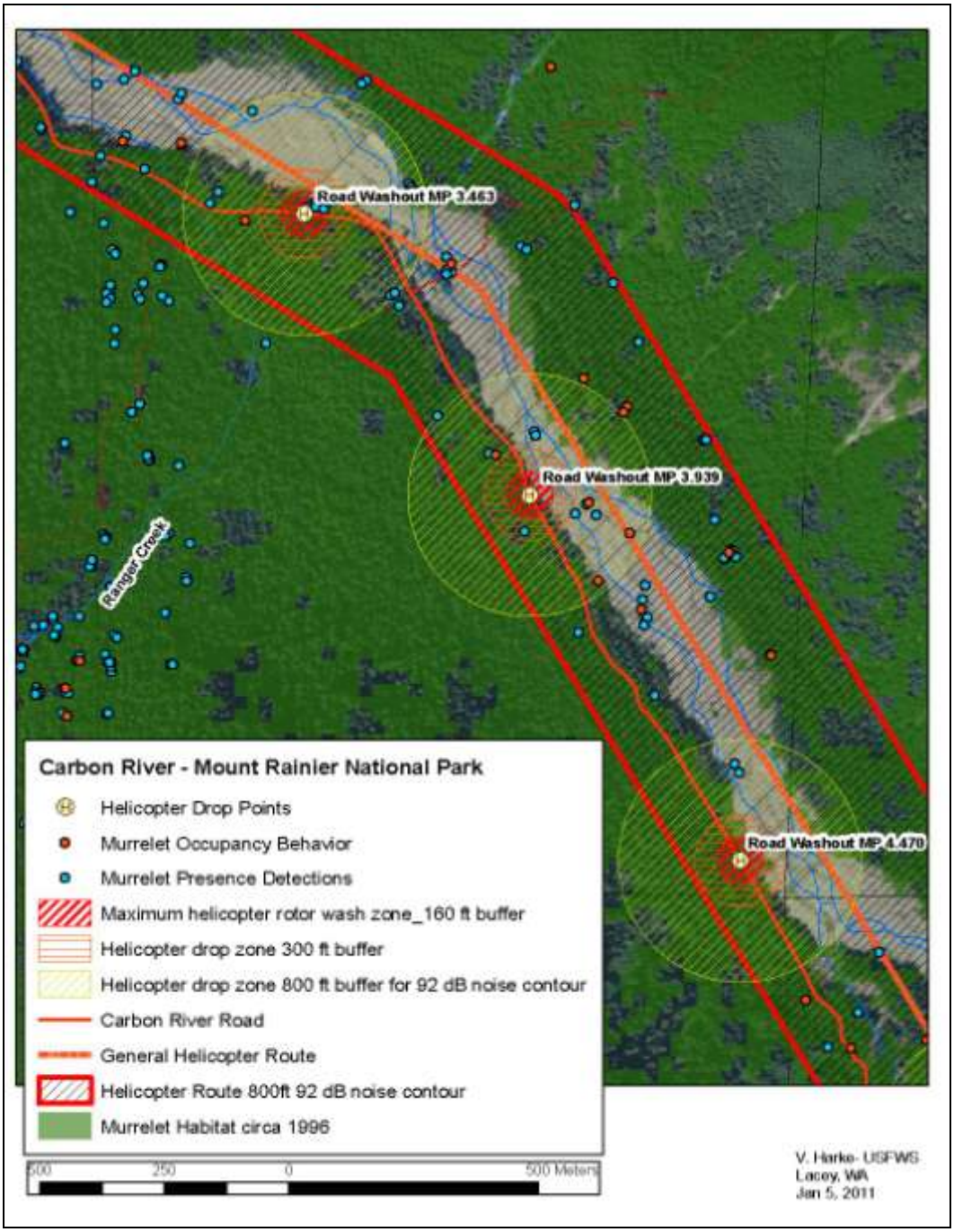

Figure 5. Detail of estimated helicopter rotor wash and noise disturbance areas associated with proposed bank protection structures along the Carbon River.

Published literature regarding helicopter impacts on wildlife focus on noise and visual stimuli, rather than potential injuries caused by rotor wash; however, we cannot discount that effects from rotor wash may occur. The close approach of the helicopter to a drop site creates multiple stressors for murrelets that must be considered, including noise and/or visual disturbance and severe rotor wash, both causing incubating adult murrelets to flush. In a worst-case scenario, rotor wash could also cause an egg or chick to fall off a nest branch or prematurely fledge, or cause direct injury to an egg or chick from flying debris or falling branches.

Based on the above analysis, we conclude that exposure to rotor wash could cause direct injury or mortality of murrelet eggs, chicks, or fledglings throughout the breeding period (April 1 – September 15). Given the small amount of nesting habitat affected by rotor wash, the probability of a direct injury to a murrelet chick is very low, but is not entirely discountable. Therefore, we conclude there is a likelihood of direct mortality of a murrelet egg or chick from exposure to hazardous rotor wash conditions for a period of 3 to 6 days during one nesting season (possibly 2012).

Blasting for Trail Realignments

The Park has identified several locations along the Carbon River Road/Trail that may require blasting to remove stumps for trail alignments. The noise associated with blasting is highly variable and depends on size of the charge and the material being blasted. The FWS identified blasts of 2 lbs. or less to have a disturbance radius of 120 yards (USFWS 2003, p.282). For this project, we assume the Park will use charges of 2 lbs. or less. All blasting activities will be scheduled to occur after August 6. Based on the seasonal timing, blasting could directly affect a murrelet chick on a nest during a mid-day blast, but would not result in flushing an adult off a nest.

Based on sound measurements recorded by Park staff, the noise from a previous trail blasting project that used 2 lb. charges to blast bedrock was reported as approximately 88 dB (unknown metric) at 500 ft. (NPS 2008, Wonderland Trail BA). Using a standard noise attenuation of -7.5 dB for each doubling of distance, the sound levels in this example would have been approximately 145-150 dB at the source. For the Carbon River trail project, small charges will be buried either underground or within the logs or stumps that are in the trail alignment, and will likely produce sound levels that are lower than blasting bedrock because wood and duff layers will absorb more sound energy than rock.

We do not expect murrelets chicks would be killed by in-air sound pressure or flying debris from trail blasting, but individuals could sustain injury in the form of temporary hearing loss. Dooling and Popper (2007, p. 7) reported that birds exposed to a single impulse of noise at 140 dB or greater are likely to suffer hearing damage. A blast with a sound of 150 dB would attenuate to less than 130 dB within 25 ft. Murrelet nests are generally located high in the forest canopy at a height of 65 to 105 ft. above ground level (McShane et al. 2004, p. 4-52). We therefore assume it is extremely unlikely that a murrelet nest would be located in close enough proximity to a blasting event for a chick to sustain hearing damage, and the potential for injury from limited blasting for trail construction to murrelets is discountable.

Disturbance Associated with Annual Opening of the Carbon River Corridor in the spring

Due to the uncertain nature of trail repair work that may be needed to allow visitor and Park staff access to the project area, we expect that significant, short-term disturbance events associated with opening the Carbon River Road/Trail in the spring could occur at any location within the corridor over the 4 years of project implementation. Any site that requires onsite work for a period of more than 2 days (such as rebuilding a trail bridge) during the early nesting season is likely to disrupt any murrelets nesting within a 35-yard radius from the work site. It is highly likely that flood damage will continue to occur along the Carbon River corridor, which will require continued trail and road reconstruction efforts. Any future road or trail reconstruction projects are considered future Federal actions that will be subject to consultation under section 7 of the Act and are not considered to be part of this proposed action.

Recreational Use in the Carbon River Corridor

The Carbon River corridor currently receives over 30,000 visitors per year. Visitor use may increase over time as access in the corridor is improved. Visitor uses include hiking, camping, and picnicking along trails and at the Ipsut Creek campground, and the new proposed campground on the Wonderland Trail. Most visitors stay on or close to Park trails, so the potential for murrelet behavior to be significantly disrupted by visitors is limited to those rare instances when a murrelet may be nesting in a tree directly adjacent to a road, trail, parking area, or campground.

There have been reported instances of murrelets flushing off a nest branch while attempting to deliver food to a chick in response to the presence of people on the ground within a distance of 15 – 40 m (Hamer and Nelson 1998, p. 9), but these situations are considered to be extremely uncommon (USFWS 2003, p. 277). Hebert and Golightly (2006, p.31) in their study of park trails did not record any instances of murrelet flush responses or detect any significant relationship between murrelet nesting success and proximity to park trails and roads. The authors (p. 39) conclude that mitigation in the form of reducing access to trails in parks appears to be unwarranted, but they caution that the established link between recreational use of campgrounds and increased corvid densities has implications for reduced murrelet nesting success by increased risk of nest predation.

Based on our review of the murrelet disturbance literature, we conclude that Park visitors that are hiking or biking along the trail are not likely to cause a murrelet to flush off a nest, or cause an adult murrelet to abort a food delivery to a chick, because the duration of visitor presence in any one location is generally brief, and the likelihood of disrupting a feeding is considered to be discountable, except in campgrounds. Because visitors are generally present at Park campgrounds throughout the nesting season, murrelets nesting at campgrounds are likely to be exposed to human disturbance that creates a likelihood of injury through increased vigilance behaviors of adults, increased predation risk, or aborted feedings of juveniles. As described below, we expect there will be about 6 acres of murrelet habitat associated with the new proposed backcountry campground along the Wonderland Trail that will be exposed to these effects for as long as the Park allows camping to occur at the site.

Indirect Effects to Murrelets

Increased Risk of Predation adjacent to Campgrounds and Roads

The relationship between human activities and predators, and their potential impact on murrelet nesting success, has been identified as a significant threat to murrelets (75 FR 3424:3432 [Jan. 21, 2010], Peery and Henry 2010, p. 2414). Research in the Pacific Northwest has identified up to 15 mammalian and avian species that potentially prey on murrelet nests (Marzluff and Neatherlin 2006, p. 308). The risk of predation on murrelet nests by avian predators (especially corvids) appears to be highest in close proximity to forest edges (including roads), campgrounds, and settlements (Raphael et al. 2002, Marzluff and Neatherlin 2006).

Research at campgrounds on the Olympic Peninsula demonstrated that American crows *(Corvus brachyrynchos)* and common ravens (*Corvus corax*) nesting within 1 km of human settlements or campgrounds increased in abundance, produced more young, and lived longer than birds nesting > 5 km from campgrounds (Marzluff and Neatherlin 2006, p. 301). Crows and ravens that foraged in campgrounds occupied smaller home ranges and tolerated a higher level of overlap with neighboring conspecifics, leading to an increased density of nesting corvids in the surrounding landscape (Marzluff and Neatherlin 2006, p. 301). This relationship was strongest with crows. Raven populations showed only slight increases in density due to proximity to campgrounds, and Steller's jays did not increase in abundance (Marzluff and Neatherlin 2006, p. 311). Steller's jays and gray jays (*Perisoreus canadensis*) are highly territorial and apparently do not tolerate encroachment by conspecifics (Marzluff and Neatherlin 2006, Strickland and Ouellet 1993).

Studies with simulated murrelet nests have documented that nest predation rates are highest within 50 m of forest edges (Raphael et al. 2002, p. 221). Nests located within 50 m of the forest edge tended to be preyed upon faster and to a greater extent than nests located further into a stand's interior. This edge effect was consistent near human activity where the edge of the forested stand abutted a campground or small settlement (Raphael et al. 2002, p. 230). Corvids accounted for 32.5 percent of nest predation events, and jays were responsible for most of the observed corvid depredation (Marzluff and Neatherlin, 2006, p. 310).

The authors suggest that the community of small corvids (jays) and mammalian predators (squirrels and mice) set a natural baseline for nest predation risk in forested habitats. Increases in overall predation risk can occur as result of increased corvid population density (as in the campground study), or through the creation of unnatural edges. Based on these studies and others (McShane et al. 2004, pp.4-89 to 4-91), we expect that murrelet nesting habitat located within 50 m of the Carbon River Road and the Ipsut Creek Campground likely have a higher risk of nest predation than interior forest habitats in the area. This equates to approximately 170 acres of murrelet nesting habitat adjacent to the Carbon River Road between the Park Entrance and the Ipsut Creek campground.

Based on the work by Marzluff and Neatherlin (2006), we would also expect that murrelets nesting within a 1 km radius of campgrounds may have a higher risk of nest predation due to increased large corvid abundance, especially in landscapes that support nesting American crows.

However, crows are rare at Mt. Rainier National Park. A recent bird survey in the Park that included 969 point counts and detected over 6,000 individual birds and 95 species, documented only one observation of a crow (Wilkerson et al. 2005). Therefore, the strong correlation for increased crow density near campgrounds is not applicable in the Park. The survey did document ravens, Steller's jays, and gray jays in most habitats within the Park, with gray jays being the most abundant corvid species present in forested habitats (Wilkerson et al. 2005).

Under the proposed action, the existing Ipsut Creek campground will continue to be managed as a hike-in/bike-in campground (with 15 individual sites and 3 group sites) until such time as flood damage in the area results in a total closure of the campground. The Park has also proposed to develop a new backcountry campground (with 4 individual sites and 1 group site) located approximately 0.5 miles south of the existing Ipsut Creek campground along the Wonderland Trail. The old-growth forest at both the existing Ipsut Creek campground and the new proposed campground site is suitable murrelet nesting habitat. For this analysis, we assume the proposed new campground will occupy about 1 acre. In the near-term, the new hike-in Wilderness campground will serve as an alternative campsite for people hiking the Wonderland Trail. In the long-term, the Ipsut Creek campground will be closed, and the proposed new campground would provide the only campsite for Park visitors in this area.

Under current management, there are approximately 170 acres of murrelet nesting habitat located within 50 m of the Carbon River Road that are likely exposed to increased predation risk due to the long history of recreational use in the corridor. Short of closing the Carbon River area to public access, there is relatively little that can be done to prevent these effects, other than to manage garbage to reduce wildlife access to human garbage. Under the Carbon River Access Management Plan, the effects associated with increased predation risk in the Carbon River corridor will continue to occur, and would be increased with the addition of the backcountry campground on the Wonderland Trail. To estimate this effect, we assumed the new campground would occupy about 1 acre, plus a 50 m buffer (based on Raphael et al. 2002, p. 230), which equals about 6 acres of forest. The total acres exposed to increased predation risk would increase from approximately 170 acres to 176 acres, which represents about 3 percent of the total available nesting habitat in the upper Carbon River valley (approx. 5,600 acres). Over the long-term, there would be a net decrease in these acres after the Ipsut campground in closed.

At the new proposed campground, increased predation risk could occur as a result of Steller's jays and gray jays foraging at the campground. However, this effect is not definite, because the rate of predation on simulated murrelet nests on the Olympic Peninsula did not correlate with the variation in small corvid abundance regardless of proximity to human settlements or campgrounds (Marzluff and Neatherlin 2006, p. 310). The abundance of jays would not be expected to increase as a result of the campground, but jays that are nesting in the area may spend more time foraging in the vicinity of the campground than they would otherwise, resulting in a potential increase in predation risk for all birds (including murrelets) nesting in the immediate vicinity. Research in Washington has demonstrated that nest predation risk can increase in close proximity to campgrounds, even in isolated settings due to the presence of refuse, food scraps, and the deliberate feeding of wildlife by recreationists. Marzluff and Neatherlin (2006, p. 311) state that the quality of nesting habitat adjacent to campgrounds may be compromised because of the increased risk of corvid predation.

We conclude that the proposed backcountry campground will result in long-term exposure of approximately 6 acres of murrelet nesting habitat to increased risk of nest site predation and disturbance to nesting murrelets associated with prolonged human presence throughout the nesting season. However, because American crows are rare in the Park, we do not expect increased American crow densities to occur as a result of the proposed campground. In the long-term, the total area associated with predation risk will decrease following the closure of the Ipsut Creek campground.

Loss of Potential Nesting Habitat

Trail realignments along the Carbon River Road/Trail corridor may indirectly affect murrelets by removing key habitat elements such as large trees with potential nest platforms, or trees that provide canopy cover for potential nest platforms. Trail construction activities would result in removal of approximately 28 trees dispersed across three different trail sections (Table 2). The total area of vegetation loss associated with trail realignments is estimated at less than 0.5 acre dispersed across three sites. Felling of six trees greater than 16 inches in diameter will only occur outside the murrelet nesting season, so there is no chance that an occupied nest tree would be felled, or that a tree providing canopy cover for an adjacent occupied nest site would be felled.

We do not know if any of the trees identified for felling contain potential murrelet nest platforms, but considering the limited number of trees to be removed and the sizes classes (16 inches to 24 inches diameter)(Table 2), the probability that one of these trees is a murrelet nest tree is extremely low. Murrelets in some areas are known to reuse to the same nest trees from year to year, but this appears to be most common in landscapes that have limited nesting habitat, and less common in landscapes with large tracts of available nesting habitat (Burger et al. 2009, p. 217). Because there are large stands of suitable nesting habitat within the upper Carbon River basin, we expect that the loss of a few individual trees during the non-breeding season would not result in a significant disruption of murrelet breeding behavior in subsequent years.

The Park has not identified any habitat loss associated with the proposed backcountry campground on the Wonderland Trail. The expectation for this area is that there will be some minor small tree or understory brush removal to clear individual campsites, but no over-story trees will be removed. We assume any brush clearing will occur during the late nesting season, or after the nesting season, so the effects to murrelets from understory vegetation removal would be insignificant

Effects of Interrelated or Interdependent Actions

One interrelated action associated with the Carbon River Access Management project will be the future need to remove hazard trees in the vicinity of campgrounds, trailheads, and visitor parking areas. The Park completed a Hazard Tree Management Plan in 2006. In accordance with the Management Plan, hazard trees may only be felled during the period of October 1 through March 14. This seasonal restriction avoids hazard tree removal during the nesting season for murrelets. Therefore, potential disturbance or injury to murrelets from hazard tree removal is not

anticipated, and the effects of hazard tree removal have been analyzed and authorized through previous consultation with the FWS (USFWS 2006).

Once the Carbon River Access Management project has been completed, there will be a need to continue active management of the road and trail system. Trail maintenance includes activities such as clearing logs and debris from the trail, maintaining drainage features, and repairing trail surfaces. These activities can occur throughout the year, but generally occur during the summer and fall months. As described above, there are approximately 110 acres of suitable murrelet nesting habitat associated with the disturbance zone immediately adjacent to the Carbon River Road. These acres will be exposed to periodic noise and activity associated with routine trail maintenance actions. The Park generally plans maintenance projects to during the early murrelet nesting season, and restricts activities to mid-day hours only. Considering the limited timing and duration associated with periodic removal of logs from the trail, we assume the effects of routine trail maintenance activities will be insignificant.

It is highly likely that flood damage will continue occur along the Carbon River corridor, which will require continued trail and road reconstruction efforts. Any future road or trail reconstruction projects are considered future Federal actions that will be subject to consultation under section 7 of the Act and are not considered to be part of this proposed action.

CUMULATIVE EFFECTS: Murrelet

Under section 7 of the Act (16 U.S.C. 1536, *et seq.*), cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this BA (50 CFR 402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

Forest Practices

In the Carbon River action area, there is a mix of non-Federal timber land and National Forest lands located adjacent to the Park. National Forest lands on the adjacent Mt. Baker-Snoqualmie National Forest in the Carbon River valley are designated as Late-Successional Reserves, or as Wilderness. Non-federal lands in the area are managed primarily for timber production, but almost all forest that was potential murrelet nesting habitat on these lands has been previously harvested. Private timber harvest in the area must comply with the Washington Forest Practices Act (RCW 76.09) as well as the Washington Administrative Code with respect to the Washington Forest Practices Rules (WAC 222).

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

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

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

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

The above situations represent the greatest risk for cumulative effects to murrelets associated with non-Federal forest practices in the action area.

Other situations that have the potential to result in adverse cumulative effects to murrelets include: (1) harvesting suitable murrelet habitat that occurs in stands less than 7 acres in size; and (2) harvesting occupied murrelet habitat that has been surveyed to protocol, but the surveys failed to detect murrelets (i.e., survey error).

There is no known minimum patch size for marbled murrelet nesting habitat. Murrelet occupancy has been documented in stands as small as 5 acres (Grenier and Nelson 1995, p. 198). The Washington Forest Practices Rules define suitable murrelet habitat as having a minimum stand size of 7 acres (WAC 222-16-010). Because murrelets require only a single tree with suitable nest platforms surrounded by other trees to provide some cover for nesting, suitable

habitat that occurs in patches smaller than 7 acres in size could be occupied by murrelets, and there is a potential for direct injury/mortality of murrelets to occur where small patches of unsurveyed suitable habitat are harvested.

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

In summary, the Washington Forest Practices rules provide a high level of protection for known occupied murrelet habitat in Washington. However, habitat that is not currently occupied, or does not meet the minimum habitat definitions provided in WAC 222-16-010 is likely to be harvested. Within the upper Carbon River valley, most murrelet habitat that occurred on non-Federal lands has been previously harvested, but there may be some small remnants that still remain. The greatest risks for adverse cumulative effects to occur are harvest of small remnant habitat patches (less than 7 acres in size), and clearcut harvest adjacent to a Federal boundary. Based on the limited amount of suitable habitat remaining on private lands in the action area, we conclude that the risk to murrelets from cumulative effects associated with forest practices is low.

Climate Change

During the next 20 to 40 years, the climate of the Pacific Northwest is projected to change significantly with associated changes to forested ecosystems. Predicted changes include warmer, drier summers and warmer, wetter autumns and winters, resulting in diminished snowpack, earlier snowmelt, and an increase in extreme heat waves and precipitation events (Salathe et al. 2009). Initially, the Pacific Northwest is likely to see increased forest growth region-wide over the next few decades due to increased winter precipitation and longer growing seasons; however, forest growth is expected to decrease as temperatures increase and trees can no longer benefit from the increased winter precipitation and longer growing seasons (Littell et al. 2009, p.15). Additionally, the changing climate will likely alter forest ecosystems as a result of the frequency, intensity, duration and timing of disturbance factors such as fire, drought, introduced species, insect and pathogen outbreaks, hurricanes, windstorms, ice storms, landslides, and flooding (Littell et al. 2009, p.14).

One of the largest projected effects on Pacific Northwest forests is likely to come from an increase in fire frequency, duration and severity. In general, wet western forests have short dry summers and high fuel moisture levels that result in very low fire frequencies. However, high fuel accumulations and forest densities create the potential for fires of very high intensity and severity when fuels are dry (Mote 2008, p.23). Westerling et al. (2006) looked at a much larger area in the western US including the Pacific Northwest, and found that since the mid-1980s, wildfire frequency in western forests has nearly quadrupled compared to the average of the period 1970-1986. The total area burned is more than six and a half times the previous level and

the average length of the fire season during 1987-2003 was 78 days longer compared to 1978-1986 (Westerling et al. 2006, p.941). Littell et al. (2009, p.2) project that the area burned by fire in the Pacific Northwest will double by the 2040s and triple by the 2080s.

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

INTEGRATION AND SYNTHESIS OF EFFECTS: Murrelet

Summary of Project Effects to Murrelets

We identified noise and visual disturbance associated with the use of helicopters and motorized equipment during the early nesting season as likely to disrupt murrelet nesting behaviors. Potential murrelet responses to disturbance include flushing from a nest, aborted or delayed feeding of juveniles, or increased vigilance/alert behaviors at nest sites with implications for reduced individual fitness and reduced nesting success. Project disturbance from these activities is anticipated to create a likelihood of injury by increasing the probability (risk) of nest predation. Under a reasonable worst-case scenario, project disturbance would indirectly result in nest failure. The Park has incorporated a daily operating restriction that will avoid project activities during the murrelets daily peak activity periods during dawn and dusk hours. This daily restriction minimizes effects to murrelets, but does not eliminate the potential for adverse disturbance effects or disrupted feeding attempts during mid-day hours.

Due to the prolonged exposure to construction activities during the early nesting season, we expect murrelets associated with 110 acres of nesting habitat immediately adjacent to the Carbon River Road will have an increased likelihood of nest failure for a period of 4 years.

We anticipate that the noise and disturbance associated with helicopter use will result in a significant disruption of murrelet nesting behaviors. All murrelets associated with approximately 400 acres of nesting habitat adjacent to the Carbon River Road/Trail corridor will be subjected to helicopter noise disturbance for a period of 3 to 6 days during one nesting season (possibly 2012 or 2013). Under a reasonable worst-case scenario, the disturbance would indirectly result in a failed nesting attempt.

We also anticipate that exposure to hazardous helicopter rotor wash would cause direct injury or mortality of murrelet eggs or nestlings. All murrelets associated with approximately 10 acres of nesting habitat adjacent to helicopter drop points will be exposed to hazardous rotor wash conditions for a period of 3 to 6 days during one nesting season (either 2012 or 2013).
The development of a new backcountry campground on the Wonderland Trail is expected to result in the general degradation of about 6 acres of murrelet habitat. Any murrelets nesting in the vicinity of the campground may be exposed to visual disturbance from the presence of people

on the ground, and a potential for increased predation risk. These effects will persist for as long the Park manages the area as a backcountry campground.

Surveys indicate the Carbon River valley likely supports the highest density of nesting murrelets of any location within the Park. Old-growth forest in the Park and adjacent National Forest Wilderness areas provide high quality murrelet nesting habitat that is mostly free from development and the presence of people. However, the Carbon River Road access corridor has a long history of recreational use. As long as the Park continues to manage the Carbon River corridor for recreational access, murrelets nesting in close proximity to the road and Ipsut Creek Campground will likely have a higher risk of nest failure from predation and human disturbance. Short of closing the area to public access, these effects are essentially unavoidable.

Effects to Murrelet Numbers, Reproduction, and Distribution

In accordance with policy and regulation, the jeopardy determination is made by evaluating the effects of the proposed Federal action in the context of the species current status, taking into account any cumulative effects, to determine if implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of both the survival and recovery of the species in the wild. The jeopardy analysis in this Opinion emphasizes consideration of the range-wide survival and recovery needs of the species and the role of the action area in the survival and recovery of the species. It is within this context that we evaluate the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the jeopardy determination.

Overview of Murrelet Population Demography

Murrelets are long-lived birds, with high adult survival, low annual fecundity, and delayed maturity (McShane et al. 2004, p. 3-34). It may take a breeding pair several successive years of nesting attempts to replace themselves in the population. Murrelet demography studies and population viability modeling indicate that murrelet populations are most sensitive to changes in adult survival and fecundity (reproductive success) (McShane et al. 2004, pp. 3-53 to 3-58). Although adult annual survival rates are relatively high in murrelets (83-92 percent), it is likely that recruitment rates throughout the species listed range are too low to reverse the current population decline.

Juvenile ratios, as an index of nest success, indicate that fecundity is well below the level needed to maintain current murrelet abundance. In California (Conservation Zones 4, 5 and 6), the leading causes of low fecundity are nest predation and poor food abundance or quality in the marine environment (Peery et al. 2004, p. 1088). We expect these factors may be the leading causes of low fecundity in Washington as well (Conservation Zones 1 and 2).

Recent monitoring efforts in Washington indicated only 20 percent of murrelet nesting attempts were successful, and only a small portion of the 158 tagged adult birds actually attempted to nest (13 percent) (Raphael and Bloxton 2009, p. 165). The authors note that the apparent low nesting rate coupled with low nesting success suggests the murrelet population in Conservation Zone 1 does not produce enough young to support a stable population (Raphael and Bloxton 2009, p.

165). The low number of adults attempting to nest is not unique to Washington. Some researchers suspect that the portion of non-breeding adults in murrelet populations can range from about 5 percent to 70 percent depending on the year, but most population modeling studies suggest a range of 5 to 20 percent (McShane et al. 2004, p. 3-5).

Mount Rainier Park is located in Conservation Zone 1, and all murrelets nesting in the Park are considered to be part of the Conservation Zone 1 murrelet population. Consistent with the range-wide trend, the murrelet population in Conservation Zone 1 has been declining over the past decade. The murrelet population in 2009 was estimated at 5,623 birds (95 percent confidence interval = 3,922 – 8,352) (Pearson et al 2010, p. 4). Due to the nature of the survey protocol and seasonal variation in the distribution of murrelets, there is a high level of variation in the annual population estimate. For the period from 2004 – 2009, the mean estimate ranged from a low of 4,699 murrelets in 2008 to a high of 7,956 murrelets in 2005 (Falxa et al. 2010). Despite this high level of annual variation, the monitoring surveys indicate the murrelet population in Conservation Zone 1 has declined at a rate of about 7 percent per year since 2001 (standard error = 1.8 percent) (Pearson et al 2010, p. 4).

In summary, the species' inherently low annual reproductive potential, coupled with the suite of mortality factors, leads us to conclude that the species will continue to experience local and rangewide population declines in the foreseeable future. Therefore, the survival and recovery of this species depends upon maintaining adult survival and improving fecundity.

<u>Effects to the Murrelet Population in Conservation Zone 1</u>

There are several factors, addressed below, that limit the magnitude of project effects to the murrelet population in Conservation Zone 1.

Murrelet Numbers

As described in the Effects of the Action section, we elected to use acres of habitat affected by the action as a surrogate for the number of breeding murrelets likely to be exposed and affected. Given the relatively small acreage of habitat exposed to disturbance stressors, we expect relatively few murrelets to be adversely affected by the proposed action. Considering the small size of the area affected and the variable response of murrelets (i.e., not all nests exposed to the disturbance are expected to fail), the proposed action is not anticipated to appreciably reduce the likelihood of survival and recovery through a reduction in murrelet numbers. This conclusion is based largely upon our finding that no direct mortality or injury to adult breeding murrelets is anticipated; therefore, there would be no reduction in the existing potential breeding population at the scale of the action area and Conservation Zone 1.

Murrelet Reproduction

Although we expect an incremental reduction in murrelet nest success in the action area, it is difficult to measure or detect population-level changes at either the scale of the action area or the Conservation Zone due to 1) the high annual variation in nesting effort and fecundity throughout Conservation Zone 1; 2) the number of potential breeding pairs (Appendix 3, Table 1) in

Conservation Zone 1; and 3) the small number of acres affected relative to what is available in the action area and the Carbon River Valley. We therefore conclude that reduced reproductive success as a result of the action is not expected to appreciably reduce the likelihood of survival and recovery of murrelets in Conservation Zone 1 or rangewide.

Murrelet Distribution

We do not expect that the proposed action would affect the distribution of murrelets within either the action area or Conservation Zone 1 for the following reasons: 1) the project would not result in the loss of murrelet nesting habitat; 2) over 90 percent of the nesting habitat in the upper Carbon River valley is essentially pristine and located away from the influence of project effects and human presence; and 3) we do not expect murrelet occupancy to be reduced over time as a result of the proposed action. Therefore, the proposed action is not expected to affect the distribution of murrelets in the action area, Conservation Zone 1, or within the listed range of the species.

Given the above analysis, we conclude that the adverse effects to murrelets that would result from the proposed actions would not contribute to an appreciable reduction in the likelihood of survival and recovery of the murrelet in the wild by reducing murrelet numbers, reproduction, or distribution, at the scale of the Park, Conservation Zone 1, or within the listed range of the species.

CONCLUSION: Marbled Murrelet

After reviewing the current status of the murrelet, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the FWS's Opinion that the Carbon River Access Management Plan, as proposed, is not likely to jeopardize the continued existence of the murrelet and is not likely to destroy or adversely modify designated critical habitat. Critical habitat for the murrelet has been designated in the Washington Cascades, however, this action does not affect that area and no destruction or adverse modification of critical habitat is anticipated.

STATUS OF THE SPECIES: Bull Trout (*Salvelinus confluentus*)

Summary of Bull Trout Status and Biology

The bull trout was listed as a threatened species in the coterminous United States in 1999. Throughout its range, bull trout are threatened by the combined effects of habitat degradation, fragmentation, and alterations associated with dewatering, road construction and maintenance, mining, grazing, the blockage of migratory corridors by dams or other diversion structures, poor water quality, incidental angler harvest; entrainment and introduced non-native species (64 FR 58910 [Nov. 1, 1999]).

Bull trout exhibit both resident and migratory life-history strategies. Resident bull trout complete their life cycles in the streams in which they spawn and rear. Migratory bull trout spawn in tributary streams where juvenile fish rear 1 to 4 years before migrating to either a lake (adfluvial form), river (fluvial form), or saltwater (anadromous form) to rear as subadults and to live as adults. Bull trout normally reach sexual maturity in 4 to 7 years and may live longer than 12 years. They are iteroparous (they spawn more than once in a lifetime). Repeat- and alternate-year spawning has been reported, although repeat-spawning frequency and post-spawning mortality are not well documented (64 FR 58910 [Nov. 1, 1999]).

Bull trout typically spawn from August through November during periods of decreasing water temperatures. Cold water temperatures play an important role in determining bull trout habitat quality. Bull trout are primarily found in colder streams (below 15 °C or 59 °F), and spawning habitats are generally characterized by temperatures that drop below 9 °C (48 °F) in the fall. Preferred spawning habitat consists of low-gradient stream reaches with loose, clean gravel. Redds are often constructed in stream reaches fed by springs or near other sources of cold groundwater. Depending on water temperature, incubation is normally 100 to 145 days. After hatching, fry remain in the substrate, and time from egg deposition to emergence may surpass 200 days. Fry normally emerge from early April through May, depending on water temperatures and increasing stream flows (64 FR 58910 [Nov. 1, 1999]).

All life history stages of bull trout are associated with complex forms of cover, including large woody debris, undercut banks, boulders, and pools. Juvenile and adult bull trout frequently inhabit side channels, stream margins, and pools with suitable cover (64 FR 58910 [Nov. 1, 1999]).

For a detailed account of bull trout biology, life history, threats, and conservation needs, refer to Appendix 4– Status of the Species: Bull Trout

Status of Bull Trout in the Puyallup Core Area

In the draft recovery plan for the Coastal – Puget Sound Distinct Population Segment of bull trout, the FWS identified the Puyallup River and its tributaries as a core area for bull trout recovery (USFWS 2004, p. 20). A core area is a large watershed or river basin that contains habitat necessary to support all life stages of bull trout (e.g., spawning, rearing, migration, overwintering, and foraging habitat) and contains one or more local populations of bull trout.

A local population is defined as a group of bull trout that spawn within a particular stream or portion of a stream system.

The Puyallup core area comprises the Puyallup, Mowich, and Carbon Rivers; the White River system, which includes the Clearwater, Greenwater, and the West Fork White Rivers; and Huckleberry Creek. Glacial sources in several watersheds drain the north and west sides of Mount Rainier and significantly influence water, substrate, and channel conditions in the mainstem reaches. The location of many of the basin's headwater reaches within the Park and designated wilderness areas (Clearwater Wilderness, Norse Peak Wilderness) provides relatively pristine habitat conditions in these portions of the watershed.

Anadromous, fluvial, and potentially resident bull trout occur within local populations in the Puyallup River system. Bull trout occur throughout most of the system although spawning occurs primarily in the headwater reaches. Anadromous and fluvial bull trout use the mainstem reaches of the Puyallup, Carbon, and White Rivers to forage and overwinter, while the anadromous form also uses Commencement Bay and likely other nearshore areas within Puget Sound. Habitat conditions within the lower mainstem Puyallup and White Rivers have been highly degraded, retaining minimal instream habitat complexity. In addition, habitat conditions within Commencement Bay and adjoining nearshore areas have been severely degraded as well, with very little intact intertidal habitat remaining.

The Puyallup core area has the southernmost, anadromous bull trout population in the Puget Sound Management Unit (USFWS 2004, p. 19). Consequently, maintaining the bull trout population in this core area is critical to maintaining the overall distribution of migratory bull trout in the management unit. The status of the bull trout core area population is based on four key elements necessary for long-term viability: 1) number and distribution of local populations, 2) adult abundance, 3) productivity, and 4) connectivity (USFWS 2004, p. 215).

Number and Distribution of Local Populations

Five local populations occur in the Puyallup core area: 1) Upper Puyallup and Mowich Rivers, 2) Carbon River, 3) Upper White River, 4) West Fork White River, and 5) Greenwater River. The Clearwater River is identified as a potential local population, as bull trout are known to use this river and it appears to provide suitable spawning habitat, but the occurrence of reproduction there is unknown (USFWS 2004, 119-121).

Information about the distribution and abundance of bull trout in this core area is limited because observations have generally been incidental to other fish species survey work. Spawning occurs in the upper reaches of this basin where higher elevations produce the cold water temperatures required by bull trout egg and juvenile survival. Based on current survey data, bull trout spawning in this core area occurs earlier in the year (i.e., September) than typically observed in other Puget Sound core areas (Marks et al. 2002). The known spawning areas in local populations are few in number and not widespread. The majority of spawning sites are located in streams within the Park, with two exceptions, Silver Creek and Silver Springs (Marks et al. 2002; R. Ladley, in litt., 2006).

Rearing likely occurs throughout the Upper Puyallup, Mowich, Carbon, Upper White, West Fork White, and Greenwater Rivers. However, sampling indicates most rearing is confined to the upper reaches of the basin. The mainstem reaches of the White, Carbon, and Puyallup Rivers probably provide the primary freshwater foraging, migration, and overwintering habitat for migratory bull trout within this core area.

With fewer than 10 local populations, the Puyallup core area is considered to be at intermediate risk of extirpation and adverse effects from random naturally occurring events.

Adult Abundance

Rigorous abundance estimates are generally not available for local populations in the Puyallup core area. Local populations in the Puyallup core area are estimated to have fewer than 100 spawning adults, based on the low number of observed redds in spawning streams and low numbers of migrating adults counted at the Buckley fish trap on the lower White River (USFWS 2004, p. 221). Although these counts may not adequately account for fluvial migrants that do not migrate downstream of the facility, these counts do indicate few anadromous bull trout and few mainstem fluvial bull trout return to local populations in the White River system. Therefore, the bull trout population in the Puyallup core area is considered at increased risk of extirpation until sufficient information is collected to properly assess adult abundance in each local population.

Productivity

Due to the current lack of long-term, comprehensive trend data, the bull trout population in the Puyallup core area is considered at increased risk of extirpation until sufficient information is collected to properly assess productivity.

Connectivity

Migratory bull trout are likely present in most local populations in the Puyallup core area. However, the number of adult bull trout expressing migratory behavior within each local population appears to be very low compared to other core areas. Although connectivity between the Upper Puyallup and Mowich Rivers local population and other Puyallup core area local populations was reestablished with the creation of an upstream fish ladder at Electron Dam in 2000, this occurred after approximately 100 years of isolation. Very low numbers of migratory bull trout continue to be passed upstream at the Mud Mountain Dam's Buckley Diversion fish trap. The overall low abundance of migratory life history forms limits the possibility for genetic exchange and local population refounding, as well as limits more diverse foraging opportunities to increase size of spawners and therefore, overall fecundity within the population. Consequently, the bull trout population in the Puyallup core area is at intermediate risk of extirpation from habitat isolation and fragmentation.

Threats

Threats to bull trout in the Puyallup core area include:

- Extensive past and ongoing timber harvest and harvest-related activities, such as road maintenance and construction, continue to affect bull trout spawning and rearing areas in the upper watershed.

- Agricultural practices, such as bank armoring, riparian clearing, and non-point discharges of chemical applications continue to affect foraging, migration, and overwintering habitats for bull trout in the lower watershed.

- Dams and diversions have significantly affected migratory bull trout in the core area. Until upstream passage was recently restored, the Electron Diversion Dam isolated bull trout in the Upper Puyallup and Mowich Rivers local population for nearly 100 years and has drastically reduced the abundance of migratory bull trout in the Puyallup River. Buckley Diversion and Mud Mountain Dam have significantly affected the White River system in the past by impeding or precluding adult and juvenile migration and degrading foraging, migration, and overwintering habitats in the mainstem. Despite improvements to these facilities, passage related impacts continue today but to a lesser degree.

- Urbanization, road construction, residential development, and marine port development associated with the city of Tacoma, have significantly reduced habitat complexity and quality in the lower mainstem rivers and associated tributaries, and have largely eliminated intact nearshore foraging habitats for anadromous bull trout in Commencement Bay.

- The presence of brook trout (*Salvelinus fontinalis*) in many parts of the Puyallup core area and their potential to increase in distribution, including in Park waters, are considered significant threats to bull trout (USFWS 2004, p. 194). Because of their early maturation and competitive advantage over bull trout in degraded habitats, brook trout in the upper Puyallup and Mowich River local population is of highest concern because of past isolation of bull trout and the level of habitat degradation in this area.

- Until the early 1990s, bull trout fisheries probably significantly reduced the overall bull trout population within this and other core areas in Puget Sound. Current legal and illegal fisheries in the Puyallup core area may continue to significantly limit recovery of the population because of the low numbers of migratory adults.

- Water quality has been degraded due to municipal and industrial effluent discharges resulting from development, particularly in the lower mainstem Puyallup River and Commencement Bay.

- Water quality has also been degraded by stormwater discharge associated with runoff from impervious surface. Impervious surface in the Puyallup watershed increased by 12 percent between 1990 and 2001 (PSAT 2007).

- Major flood events in November 2006 significantly impacted instream habitats within the Puyallup River system. These events are assumed to have drastically impacted bull trout brood success for the year, due to significant scour and channel changes that occurred after peak spawning. Significant impacts to rearing juvenile bull trout were also likely, further impacting the future recruitment of adult bull trout.

- In November 2006, an 18,000 gallon diesel spill in the head waters of Spring Creek (C. Hebert, *in litt.*, 2006), a bull trout spawning area of the Upper White River local population, likely impacted the available instream spawning habitat. The duration of ongoing contamination of instream habitats by residual diesel is unknown.

Changes in Environmental Conditions and Population Status

Since the bull trout listing, the FWS has issued Opinions that analyzed the effects of federal actions in the Puyallup core area. The effects of these actions to bull trout were primarily from hydrologic impacts associated with increased impervious surface, temporary sediment increases during in-water work, habitat loss or alteration, and handling of fish. None of these projects were determined to result in jeopardy to bull trout. The combined effects of actions evaluated under these Opinions have resulted in short-term and long-term adverse effects to bull trout and degradation of bull trout habitat within the core area.

Of particular note, in 2003 the FWS issued an Opinion (FWS Ref. No. 1-3-01-F-0476) on the State Route 167 North Sumner Interchange Project. This project was located in Pierce County in the White River portion of the Puyallup watershed and was proposed by Washington State Department of Transportation. The project's direct and indirect impacts and cumulative impacts within the action area included urbanization of approximately 600 acres of land. We anticipated that conversion of this land to impervious surface would result in the permanent loss and/or degradation of aquatic habitat for bull trout and their prey species through reduced base flows, increased peak flows, increased temperatures, loss of thermal refugia, degradation of water quality, and the degradation of the aquatic invertebrate community and those species dependent upon it (bull trout prey species). These impacts will result in thermal stress and disrupt normal behavioral patterns. These adverse effects are expected to continue in perpetuity.

State forest practice regulations for private land timber harvests were significantly revised in 2000, following the Forest and Fish agreement, which culminated in the Washington State Forest Practices HCP for aquatic species (WDNR 2005). The revised regulations increased riparian and unstable slope protections. Road construction and maintenance standards are included in the rules. The FWS completed formal consultation on the Washington State Forest Practices HCP in 2006. Significant adverse effects to approximately 40 miles of bull trout spawning and rearing streams, and 75 miles of foraging and migration habitat from private forest practices was anticipated in the Puyallup watershed (USFWS 2006, p. 860).

Section 10(a) (1) (B) permits have also been issued for HCPs that address bull trout in this core area. Although these HCPs may result in both short and/or long-term negative effects to bull trout and their habitat, the anticipated long-term beneficial effects are expected to maintain or improve the overall baseline status of the species. Additionally, capture and handling, and

indirect mortality, during implementation of section 6 and section 10(a) (1) (A) permits have directly affected some individual bull trout in this core area.
The number of non-Federal actions occurring within the Puyallup core area since the bull trout were listed is unknown. However, activities conducted on a regular basis, such as emergency flood control, development, and infrastructure maintenance affect riparian and instream habitat which typically results in negative affects to bull trout and their habitat.

In summary, the majority of the Puyallup River basin outside of designated wilderness areas has been significantly altered by a variety of factors including dams that impede natural bull trout migration, extensive timber harvest and associated road construction; conversion of landscape to residential, commercial, and agricultural use; substantial channelization of lower mainstem reaches; and total commercial development of the estuarine habitat. These factors have undoubtedly reduced the overall productivity and abundance of bull trout populations in the Puyallup River basin, and strongly influence the number and distribution of bull trout now present in the Puyallup core area (USFWS 2004, p.121).

ENVIRONMENTAL BASELINE: Bull Trout

Regulations implementing the Act (50 CFR 402.02) define the environmental baseline as the past and present impacts of all Federal, State, or private actions and other human activities in the action area. Also included in the environmental baseline are the anticipated impacts of all proposed Federal projects in the action area that have undergone section 7 consultation, and the impacts of State and private actions which are contemporaneous with the consultation in progress.

Status of Bull Trout in the Carbon River

The project is located in the upper Carbon River watershed from the Park entrance at RM 23 upstream to the Ipsut Creek Campground at approximately RM 28. The aquatic action area includes the Carbon River for 0.5 miles downstream from the Park entrance to account for sediment plumes and changes in the channel configuration that may result from placement of bank protection structures in the stream channel. The action area also includes all aquatic habitat in affected tributary streams such as Falls Creek and Ranger Creek to the upper limits of bull trout distribution located upstream from fish passage barrier culverts.

The action area provides habitat to multiple life stages of resident and fluvial bull trout, including spawning, rearing, foraging, and migration habitat. All known reports of spawning bull trout in the Carbon River watershed are confined to the upper Carbon River and its tributaries, indicating a spatial separation from other bull trout local populations in the Puyallup core area. Therefore, bull trout in Carbon River are currently considered to represent a local population (USFWS 2004, p. 123). The overall abundance of the Carbon River local population is currently unknown, but is estimated to be less than 100 spawning adults (USFWS 2004, p. 221). Migratory connectivity to other local populations and forage areas within the Puyallup basin is believed to be good, although the canyon reach in the Carbon River may present some short-term upstream migration delays (USFWS 2004, p. 123).

Fisheries surveys have detected juvenile, subadult, and adult bull trout in the upper Carbon River and in several tributary streams including June Creek, Falls Creek, Chenuis Creek, and Ipsut Creek (USFWS 2004, p. 123, NPS 2009c). Park staff documented spawning bull trout and bull trout redds in June Creek, Chenuis Creek, and a small tributary stream to lower Chenuis Creek, Ranger Creek, and lower Ipsut Creek (Figure 6). Of the 33 bull trout redds documented in Carbon River tributaries between 2002 and 2009, 17 redds were counted in Ranger Creek, indicating this is likely the most significant spawning stream for the Carbon River local population (NPS 2009c). In 2009, Park staff counted 5 bull trout redds in Ranger Creek. Spawning activity has generally been documented from late September into October in the Carbon River tributaries, but active spawning may begin as early as mid-September based on bull trout surveys in the upper White River basin (Marks et al. 2009, p. 167).

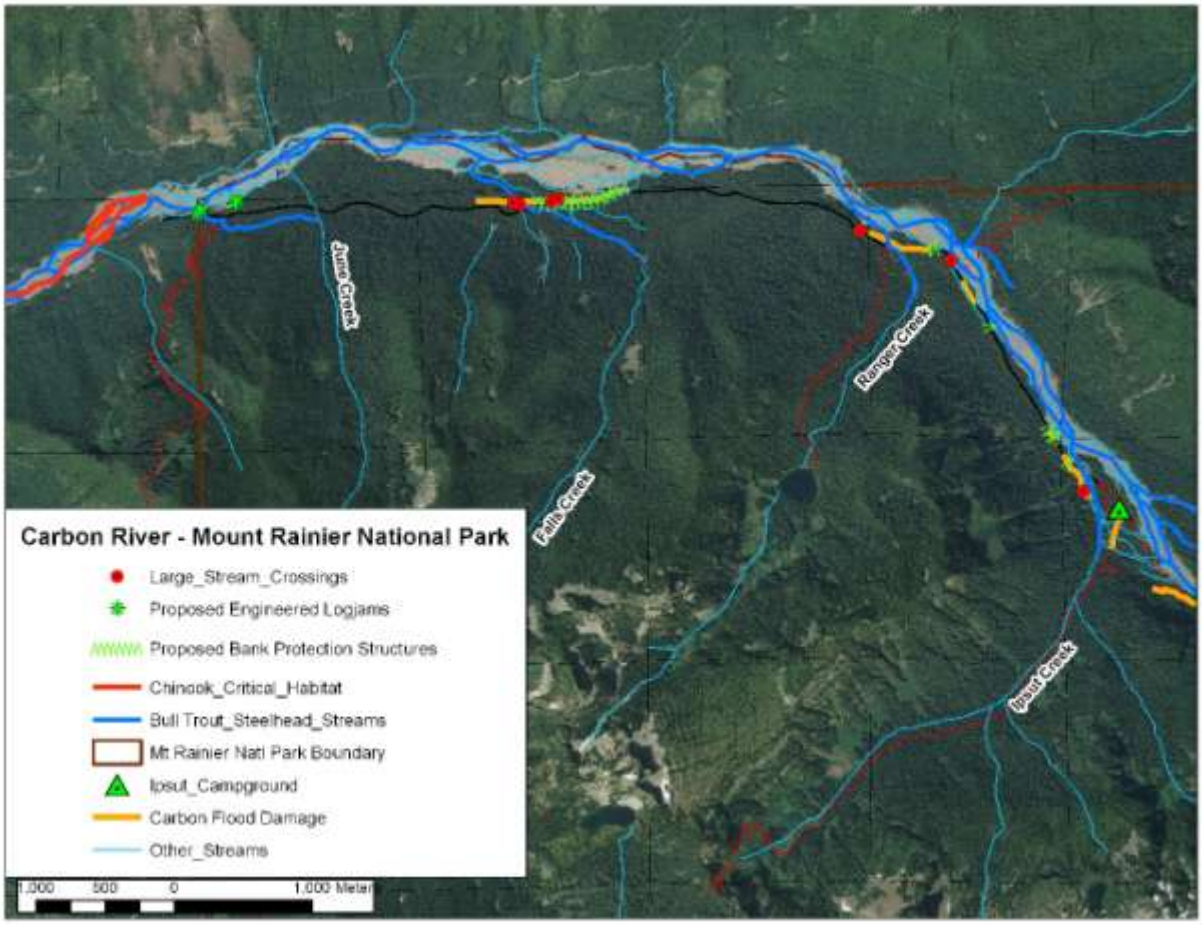

Figure 6. Distribution of bull trout habitat and proposed actions in the upper Carbon River.

The Park collected fin clip samples from 100 individual native char in 2006 to assess genetic variation within and among bull trout collected from three tributaries to the Puyallup River in the Park (Carbon, White, and West Fork) (B. Samora, pers. comm. 2010). Of the 100 individuals analyzed, four fish were identified as brook trout and all other individuals were identified as bull trout. Within the three tributaries, the lowest levels of genetic variation occur in the Carbon River. Significant genetic variation was observed among all three tributary populations

suggesting that each of the three tributaries contains a distinct local spawning population. The level of variation between the White River and the West Fork White River was much lower than the level of variation between these two tributaries and the Carbon River. These data suggest that gene-flow occurs between the White River and West Fork White River local populations, but individuals do not likely migrate between the Carbon River and the other two local populations (Samora, pers. comm. 2010).

Other salmonid species present in the action area include coastal cutthroat trout (*Oncorhynchus clarki clarki*), steelhead/rainbow trout (*O. mykiss*), Chinook salmon (*O. tshawytscha*), coho salmon (*O. kisutch*), mountain whitefish (*Prosopium williamsoni*), and brook trout (USFS 1998). All of these species potentially serve as important prey species for bull trout, and brook trout potentially represent a competitive threat to bull trout in Park streams.

Conservation Role of the Action Area for Bull Trout

The Carbon River and its major floodplain tributaries in the action area provide essential spawning and rearing habitat necessary to maintain the Carbon River local population. In the draft bull trout recovery plan, the upper Carbon River and its tributaries are identified as key freshwater habitat for bull trout (USFWS 2004, p. 120), and in 2010, the FWS designated approximately 17 miles of river and stream habitat in the action area as critical habitat essential for bull trout recovery (Table 9). The Carbon River Road is specifically identified in the draft bull trout recovery plan as a high priority area for addressing chronic habitat degradation associated with unstable road locations (USFWS 2004, p. 239).

Table 9 provides a summary of the bull trout streams in the action area and their current conditions:

Table 9. Summary of bull trout habitat and existing conditions in the action area (RM 22.5 upstream to RM 30.7. This includes 0.5 miles downstream from the Park entrance upstream to the end of known bull trout distribution, 1.4 miles downstream from Carbon Glacier, and encompasses all known documented spawning locations for Carbon River bull trout.

Stream Segment	Approximate stream length identified as bull trout habitat (miles)	Comments/Existing Conditions
Carbon River – main channel	7.90	The active Carbon River channel is 500 to 1,300 ft. wide, with an average width of about 600 ft. During normal summer flows, the wetted channel width is about 20 to 25 percent of the active channel width, and is divided into 3 to 5 braided channel segments. About 2 miles of Carbon River Road (40 percent) is located at a distance of 0 to 200 ft. from the Carbon River within the active channel migration zone, and is rated as having a high risk of failure (Appendix 1). Bank armoring with rip-rap is located along approx. 0.25 mile of the south bank (2 percent).
Carbon River – additional braided channel segments	5.88	
June Creek	0.66	Lower 0.17 miles (25 percent) of June Creek is located within 200 ft. of Carbon Road and Park entrance parking facilities. Trail bridge crossing on lower stream. Bull trout spawning has been documented both above and below the culvert crossing on county road.
Falls Creek	0.97	Carbon River Road has 3 stream crossings, Falls Creek and 2 tributaries, extensive flood damage from road scour along 0.5 miles. Gravel aggradation in vicinity of the road causes tributary streams to go dry seasonally, resulting in loss of perennial fish habitat. Lower 0.4 miles now carries combined flow from Falls Creek and an active Carbon River side channel. A total of 13 fish (cutthroat and bull trout) were counted in the new scour channel in 2007. Emergency flood repairs in 2007 (check dams) installed in the scour channel block fish passage into upper Falls Creek (NPS 2009c).

Table 9 continued.

Stream Segment	Approximate stream length identified as bull trout habitat (miles)	Comments/Existing Conditions
Ranger Creek	0.61	Identified as the most significant spawning stream for the upper Carbon River. The lower 0.21 miles below culvert is now combined with an active Carbon River side channel which closely parallels the road, and is beginning to cause road failure. The culvert is a partial barrier to fish passage that blocks access to upper 0.5 miles of bull trout spawning and rearing habitat, although spawning bull trout were documented above the culvert for the first time in 2009. Road fill at culvert is failing, resulting in road fill deposition in the stream, and degradation of spawning habitat. Upstream side of culvert is forming a logjam and gravel aggradation. The culvert is highly threatened and could fail with the next major flood (NPS 2009c).
Unnamed tributary at Chenuis Falls trailhead (not designated as critical habitat)	0.25	Culvert crossing is total barrier to fish passage, blocks access to 0.25 miles of potential spawning and rearing habitat. Extensive aggradation of fine sediment above culvert (estimated at over 600 cy, Appendix 1).
Chenuis Creek	0.12	Recreation trail to falls. Trail does not cross stream directly, but parallels stream along lower 200 ft. High quality spawning and rearing habitat in lower reach of stream below barrier falls.
Chenuis Creek tributary stream	0.32	Recently documented bull trout spawning tributary. Recreation trail to falls crosses the stream with a trail bridge.
Ipsut Creek	0.54	Major changes to channel configuration resulted from the 2006 flooding. A side channel from Carbon River now intercepts Ipsut Creek above the historic road crossing. The concrete bridge is blocked by a massive logjam, and caused the channel to reroute and scoured out 0.21 miles of road surface. The lower 0.5 miles of Ipsut Creek channel now carries the combined flow of Ipsut Creek and an active side channel of the Carbon River during high flow events.
Totals	17.00 miles	13.78 miles of braided channels along Carbon River from RM 22.5 up to RM 30.7 is identified as bull trout habitat. 3.22 miles of tributary streams identified as bull trout habitat (19 percent).

Note: All stream miles are approximate values derived from GIS data and based off 1:24,000 scale maps used to designate bull trout critical habitat (75 FR 63898 [Oct. 18, 2010]). These values likely underestimate the total length of accessible habitat in this area due to inaccuracies in stream mapping data.

Aquatic Environmental Baseline Conditions in the Action Area

Water Quality and Flow Regime

The Carbon River has a high level of suspended sediment due to its origins at the Carbon Glacier on Mount Rainier. Based on water quality data collected on the Carbon River, the suspended sediment concentration is in the range of 120 to 475 milligrams per liter during mid-July through mid-August, with average values likely at the lower of end of this range around 150 mg/L during the in-water work window of the proposed project (WDOE 2010). This range of suspended solids equates to a range of 22 to 88 nephelometric turbidity units (NTUs). A maximum turbidity of 400 NTUs was estimated for a winter storm flow of 6,700 cfs. With the exception of high flow events during the winter, turbidity levels are highest during the summer and correspond with increased runoff from the Carbon Glacier. Mean flows during this period are in the range of 300 to 500 cfs, as reported at the USGS gage station located at Fairfax (USGS 2008). The lowest mean flows for the Carbon River actually occur in September and October (mean flows = 310 – 315 cfs), after the preferred in water work window (USGS 2008). Tributary streams such as Ranger Creek and Ipsut Creek have very low levels of turbidity during the summer. Inwater work windows are based on the timing of fish spawning and incubation, rather than strictly on low flow periods.

Other water quality indicators such as water temperature and contaminants have not been monitored consistently. However, the Washington Department of Ecology water quality database indicates there are no water quality standard violations noted for the Carbon River, and all indicators except suspended solids are ranked as high quality (WDOE 2010).

Channel Conditions and Sediment

The Carbon River channel carries a very high bedload due to active sources of coarse sediment from glacial outwash. In the action area, the river forms a braided "D4" channel type which is typical of glacially fed rivers which have a high sediment supply (Rosgen 1994). Braided channels are naturally unstable and harbor important habitat-maintaining and formation processes including local gravel-size sediment input (the size suitable for salmonid spawning), and recruitment of large wood from the erosion of alluvial terraces. Braided reaches include important salmonid habitat, including side- and off-channel habitats, and channel margins consisting of eroding banks and habitat complexity provided by large wood. Floodplain springs, forested side channels, and valley wall tributary streams provide the most productive and complex fish spawning and rearing habitats in the system.

The braided active channels in the Carbon River are unstable with bedload consisting of large rubble, boulders, and pockets of fine sorted materials (Kerwin 1999, p. 49). Although the upper Carbon River has additional sediment loading from management related activities (e.g. forest roads), sediment loading from glacial erosion is an order of magnitude higher than from management activities (USFS 1998). Between 1990 and 1996, the active channel widened by up to 100 ft. in several locations, and the channel is aggrading rapidly. The widening and lateral channel migration are likely a result of extreme peak flows and resulting bedload movements associated with several record flows that have occurred since 1990, and the retreat of the Carbon Glacier that began in the early 1980's. Natural aggradation of the Carbon River bed has resulted

in more frequent flooding of the Carbon River Road over the past 2 decades. Flood damage to the road has resulted in major washouts which have resulted in altered stream channels and deposition of large amounts of road surface materials into tributary streams, most notably in the Falls Creek area.

Impacts from Existing Bank Protection Structures

The presence of the Carbon River Road and bank armoring with riprap to protect the road has altered natural channel migration in several locations along the upper Carbon River. As described in the Environmental Assessment (NPS 2010, p. 149), there are three segments of riprap located along the road in the Park. Riprap is located near Falls Creek, just east of the Green Lake Trailhead, and near Chenuis Falls. The riprap associated with Falls Creek is approximately 20 ft. long and consists of large angular rocks that may be mixed with historic riprap. Riprap associated with the Green Lake Trailhead is significantly longer stretching from 2.69 miles to 2.95 and contains large rock material. Finally, the riprap near the Chenuis Falls Trailhead stretching from 3.48 miles to 3.82 miles, serves as a retaining wall buffering the edge between the Carbon River and the Carbon River Road. The amount of bank armoring with riprap along the upper Carbon River within the Park is about 0.58 miles, with an additional 0.12 miles immediately below the Park boundary near June Creek.

The total amount of riprap that is currently affecting the upper Carbon River channel (from the USFS 7810 bridge upstream) is estimated at approximately 0.7 mile. Additional areas of historic riprap, log cribbing, and gabions are located at various locations along the floodplain, but many of these structures do not currently interact with the active river channel, and the total length of these historic structures is unknown. Perhaps as much as 30 percent of the road length (~1.5 miles) has some form of bank protection in the floodplain (B. Samora, pers. comm. 2010). Bank armoring with riprap halts natural channel migration, disrupts the natural recruitment of large wood, and increases channel depth and scour along the toe of the rip-rap, all of which reduce channel complexity and degrade fish habitat (ISPG 2003, p. 6-69).

Impacts Associated with Existing Culverts

The Carbon River Road has a long history of flood damage resulting in direct input of road fill sediments and potentially contaminants (e.g. oil and grease vehicles) into tributary streams (USFS 1998). The Carbon River Road is identified in the draft bull trout recovery plan as a high priority area for addressing chronic habitat degradation associated with unstable road locations (USFWS 2004, p. 239). Culverts in tributary streams crossed by the Carbon River Road block natural sediment transport and have resulted in significant aggradation of sediment behind culverts, resulting in seasonal loss of surface flow in some stream segments, particularly in the Falls Creek area (NPS 2009c). Scour and erosion at culvert outlets has left several culverts perched, forming partial or full barriers to fish passage, most notably at the Ranger Creek and the unnamed tributary stream at the Chenuis Falls Trailhead. These culverts block fish access to at least 0.75 miles of high quality spawning and rearing habitat in these streams.

Impacts from Climate Change

Salmonids throughout the Pacific Northwest (including bull trout) are likely affected by climate change. Several studies have revealed that climate change has the potential to affect ecosystems in nearly all tributaries throughout the state (ISAB 2007, Battin et al. 2007.). The largest driver of climate-induced decline in salmonid populations is projected to be the impact of increased winter peak flows, which scour the streambed and destroy salmonid eggs (Battin et al. 2007). Higher water temperatures and lower spawning flows, together with increased magnitude of winter peak flows are all likely to increase salmonid mortality. Recent trends in channel widening and increased peak flow events in the Carbon River indicate climate change effects are already having a profound impact on salmonid habitats in the upper Carbon River, and these effects are likely to become more severe with further recession of the Carbon Glacier. Refugia habitat provided by floodplain tributary streams in the upper Carbon River will become increasingly important for maintaining viable fish populations as habitat in the Carbon River becomes increasing unstable with the ongoing effects of climate change.

Summary of the Aquatic Environmental Baseline (Matrix of Pathways and Indicators)

The condition of habitat in the action area is evaluated in terms of seven broad classes of habitat features (pathways), each of which has a related set of specific metrics (indicators) that are rated based on their functional condition. Baseline conditions for each indicator are described on a relative scale of functionality ("functioning properly," "functioning at risk" or "not properly functioning"). This analytical framework is referred to as the Matrix of Pathways and Indicators (USFWS 1999). The scale of this analysis is at the upper Carbon River 6th-field watershed. The environmental baseline information for the watershed is summarized from the Forest Service's 1998 *Carbon River Watershed Analysis* (USFS 1998), and other sources of information as cited (Table 10). The overall ranking for the watershed is "functioning at risk" due to past and ongoing aquatic habitat degradation associated with roads, stream crossings, and increased peak flows and bedload from the Carbon Glacier.

Table 10. Summary of the environmental baseline in the upper Carbon River watershed ("Matrix of Pathways & Indicators").

Pathway	Indicator	Baseline Conditions	Rationale/Comments
Local Population Conditions	Local Population Size	Functioning at Risk?	The overall abundance of the Carbon River local population is currently unknown, but is estimated to be less than 100 spawning adults. Possible that the population could contain less than 50 spawning adults, but this is unknown. Only 33 redds were documented during the period from 2002-2009 (NPS 2009c), but redd surveys are not comprehensive or designed to indicate trends.
	Growth and Survival	Functioning at Risk	No trend data available, but major flood events in recent years (e.g., 2006) have likely resulted in a significant loss of redds and decreased recruitment following the flood. Since trend data cannot be confirmed, the local population is considered to be at risk.
	Life History Diversity and Isolation	Functioning at Risk	Migratory connectivity to other local populations and forage areas within the Puyallup basin is believed to be good, although the canyon reach in the Carbon River may present a partial barrier to upstream migration (USFWS 2004, p. 123). Current data suggest the Carbon River population is primarily a fluvial or resident type. Anadromy potentially occurs in this population, but the degree to which fish express the anadromous life history form is unknown.
	Persistence and Genetic Integrity	Functioning at Risk	Genetic information indicates the Carbon River population is apparently genetically isolated from other local populations, despite apparent connectivity (lack of barriers) between local populations in the larger core area.
Water Quality	Temperature	Functioning at Risk	Not listed as a concern in the WDOE water quality assessment or identified in State 303(d) list (WDOE 2010) Riparian harvest outside Park may influence tributary stream temperature in some areas.
	Sediment / Turbidity	Functioning at Risk	High natural turbidity from glacial sources in Carbon River. Very high water quality in tributary streams (WDOE 2010).
	Chemical Contamination & Nutrients	Functioning Properly	Not listed as a concern the WDOE water quality assessment or identified in State 303(d) list (WDOE 2010).
Habitat Access	Physical Barriers	Not Properly Functioning	Culverts on several tributary streams present partial or full barriers to fish passage.
Habitat Elements	Substrate	Functioning At Risk	Chronic road sediment sources delivered to key tributary streams along Carbon River Road.

Pathway	Indicator	Baseline Conditions	Rationale/Comments
	Large Woody Debris	Functioning At Risk	Past logging on private and National Forest lands in watershed has reduced old-growth riparian to less than 50 percent (USFS 1998)
	Pool Frequency / Quality	Functioning At Risk	Pool habitat potentially decreasing in Carbon River due to increasing bedload from Carbon Glacier.
	Large Pools	Functioning At Risk	Pool habitat potentially decreasing in Carbon River due to increasing bedload from Carbon Glacier.
	Off-Channel Habitat	Functioning At Risk	Side channel habitats constrained or directly impacted by location of Carbon River road in several areas.
	Refugia	Functioning At Risk	Refugia habitats are present, but are currently reduced due to passage barriers.
Channel Conditions & Dynamics	Width/Depth Ratio	Functioning At Risk	Width/depth ratio is increasing in Carbon River due to rapid channel widening in response to peak flood events and increasing bedload from Carbon Glacier.
	Streambank Condition	Functioning At Risk	Rapid channel widening and bank erosion in response to increased peak flood events and increasing bedload from Carbon Glacier.
	Floodplain Connectivity	Functioning at Risk	Bank armoring with rip-rap to is present in several locations both above and below Park boundary.
Flow / Hydrology	Peak / Base Flows	Functioning at Risk	Peak flow events appear to be increasing in severity. 3 largest recorded flood events with flows over 12,000 cfs have occurred in since 1991(USGS 2010 Fairfax gage data). Most likely cause is due to effects of Carbon Glacier recession, rather than clear-cut timber harvesting in watershed.
	Drainage Network	Functioning at Risk	Moderate increase in drainage network – road density is 1.33 miles/mi^2 (USFS 1998).
Watershed Conditions	Road Density / Location	Not Properly Functioning	Low road density overall (<2 miles/mi^2), but presence of valley bottom roads causes chronic flood damage and sediment delivery to tributary streams (USFWS 2004).
	Disturbance History	Functioning at Risk	Past logging on private and National Forest lands in watershed has reduced old-growth to less than 50 percent but recent clearcuts are less than 15percent (USFS 1998).

Pathway	Indicator	Baseline Conditions	Rationale/Comments
	Riparian Areas	Functioning at Risk	Past logging on private and National Forest lands in watershed has reduced old-growth riparian to less than 50 percent (USFS 1998)
Integration of Species and Habitat		Functioning at Risk	The overall ranking for the watershed is "functioning at risk" due to past and ongoing aquatic habitat degradation associated with roads, stream crossings, and increased peak flows and bedload from the Carbon Glacier. The local population is apparently small (less than 100 adults) and genetically isolated from other local populations.

EFFECTS OF THE PROPOSED ACTION: Bull Trout

The proposed action includes several projects that will require the use of heavy equipment below the bankfull elevation in the Carbon River and its tributaries. These projects will result in both direct and indirect effects to bull trout and their habitat. Some of these effects will be temporary, construction-related and limited in both physical extent and duration. Others will be long-term, lasting for the functional life of the proposed stream bed and stream bank stabilization measures:

- Direct short-term effects (i.e., stress, injury and/or mortality) resulting from fish capture and handling operations associated with work site isolation and dewatering.
- Direct short-term effects (i.e., stress and/or injury) resulting from exposure to construction-related turbidity and sediments.
- Indirect short-term effects (mortality and reduced incubation success) associated with stream substrate scouring and deposition in fish spawning areas that result from changes in channel configuration.
- Permanent effects to instream habitat structure, function, and diversity. The project will construct bank protections structures that will inhibit natural channel migration and recruitment of large wood in the affected areas. Structures will also result in local scouring and deposition of stream substrates and sediments. The project would also improve natural stream habitat function and connectivity over the long-term by removing barrier culverts and replacing them with bridges.

Construction activities have the potential to kill or injure a limited number of adult, subadult, and juvenile bull trout. Temporary exposures to turbidity plumes may also significantly disrupt normal bull trout behaviors (i.e., ability to successfully feed, move, and/or shelter). These exposures may temporarily cause bull trout to avoid the action area, may impede or discourage free movement through the action area, prevent individuals from exploiting preferred habitats, and/or expose individuals to less favorable conditions.

The seasonal timing for inwater excavation work (July 16 - August 15 for Ranger Creek and Ipsut Creek, and July 9 to August 22 for Carbon River) will avoid direct impacts to spawning fish and incubating bull trout eggs, alevins, and pre-emergent fry. Indirect effects to bull trout eggs and fry may occur during the first season after project implementation as disturbed instream construction sites respond and adjust to increased stream flows during the fall and winter months.

Direct Effects to Bull Trout

Direct Effects associated with Worksite Isolation, Dewatering, and Fish Removal

Work area isolation and dewatering are conservation measures intended to reduce exposure and the risk of potential injury associated with increased turbidity and sedimentation, operation of heavy equipment, and extensive placement of rock and large wood. While a small number of individual bull trout may be exposed to stresses resulting from fish capture, handling, and exclusion, these practices have the benefit of reducing more intense exposures and/or exposures that might affect a substantially greater number of individuals. It is possible that a small number of juvenile bull trout may be killed or injured when captured and removed from isolated work areas.

Our expectation that rescue activities will result in a few mortalities is based on research studies that documented mortality rates of 0.5 to 9 percent for fish capture and handling activities. These research-related mortality rates considered the cumulative handling mortality associated with capture by electrofishing, anesthetizing, measuring, tagging, and holding tagged fish overnight (Peterson et al. 2004, pg. 757). Rescued fish will be exposed to much less manipulation and a much shorter duration of captivity, making mortality rates on the low end of this range a reasonable expectation. Sublethal effects will include a variety of minor injuries and exposed fish will be temporarily disrupted from their normal behavior during the capture and relocation activities.

When in-water work occurs within isolated reaches of streams, fish that avoid capture and rescue are at risk of being crushed or buried during placement of material and operation of equipment in wetted channels. The substrate-oriented behavior of bull trout fry, especially their tendency to hide in interstitial spaces in the substrate as an escape response, increases their susceptibility to being crushed or buried during in-water construction. A few juvenile fish (most likely age 0 fry) will likely avoid capture and die as a result of local work site dewatering and construction impacts. Stream substrate in project areas is frequently compressed by new fill, coffer dams, and heavy equipment.

The total number of fish exposed to worksite isolation and dewatering effects is unknown. For this analysis, we are using estimates of stream length and area affected to represent these effects. For dewatering and fish handling effects, we are assuming that 1.5 x the length of each proposed bank protection structure will be dewatered for work site isolation, and 100 ft. for each culvert removal site that requires dewatering. In total, we expect direct effects (i.e., stress, injury and/or mortality) resulting from fish capture and handling operations associated with work site isolation

and dewatering along 0.38 miles of streams. Most of these effects (0.30 mile) are located along the margin of the main Carbon River channel (Tables 11, 12, 13, 14).

Direct and Indirect Effects associated with Turbidity, Sediment, Substrate Scour and Deposition

Construction of bank protection structures and culvert removal will cause increased transport of suspended sediment and turbidity, at and below a project site. Worksite isolation and erosion control measures will greatly reduce these impacts. However, once onsite construction is completed and a worksite is exposed to flowing water, there will be increased levels of turbidity released in the project vicinity. These project-related sediment plumes will be of short duration (hours to 1 day), but may occur more than once per project site depending upon stream flow. Following construction, both fine and coarse sediments at the project site will be subject to scouring and deposition which can result in short-term (1 season) impacts to downstream bull trout spawning and rearing habitats.

Direct Effects to Fish from Turbidity/Suspended Sediment

Bull trout in the vicinity of project sites will be exposed to project-related turbidity plumes. High levels of turbidity can adversely affect bull trout and have lethal or sublethal effects depending on the sediment concentration and the duration of exposure (Newcombe and Jensen 1996). Foltz et al. (2008, p. 335) reported that the peak sediment concentrations below culvert removal sites ranged from 11 mg/L to 900 mg/L, with an average of 830 mg/L for projects that employed best management practices to minimize turbidity. Projects that did not employ erosion control measures had average sediment concentrations over 13,000 mg/L. The average concentration of 830 mg/L is well above the normal background levels of 120 to 400 mg/L in the Carbon River. These concentrations can be expected to last for several hours after construction to 1 day after construction. Based on minimization measures incorporated into the project, we expect that the stream channel excavation will generate relatively low-levels of suspended sediments that are comparable to the mitigated values reported by Foltz et al. (2008, p. 335).

Exposure to suspended sediment concentrations of 830 mg/L for a period of 3 to 24 hours would be expected to cause sublethal effects to juvenile and adult salmonids such as avoidance, abandonment of cover, short-term reductions in feeding rates, gill irritation, and increased respiration (Newcombe and Jensen 1996, p. 699). These sublethal effects are considered to be a significant impairment of normal behaviors. A similar exposure to salmonid eggs and alevins can result in delayed hatching, reduced growth, and a potential mortality rate of 0 to 20 percent. Only bull trout juveniles or adults will be exposed to turbidity plumes. Based on the timing for inwater excavation work, bull trout eggs or alevins would not be exposed to construction related turbidity plumes.

Estimating the Extent of Downstream Sediment Effects

The concentration of suspended sediment in a turbidity plume and the distance downstream that the turbidity plume will carry a significant sediment concentration varies greatly based on site-specific characteristics such as stream substrate, stream gradient, and stream flow. As sediment enters a stream, it is transported downstream under normal fluvial processes and deposited in

areas of low shear stress (MacDonald and Ritland 1989). These areas are usually behind obstructions, near banks (shallow water) or within interstitial spaces in the stream substrate. Estimating the extent of downstream suspended sediment effects is difficult because sediment conveyance and mixing characteristics are different for each stream.

Foltz et al. (2008, p. 329) monitored suspended sediment concentrations at 11 culvert removal projects in small streams in Idaho and Washington. They found that suspended sediment and turbidity was highest within 20 m (66 ft.) of the project site, and decreased by an order of magnitude at a distance of 100 m (328 ft.) downstream. Although there was a significant reduction in turbidity at 100 m downstream, turbidity levels still exceeded water quality standards at this distance. At 810 m (2,657 ft., or 0.5 mile) downstream, suspended sediment concentrations had returned to near background levels. This study provides empirical evidence to indicate that significant sediment plumes are likely to occur at distances exceeding 100 m downstream from culvert removal sites, but all but the finest sediments fall out of suspension within a distance of 810 m (0.5 mile).

The FWS has compiled sediment monitoring data for a number of instream construction projects in the Pacific Northwest (USFWS 2010b). Reported suspended sediment concentrations below culvert removal sites and bank protection projects were highly variable. A few projects did not generate high enough sediment concentrations to affect fish behavior or degrade fish habitat, while other projects generated very high concentrations of sediment, similar to the unmitigated values reported by Foltz et al. (2008, p. 335). The majority of the monitoring data indicate the highest sediment concentrations (i.e., levels sufficient to cause adverse effects to fish and fish habitat) generally occur within the first 100 ft. to 600 ft. downstream from construction sites (USFWS 2010b, pp. 45-56). Beyond 600 ft. downstream from construction sites, suspended sediment concentrations rapidly decrease to low levels, and all but the finest materials rapidly settle out. We expect that bull trout may be exposed to low concentrations of suspended sediment at distances up to 0.5 mile downstream from construction sites, but the effects of such exposures will be insignificant due to the brief duration and low severity of sediment concentrations at these distances (USFWS 2010b, pp. 45-56).

Based on the above information, we used the project footprint length plus 600 ft. downstream to estimate the area where bull trout are most likely to be subjected to adverse effects from turbidity plumes. We acknowledge that this distance may over-estimate or under-estimate the extent of these effects, but given the highly variable nature of sediment transport and deposition, we argue that this is a reasonable worst-case assumption to account for these effects.

Given the above assumptions, we expect direct effects (i.e., stress and/or injury) resulting from short-term exposures to construction-related turbidity and sediment along 2.68 miles of streams. Over half of these estimated impacts (1.37 miles) are located in floodplain tributary streams and side channels (Tables 11, 12, 13, 14, below).

Direct Effects to Bull Trout from Sediment and Substrate Embeddedness

Fine sediments from turbidity plumes will deposit rapidly below project sites causing short-term increases in substrate embeddedness in deposition areas. Following construction, both fine and

coarse sediments at project sites will be subjected to scouring and deposition which can result in short-term impacts (1 season) to downstream fish spawning habitat. These sediment deposits can result in mortality of bull trout eggs, alevins, and age-0 fry if deposited in spawning areas through increased substrate embeddedness, or loss of redds due to scouring effects. Egg survival depends upon a continuous supply of well oxygenated water through the streambed gravels (Cederholm and Reid 1987). Deposition of fine sediments can reduce the water flow through the substrate and, therefore, reduce oxygen to eggs and alevins which can decrease egg survival, decrease fry emergence rates (Bash et al. 2001; Cederholm and Reid 1987; Chapman 1988), and delay the development of alevins (Everest et al. 1987).

The inwater work window occurs in July and August during a period of decreasing flows in the Carbon River. Mean flow levels in the Carbon River and its tributaries will continue to remain at low levels during the bull trout spawning period in September and October. Therefore, bull trout that spawn directly below construction sites are at risk of having their redds scoured or buried due to changes in the channel configuration, resulting in decreased egg survival and fry emergence rates. Any reduction in incubation success is a significant adverse effect that represents injury or mortality. Bull trout eggs and alevins are most likely to be affected by these substrate impacts.

Estimating the Extent of Downstream Substrate Effects

To our knowledge, there are no studies that report specifically on the extent of changes in channel configuration or substrate embeddedness that can occur below instream construction sites, and we expect that these effects are highly variable depending upon site-specific conditions. Lachance et al. (2008, p. 1836) reported significant increases in fine sediments (particle sizes less than 5 mm) in stream substrate occurred up to 200 m (656 ft.) downstream from newly installed culverts, and noted that fine sediment concentration was highest in the year following construction due to road fill and road surface erosion. The context of this study was new road construction over low-gradient, trout spawning streams, but the study illustrates the temporal nature of fine sediment erosion and deposition at disturbed sites.

As with our assumptions for downstream turbidity effects, we assume that significant levels of scour and sediment deposition are most likely to occur within a distance of 600 ft. from instream construction sites. To account for these effects, we used the project footprint length plus 600 ft. downstream to estimate the area where bull trout are most likely be subjected to adverse effects from increased substrate embeddedness and substrate scour and deposition effects. We acknowledge that this distance may over-estimate or under-estimate the extent of these effects, but given the highly variable nature of substrate scour and deposition, we argue that this is a reasonable worst-case assumption to account for these effects. In total, we expect indirect effects associated with stream substrate scouring and sediment deposition in fish spawning areas that result from changes in channel configuration along 2.68 miles of streams. The effect is mortality and reduced incubation success for 1 season in the affected areas. Over half of these estimated impacts (1.37 miles) are located in floodplain tributary streams and side channels that provide important spawning and rearing habitat (Tables 11, 12, 13, 14, below).

Effects of Sediment on Salmonid Food Sources

Salmonids favor certain groups of benthic macroinvertebrates, such as mayflies, caddisflies, and stoneflies. These species prefer large substrate particles in riffles and are negatively affected by fine sediment (Everest et al. 1987; Waters 1995). Any modification of the streambed by deposited sediments will most likely have a profound effect upon the benthic invertebrate community (Waters 1995). The degree to which substrate particles are surrounded by fine material was strongly correlated with macroinvertebrates abundance and composition (Birtwell 1999). At an embeddedness of one-third, insect abundance can decline by about 50 percent, especially for riffle-inhabiting taxa (Waters 1995). In addition to impacts to aquatic invertebrate communities, the project will also impact fall spawning salmonids in the action area, such as brook trout, coho salmon, and mountain whitefish. All of these species provide potential prey resources for Carbon River bull trout. The effects to these other species are the same as described for bull trout above. Fish that spawn in the immediate vicinity of culvert removal sites or bank protection structures are likely to have reduced incubation success and fry recruitment due to substrate scour. The potential effects to salmonid food sources are considered a general degradation of fish habitat conditions. For this analysis, we assume that the extent of adverse impacts associated with sediment and substrate effects listed in Tables 11, 12, 13, and 14, accurately describe these effects.

Indirect Effects to Bull Trout

Effects of Bank Protection Structures along the Carbon River

Large bank protection structures are proposed in five locations along the Carbon River between the Park entrance and Ipsut Creek Campground. This segment of the Carbon River is approximately 5 miles long. The total length of bank protection proposed by the Park is 1,060 ft. (0.20 mile). This represents about 4 percent of bank along the south side of the river, or 2 percent of the total river bank in the action area considering both the north and south banks. The existing bank armoring with riprap in this section of the river is estimated at 0.7 miles along the south bank, so the combined total of existing bank protection and new structures will equal approximately 0.9 miles or about 18 percent of the south bank of the Carbon River between the Park entrance and Ipsut Creek Campground. These bank treatments will function to directly armor or reinforce eroding banks and deflect flows away from the river bank to protect threatened sections of the Carbon River Road.

Bank protection structures that halt lateral scour and natural channel migration disrupt the natural fluvial process of bank erosion. Bank erosion recruits sediment and wood to the stream, creates and maintains in-stream and floodplain habitats (e.g., side channels), maintains overall aquatic habitat diversity within the stream corridor, and enables the stream to respond to changing conditions within its watershed (SHRG 2004). Much of the large wood that enters the upper Carbon River is transported downstream during flood events and contributes to formation of logjams and fish habitat features in the lower watershed. The ecological function that large wood provides in habitat structure and nutrients for salmonids and a variety of other aquatic organisms is well documented (Everest and Reeves 2007, p.19). Any reduction of large wood

recruitment due to bank protection potentially reduces habitat complexity and productivity for bull trout and their associated prey species.

Construction of bank protection structures will require work site isolation, dewatering, and sediment and erosion control measures. Each site requires extensive excavation of the bank and channel bed to allow the structure to be placed below the potential scour depth of the river and built up from that elevation. Bank protection structures also need to be keyed into intact bank areas, resulting in streambank and riparian area disturbance and short or long-term loss of riparian vegetation at construction sites.

The proposed stream bed and stream bank stabilization measures include a series of approximately (4) ELJs, (3) toe-roughened gabion/log structures, (1) rock barb, and (1) log cribwall. At this time, funding for these structures has not been secured. Additionally, the bank protection measures proposed by the Park are conceptual designs. Final designs and engineering considerations have not been completed, and some structures may be determined to be infeasible. For the purpose of this analysis, we are analyzing the general effects anticipated from the proposed conceptual designs in Appendix 1.

Rock Barbs

Under the proposed action, two rock barb structures will be placed in the maintenance area. The structures will be recycled later as ballast for an ELJ on the same site. For a barb to be effective, the footprint of the barb is excavated down below the potential scour depth of the river channel and built up from that level. Barbs redirect flow away from an eroding bank. Realignment of flow and redistribution of sediment may impact existing fish spawning areas. A decrease in bank erosion will reduce periodic inputs of gravel and woody debris into the channel, which represents a lost opportunity for continued development of habitat complexity. Riparian function is also impacted by replacing riparian vegetation with a barb (ISPG 2003, p. 6-26).

Engineered Logjams

Engineered Logjams generally produce scour adjacent to themselves. The scour at the margin of the jam and the associated downstream deposition moves the location of the main current away from an eroding bank. Engineered Logjams offer a distinct advantage over most rock structures such as barbs and groins. As scour holes develop adjacent to the logjam, the interlocking nature of logjams allow them to deform and settle; effectively retaining the structural integrity of the structure (ISPG 2003, p. 6-33). Engineered Logjams can provide valuable fish and wildlife habitat. Immediately following placement of ELJs, there may be temporary, short-term impacts on spawning and rearing habitat. Existing spawning areas may shift or scour; while others may accrete with fines while new spawning areas are forming. It may take the channel a period of time to adjust to the jams. However, the long-term habitat benefits of ELJs generally outweigh these short-term impacts. The structural and hydraulic diversity that ELJs provide creates habitat for a multiple fish species at nearly every stage of life. ELJs create excellent cover, holding and rearing habitats. Spawning habitat may be created at the tailout of the scour hole created by an ELJ. The detritus they accumulate, particularly smaller twigs and leaves that decay rapidly, also serves as a food to some aquatic insects that fish consume (SHRG 2004). Placement of ELJs

results in unavoidable short-term direct and indirect impacts to bull trout and bull trout spawning and rearing habitat. Engineered Logjams that are not keyed into rip-rap hardened banks do not result in a long-term disruption of natural fluvial processes because the structures are deformable and degradable over time, and even if the structure ultimately fails as a bank protection, the structures create complex habitat features.

Log Cribwalls and Rock/Log Toe-Roughened Structures

Log cribwalls can be very effective at controlling bank erosion and can provide relatively permanent protection. However, permanent protection eliminates a source of sediment supply and recruitment of large woody debris, which affects the natural balance of erosion and deposition within a channel. Also, cribwalls tend to arrest downstream meander migration, increasing bank erosion upstream and/or downstream from their placement. Because logs have a limited life span, this effect is not permanent, but it may go on for decades. The reduced roughness characteristics of log cribwalls may also have a detrimental impact to adjacent spawning beds, cover and holding habitat. Roughness can be enhanced in the design of a log cribwall by incorporating roughness elements such as rootwads into the cribwalls construction (ISPG 2003, p. 6-100).

Log and rock roughened toe structures harden the bank into a relatively uniform and permanent position and shape, resulting in short-term lost opportunity for sediment supply, recruitment of large woody debris and off-channel habitat. Log toes are considered superior to rock toes in terms of providing habitat elements, and log toes will eventually degrade; rock does not. Fish tend to prefer the complexity of wood structures more than rock, so log toes are the preferred bank-protection option over rock toes. Salmonids are found along riprap banks, but the habitat is not preferred in most cases where they have a choice. Rock toes and revetments with large woody debris have been shown to have more fish abundance than plain rock (ISPG 2003, p. 6-91). Because these structures are designed to halt lateral channel migration, they result in a degradation of stream and riparian habitat in the affected reaches.

Gabions

Due to equipment limitations along the upper Carbon River Road, the Park is proposing to use gabions in the place of large riprap in the construction of toe-roughened structures. Gabion baskets would be filled with river rock excavated onsite and used in place of boulders in the construction of log and rock toe roughened structures. In this application, the gabion baskets would be buried within the toe-roughened structure, and logs with rootwads will be used to form the face of the structure that is exposed during high flow events. The other proposed application of gabions is for bridge abutments at trail bridge crossings.

The use of gabions in bank protection structures is limited to specific applications, and is generally not recommended in areas where gabions will be exposed to high velocity currents and potential damage from floating logs or other debris. Under these conditions, the wire can be damaged and the protection lost. Gabions must also be protected against impact from large woody debris and sharp objects. These materials tend to distort and break the gabions (Freeman and Fishenich 2000, p. 8).

The most important consideration for the installation of gabions is the stability of the stream. If the stream is undergoing rapid changes in base elevation (down- cutting or deposition), there is a high risk of failure due to the structures being overwhelmed or flanked (Freeman and Fishenich 2000, p. 3). Considering the rapid rate of lateral scouring occurring along the Carbon River, the risk of gabion failure is high. The U.S. Forest Service used gabions for bridge abutments on the Carbon River Bridge (Forest Road 7810, located just below the Park boundary) from 1986 to 1996. These gabions were frequently damaged and undermined by high flows on the Carbon River, and ultimately failed (USFS 1998).

Over time the gabion baskets can rust and break due to abrasion, resulting in a potential hazard to fish, wildlife and people (CDFG 1998, p. VII-7). In this application, the gabions will be buried within toe-roughened log structures and will not be directly exposed to surface erosion from the Carbon River. However, the Carbon River has highly erodible banks in the areas where the structures are proposed, so there is real potential that the bank protection structures could fail over time and gabion baskets could be exposed. Because the gabions are non-biodegradable and will be used in structures that are designed to halt lateral channel migration, they result in a general degradation of stream and riparian habitat in the affected reaches.

Excavation of River Rock for Gabions

Due to equipment limitations along the upper Carbon River Road, the Park is proposing to use river rock excavated from gravel bars in the active Carbon River channel to use for fill in gabions in the place of large riprap in the construction of toe-roughened structures. Excavation of river rock is limited to dry gravel bars, although equipment (e.g., a small excavator and ATVs with trailers) may need to cross wetted channels to access excavation sites. Equipment crossings will be confined to single designated crossing point for each site. All channel excavation is limited to the depth of the adjacent wetted channel elevation. No excavation below the wetted channel elevation is proposed, and all excavation of rock below the bankfull channel width will occur during the approved inwater work season.

The amount of gravel needed for proposed bank protection structures has been roughly estimated at over 5,100 cy. Some of the rock needed will come from within the footprint of proposed structures. Additional rock will be excavated from gravel bars within the braided channel complex. To estimate the area associated with gravel excavation, we assumed that each cubic yard will result in an average of 9 ft^2 of gravel bar surface excavation. Based on the estimated project construction footprint for bank protection structures (1.15 acres) and additional excavation area needed for rock (0.74 acres), an estimated total 1.89 acres of channel area will be excavated in 5 locations along the Carbon River between the Park entrance and Ipsut Creek (Table 11). Most gravel excavation would occur along a 1.14 mile reach located between MP 3.46 and 4.47 along Carbon River Road. The channel in this section is about 500 ft. wide by 6,000 ft. long, and occupies an area of about 70 acres. About 25 percent of the channel width is occupied by wetted channels, so there are about 50 acres of exposed gravel bars in this reach. The proposed gravel excavation would affect about 4 percent of the exposed gravel bars in this reach.

The Carbon River channel is transporting massive amounts of stream bedload and sediment annually. The removal of gravel does not represent a significant loss stream substrate material. The effects of the gravel excavation will primarily be in the form of indirect effects to adjacent areas as the channel configuration changes during subsequent high flow events. Any bull trout redds that are located in the vicinity of the gravel excavation sites are likely to be scoured or buried as a result of subsequent channel adjustments during high flow events. The extent that bull trout spawn in the Carbon River is unknown, but spawning within the Carbon River channel has been documented in the vicinity of the tributary confluences at June Creek and Ipsut Creek (NPS 2009c), indicating some spawning use along the margins of the Carbon River channel. Generally, the risk of spawning bed impacts associated with gravel excavation is considered to be very low at all gravel excavation sites except in the vicinity of M.P. 4.47 which is located near the Ipsut Creek confluence.

We are not able to predict exactly the extent or configuration of excavated areas. To estimate the adverse impacts to stream substrates we assumed that each site that requires additional gravel excavation results in a doubling of adverse substrate impacts (Table 11).

Use of Large Wood from within the Carbon River Channel

Some logs from the active Carbon River channel will be moved for use in the construction of bank protection structures. There are large deposits of logs and other woody debris located on dry gravel bars in the Carbon River channel. These are locations that collect woody debris over time and often result in the formation of stable, vegetated gravel bars, or result in the formation of debris jams that interact with the channel to create local scour and deposition features. Large wood in the floodplain can also be transported downstream during flood events and contributes to formation of logjams and fish habitat features in the lower reaches of the watershed.

This action will relocate existing large wood within the channel, but would not result in a net reduction of large wood within the affected stream reaches. Only logs that are located in the footprint of a construction site, or are located on adjacent dry gravel bars may be moved. The total number of logs to be used from the river channel has not been quantified. For each 100 ft. of log crib structure, approximately 28-35 logs are needed (Appendix 1). There are approximately 820 ft. of log structures proposed at 3 locations above Ranger Creek (Table 11). Assuming there are 30 logs needed per 100 ft. of structure, a total of 246 logs would be needed to construct 820 ft. of bank protection structures. At road washouts there are typically several large trees that have fallen into the scoured area that could be used in the construction of bank protection structures. The expectation is that onsite logs will provide some of the needed material for each structure (e.g., about 25 percent, or approximately 62 logs), and that additional logs will purchased from a commercial source and brought in with a helicopter as needed. Logjams near the Park entrance will be constructed primarily with purchased logs.

No intact logjams that are interacting with active, wetted channels may be moved, except within the construction footprint of proposed bank protection structures. The effect is that large wood that is currently available for downstream transport and formation of salmonid habitat will be relocated to long-term bank protection structure. The result is that there would be no net reduction in large wood within the bankfull channel width at the reach scale, but the amount of

large wood available for downstream transport would be reduced. Because the Carbon River is large, active channel with high levels of large wood, the relocation of a limited amount of logs (approximately 62 pieces at 3 locations) for structures is not expected to significantly affect the productivity of downstream bull trout habitat.

Heavy equipment may need to cross wetted channels to access and transport logs. Equipment crossings will be confined to a single designated crossing point for each construction site, and use of heavy equipment below the bankfull channel width will occur during the approved inwater work season. Adverse impacts associated with heavy equipment crossings and gravel bar disturbance (e.g., substrate and turbidity impacts) are limited to the immediate project area. For this analysis, we assume that the extent of adverse impacts listed in Table 11 accurately describe these effects.

Streambank Disturbance and Loss of Riparian Vegetation

Construction of bank protection structures will result in adverse effects to streambanks, including removal or damage to streamside vegetation while construction activities are occurring, and removal or reshaping of streambank materials during site preparation or project feature installation. These streambank modifications remove overhead cover for fish, and remove bank-stabilizing plants and materials (e.g., rocks and large wood), which results in short-term increases in turbidity and downstream sediment deposition. Impacts to listed fish also include removal of stream vegetation, which increases solar radiation, decreases overhead cover for listed fish, and reduces contribution of terrestrial food to listed fish. Due to the limited amount vegetation removal proposed, the potential effects to water temperature are considered to be insignificant. For this analysis, we assume that the extent of adverse impacts associated with the construction footprint listed in Table 11 accurately describes the short-term and long-term streambank disturbance effects.

Chemical Contaminants from Heavy Equipment

Constructing the proposed bank protection structures will require that one or more pieces of heavy equipment enter and operate below the bankfull channel width of the Carbon River. A release of harmful materials (e.g., fuel, lubricants, hydraulic fluid, etc.) is possible. All equipment operating below the bankfull width will use vegetable-based hydraulic fluid, and no oils, fuels, cleaning agents or solvents, concrete or equipment wash water, slurry, waste, or construction debris will be discharged to surface waters or onto land with a potential to reenter surface waters. With full implementation of the minimization and avoidance measures, effects to water quality due to chemical contamination during construction are unlikely to occur and are therefore discountable.

Future Flood Damage and Deposition of Road/Trail surface fill into the Carbon River

Road segments in the vicinity of the washouts and along other flood damaged areas have a high risk of damage from future floods. There is a high probability that flooding will damage road segments and deliver road or trail surface fill into the Carbon River. Road and trail humps installed along the trail will function to limit the severity and extent of surface erosion.

Considering the magnitude of bedload movement that occurs during high flow events in the Carbon River, the effects of road/trail fill delivery to the Carbon River channel are considered to be insignificant. Road/trail fill materials that are delivered to tributary streams (e.g. Falls Creek), however, are considered an adverse impact to fish spawning and rearing habitat due to the potential for increased substrate embeddedness in the affected stream reaches from road fill material. Any increase in substrate embeddedness in spawning and rearing habitat will ultimately result in reduced incubation success and productivity.

Table 11. Summary of aquatic impacts associated with bank protection structures along the Carbon River.

MP - General location	Structure type	Estimated construction impacts within the bankfull channel width				
		Constr-uction footprint (length)	Constr-uction footprint (area)	Additional excavation area for river rock	Worksite isolation / dewatering and fish handling	Extent of adverse turbidity/ substrate impacts
MP 0.0 – Park entrance Carbon River at June Creek	(2) ELJs (60' x 20')	240 ft.	4,800 ft^2	NA	180 ft.	840 ft.
MO 0.15 Maintenance Area Carbon River	(1) Rock barb deflector to be replaced with (2) ELJs (60' x 60' each)	240 ft.	14,400 ft^2	NA	180 ft.	840 ft.
Washout at MP 3.46 Carbon River below Chenuis Falls Trailhead	(1) Gabion log / rock roughened toe structure 15' x 240' River rock for gabions is estimated at 1,300 CY	240 ft.	3,600 ft^2	8,100 ft^2	360 ft.	840 ft. x 2 = 1,680 ft.
Road washout at MP 3.93 Carbon River	(1) Gabion log / rock roughened toe structure 15' x 200' River rock excavation for gabions is estimated at 1,084 CY	200 ft.	3,000 ft^2	6,756 ft^2	300 ft.	800 ft. x 2 = 1,600 ft.
Road washout at MP 4.47 Carbon River near Ipsut Creek	(1) Log crib wall or gabion log / rock roughened toe structure 15' x 380' River rock excavation for gabions is estimated at 2,060 CY	380 ft.	5,700 ft^2	12,840 ft^2	570 ft.	980 ft. x 2 = 1,960 ft.
Carbon River Totals		1,300 ft.	31,500 ft^2 0.72 acres	27,696 ft^2 0.63 acres	1,590 ft. 0.30 mile	6,920 ft. 1.31 miles

Assumptions:
1 cubic yard of gravel excavation = 9 ft^2 of gravel bar surface area.
Each site that requires additional gravel excavation results in a doubling of adverse substrate impacts.
Worksite isolation and dewatering = 1.5 x proposed structure length
Logjam construction footprint = 2 x length and width of proposed structure
Gabion log / rock roughened toe footprint = 1 x length and width of proposed structure.
Downstream turbidity/sediment effects = construction footprint + 600 ft.
Worksite isolation and dewatering along the Carbon River is confined to the channel margin along the south bank.

Effects to Bull Trout in the Falls Creek/Carbon River Side Channel

Modified Drop Structures as Partial Check Dams

The footprint of the Carbon River Road in the vicinity of Falls Creek was scoured to a depth of about 6 ft. below ground level for a distance of about 2,600 ft. The scour channel intercepts Falls Creek for a short distance (400 ft.) along the old footprint of the road, but most of the channel length is now an active side channel of the Carbon River. Prior to 2010, the scour channel had gone dry in late July and remained dry into the fall months (NPS 2009c). Since the 2006 flood, subsequent high water events have deepened the scour channel and increased the connectivity with the Carbon River. The channel captures both surface flows and ground water, and is used seasonally by bull trout and other salmonids as rearing habitat. Fish spawning has not been documented in the channel, but may occur in or below the project area in the lower stream reach that now carries the combined flows from Falls Creek and the Carbon River side channel.

The Park proposes to use onsite logs and wood debris to create modified drop structures (Appendix 1) along approximately 2,600 linear ft. of the channel. The total number of structures has not been determined, but is estimated at one structure per 100 ft. of channel. The objective is to dissipate stream energy and cause channel aggradation behind the structures. The structures will be positioned to deflect flows away from the south bank (trail side) of the channel, and encourage bank erosion and channel widening along the north bank of the channel. All drop structures will be constructed with low notches with a maximum drop height of 8 inches to maintain fish passage over the structure. No dewatering or fish handling is anticipated in this area, because there would be no excavation with heavy equipment below the bankfull channel width. Construction turbidity is expected to be minimal, and there is a possibility that the channel could be dry during construction.

There is a high level of uncertainty associated with predicting the effects of these structures. The Falls Creeks area was ranked as having an extremely high risk of future flooding and lateral channel migration along the Carbon River (Appendix 1). Potential outcomes include:

- A diversification and improvement of stream habitat complexity due to the placement of large wood into the wetted channel width. These features will encourage local scouring and deposition that will create small pool/riffle features in the channel, and could ultimately improve the productivity and capability of the side channel to support fish.

- During high flow events, check dams could constrict flows and have a damming effect that causes water to back up and scour around the structures, resulting in more severe bank erosion and a widening of the channel. High levels of substrate aggradation in the treated area could result in a subsequent loss of surface flows during low flow periods, and stranding or mortality of fish trapped in isolated areas.

- Blocked fish passage for juvenile salmonids. Considering the number of structures proposed, there is a high probability that one or more structures could create partial or total barriers to fish passage. These structures will need to be monitored annually to ensure fish passage is maintained.

Significant adverse effects to rearing bull trout associated with excessive aggradation of stream substrates and potential losses of surface flow during low-flow periods, as well partial barriers to fish migration, are anticipated along 4,500 ft. of the Falls Creek / Carbon River side channel (Table 12).

Location of Carbon River Road Hiking and Biking Trail in the Riparian Zone

The by-pass trail that will be constructed in the Falls Creek area is located at a distance of 0 to 25 ft. from the south bank of the channel for about 2,600 ft. Therefore, the trail location will have a direct and long-term impact on streambank condition and riparian vegetation along this area. Primary stream shade and nutrient inputs would still be provided by overstory trees along the trail corridor, but there will be a continued, long-term loss of about 0.6 acres of streamside understory vegetation along this section. These impacts will result in reduced organic inputs via litterfall and terrestrial invertebrates to the stream, resulting in a reduced aquatic primary productivity in this reach.

The primary impact associated with this trail location is the high risk of trail failure during future flood events. There is a high probability that this section of the trail will be subjected to frequent flood damage and delivery of the trail surface materials to the channel, resulting in local aggradation of sediments in this reach. Trail humps installed throughout this section would reduce the severity of this impact, but adverse impacts to stream substrates are likely to continue to occur from this trail location. For this analysis, we assume that the extent of adverse impacts listed in Table 12, accounts for these effects.

Table 12. Summary of aquatic impacts along the Falls Creek/Carbon River side channel.

MP - General location	Structure type	Estimated construction impacts within the bankfull channel width				
		Const-ruction footprint (length)	Constr-uction footprint (area)	Additional excavation area for river rock	Worksite isolation / dewatering and fish handling	Extent of adverse turbidity/ substrate impacts
MP 1.468 – Falls Creek trib. #1 (CR 21) Estimated channel width = 5 ft.	Remove 2' x 30' cmp, replace with 4-stringer bridge, 15 ft. long. Install grade-control check dam upstream of crossing	50 ft.	250 ft^2	NA	NA – seasonally dry	650 ft. Beneficial effect = restored access to 0.05 miles of fish rearing habitat
MP 1.496 – Falls Creek trib. #2 (CR 19) Estimated channel width = 10 ft.	Remove 2' x 30' cmp, replace with 4-stringer bridge, 15 ft. long. Install grade-control check dam upstream of crossing.	50 ft.	500 ft^2	NA	NA – seasonally dry	650 ft. Beneficial effect = restored access to 0.2 mile of fish rearing habitat
MP 1.644 – Falls Creek, new stream channel location. Estimated channel width = 20 ft.	Existing trail bridge will be replaced in the new trail alignment. Replace with a 4-stringer bridge, 35 ft. long with gabion basket abutments.	20 ft.	400 ft^2	NA	NA – seasonally dry	NA – Impacts accounted for with instream structures along the side channel.
MP 1.680 – Falls Creek historic channel location, now filled with gravel. – intersects with active Falls/Carbon side channel	11' x 6' cmp, 33 ft. in length. Remove culvert, back-fill trench with coarse rock and re-grade site to existing trail alignment and elevation.	Excavate 20 ft. along south bank of active side channel	NA	NA	30 ft. – at intersection with active Falls/Carbon side channel.	NA- impacts accounted for with instream structures along the side channel.
MP 1.56 – 1.95 Falls Creek/ Carbon River side channel - Estimated average channel width = 25 ft.	Install approx. (26) logs / modified drop structures along 2,600 ft. of channel 2,600 ft. of riparian impacts with trail location.	Estimated at 20 ft. for each structure =520 ft. below bankfull,	13,000 ft^2	NA	NA – not proposed due to no excavation below bankfull width with heavy equipment	3,200 ft. Substrate impacts along entire length and 600 ft. downstream.
Totals for Falls Creek/Carbon side channel		660 ft.	14,150 ft^2 0.32 acres	-	30 ft.	4,500 ft. 0.85 mile

Assumptions:
Worksite isolation and dewatering = 1.5 x proposed structure length, or 100 ft. for culvert sites.
Log check dams or modified drop structures = 20 ft. of streambed disturbance for each structure.
Downstream turbidity/sediment effects = construction footprint + 600 ft.

Effects of Culvert Removal at Ranger Creek and other sites

As described above under direct and indirect effects to bull trout, we expect that culvert removal will result in unavoidable, short-term adverse effects to bull trout including mortality of juveniles, alevins, and eggs. Culverts at Ranger Creek and the Chenuis Falls trailhead tributary have large deposits of sediments that have aggraded above the culverts. The Chenuis Falls trailhead tributary will require the placement of a series of drop structures to control channel incision and upstream headcutting after culvert removal. Even with these structures in place, there will be downstream movement and deposition of sediments after culvert removal. Large scour pools below the culvert outfalls will likely fill in and eventually attain a profile that is more consistent with the natural profile of these streams. Despite these short term impacts, the removal of barrier culverts is identified as a high priority recovery action in the draft bull trout recovery plan (USFWS 2004, p. 245). Replacing undersized culverts that were partial or full barriers to fish will improve the ability of rearing salmonids to use all available rearing habitat more effectively. Restoring fish passage and access to high quality floodplain tributary habitat will contribute to improved survivorship, population growth and potential recovery (Table 13).

Table 13. Summary of aquatic impacts at Ranger Creek/Chenuis Falls Trailhead tributary**.**

MP - General location	Structure type	Estimated construction impacts within the bankfull channel width				
		Const-ruction footprint (length)	Constr-uction footprint (area)	Additional excavation area for river rock	Worksite isolation / dewatering and fish handling	Extent of adverse turbidity/ substrate impacts
MP 3.142 Ranger Creek – channel width is about 25 ft.	12' x 7.6' cmp, 30 ft. in length. Remove culvert. Construct steel I-beam bridge, 40 ft. long, 10 ft. wide with concrete footings.	30 ft.	750 ft.	NA	100 ft.	630 ft. 0.12 mile
Ranger Creek beneficial effects = restored access to 0.5 mile of high quality spawning and rearing habitat						
MP 3.586 Unnamed tributary at Chenuis Falls trailhead channel width is about 15 ft.	9.6' x 6.6' cmp, 39 ft. in length. Remove culvert. Construct steel I-beam bridge, 30 ft. long, 10 ft. wide with concrete footings. Install grade-control check dam upstream of crossing.	60 ft.	900 ft.	NA	100 ft.	660 ft. in Carbon River side channel below culvert. 0.125 mile
Tributary beneficial effects = restored access to 0.25 mile of spawning and rearing habitat						

Assumptions:
Worksite isolation and dewatering = 1.5 x proposed structure length, or 100 ft. for culvert sites.
Log check dams or modified drop structures = 20 ft. of streambed disturbance for each structure.
Downstream turbidity/sediment effects = construction footprint + 600 ft.

Effects to Fish Habitat at Ipsut Creek

Major changes to channel configuration in Ipsut Creek resulted from the 2006 flooding. An active side channel from the Carbon River now intercepts Ipsut Creek above the historic road crossing, and now the lower 0.5 miles of Ipsut Creek channel now carries the combined flow of Ipsut Creek and the side channel during high flow events. About 1,100 ft. of the new Ipsut Channel is located in the former footprint of the Carbon River Road (Appendix 1). The new channel location threatens the by-pass trail in the vicinity of MP 4.65. The proposed action includes the construction of a 130 ft. gabion log/rock roughened toe structure. Along with the short-term direct and indirect adverse impacts associated with fish handling (195 ft.) and substrate impacts (1,460 ft.), this action would result in long-term adverse effects to bull trout from bank protection and placement of non-biodegradable gabions within the active stream channel (Table 14). Due to the increasing flows from the active Carbon River side channel in this area, this structure will likely be subjected to increasing flows over time, and the long-term risk of structure flanking and failure is very high.

Construction of toe-roughened structure in Ipsut Creek will result in significant adverse direct and indirect effects to bull trout because of the known documented spawning use in this stream, Subsequent changes in channel configuration have a high likelihood of impacting bull trout redds in the vicinity of the structure in the first season after construction (Table 14).

Table 14. Summary of aquatic habitat effects at the Ipsut Creek/Carbon River side channel.

MP - General location	Structure type	Estimated construction impacts within the bankful channel width				
		Const-ruction footprint (length)	Constr-uction footprint (area)	Additional excavation area for river rock	Worksite isolation / dewatering and fish handling	Extent of adverse turbidity/ substrate impacts
MP 4.65 - trail location threatened by Ipsut/Carbon channel - channel width is about 35 ft.	Potential site for (1) Gabion log / rock roughened toe structure 15' x 130ft' River rock excavation for gabions is estimated at 704 CY	130 ft.	1,950 ft.	4,386 ft^2	195 ft.	730 ft. x 2 = 1,460 ft.
MP 4.802 Ipsut/Carbon new channel location – channel width is about 35 ft.	Existing trail bridge will be replaced. Construct a small log cribwall structure on west bank as bridge abutment. Replace bridge with a new 8' x 50' log stringer bridge, on elevated footings	25 ft.	700 ft.	NA	NA - not proposed due to limited work below bankfull channel width.	25 ft. – limited to the immediate area of trail bridge construction work.
Totals for Ipsut Creek/Carbon side channel		155 ft.	2,650 ft.	4, 386 ft^2	195 ft.	1,460 ft. 0.28 mile

Assumptions:
1 cubic yard of gravel excavation = 9 ft^2 of gravel bar surface area.
Each site that requires additional gravel excavation results in a doubling of adverse substrate impacts.
Worksite isolation and dewatering = 1.5 x proposed structure length, or 100 ft. for culvert sites.
Gabion log / rock roughened toe footprint = 1 x length and width of proposed structure.
Log check dams or modified drop structures = 20 ft. of streambed disturbance for each structure.
Downstream turbidity/sediment effects = construction footprint + 600 ft.

Effects of Interrelated and Interdependent Actions

It is likely that sections of the Carbon River Road / Trail will be subjected to frequent flood damage and delivery of the trail and road surface materials to stream channels, resulting in local sedimentation or aggradation effects. Depending on the severity of the flood damage, some trail sections may be damaged and rebuilt several times over subsequent years. Trail and road humps would reduce the severity of these impacts, but adverse impacts to stream substrates are likely to continue to occur from this trail and road location. Future reconstruction of any failed bank protection structures is not a covered action under this Opinion and will require separate analysis and consultation under section 7 of the Act.

Summary of Direct and Indirect Effects to Bull Trout

The proposed action includes several projects that will require the use of heavy equipment below the bankfull elevation in the Carbon River and its tributaries. These projects will result in both direct and indirect effects to listed fish and their habitat. Some of these effects will be temporary, construction-related and limited in both physical extent and duration. Others will be long-term, lasting for the functional life of the proposed stream bed and stream bank stabilization measures. Project construction impacts will occur over a period of three to four years, depending on funding and the logistics of project implementation. Long-term effects associated with the Carbon River Road/Trail location will continue to occur for as long as the Park maintains access along this route:

- Direct effects (i.e., stress, injury and/or mortality) resulting from fish capture and handling operations associated with work site isolation and dewatering along 0.38 miles of streams. Most of these effects (0.30 mile) are located along the margin of the Carbon River channel (Table 15).

- Direct effects (i.e., stress and/or injury) resulting from short-term exposures to construction-related turbidity and sediment along 2.68 miles of streams. Over half of these estimated impacts (1.37 miles) are located in floodplain tributary streams and side channels (Table 15).

- Indirect effects associated with stream substrate scouring and sediment deposition in fish spawning areas that result from changes in channel configuration along 2.68 miles of streams. The effect is mortality and reduced incubation success for 1 season in the affected areas. Over half of these estimated impacts (1.37 miles) are located in floodplain tributary streams and side channels that provide important spawning and rearing habitat (Table 15).

- Long-term adverse effects to fish habitat structure, function, and diversity. The project will construct bank protections structures that will inhibit natural channel migration, degrade riparian vegetation, and inhibit the recruitment of large wood to stream channels in the affected areas along 0.72 miles of stream channels. Most of these impacts are located in the Falls Creek area (0.49 mile), and along the margins of the Carbon River (0.20 mile). The cumulative effect of proposed structures and existing structures would be 0.9 miles of bank protection structures along the Carbon River (Table 15).

- Long-term beneficial effects associated with restored habitat access to approximately 1 mile of floodplain tributary streams, including Ranger Creek. Removal of Ranger Creek culvert will restore access to approximately 0.5 miles of high quality spawning and rearing habitat (Table 15).

Table 15. Summary of short- and long-term effects to bull trout along the Carbon River Access Corridor.

Location	Long-term adverse stream bank impacts	Worksite isolation / dewatering and fish handling	Extent of adverse turbidity/ substrate impacts	Beneficial effects from restored habitat access
Carbon River Effects limited to channel margin along south bank.	1,060 ft.	1,590 ft. 0.30 mile	6,920 ft. 1.31 miles	NA
Falls Creeks, Falls Creek tributaries, and Carbon side channel	2,650 ft.	30 ft.	4,500 ft. 0.85 mile	0.25 mile
Ranger Creek	25 ft.	100 ft.	630 ft.	0.5 mile
Unnamed tributary stream at Chenuis Falls trailhead	25 ft.	100 ft.	660 ft. in Carbon River side channel	0.25 mile
Ipsut Creek/Carbon side channel	155 ft.	195 ft.	1,460 ft. 0.28 mile	NA
Total estimated adverse impacts for project	3,815 ft. 0.72 mile	2,015 ft. 0.38 mile	14,170 ft. 2.68 miles	-
Total estimated beneficial effects for project	-	-	-	1 mile

Long-term adverse stream bank impacts are associated with the bank protection structures, reconstruction of the by-pass trail through the Falls Creek washout, and 25 ft. for each trail bridge location.

In the analysis of the aquatic environmental baseline, we applied the *Matrix of Diagnostics / Pathways and Indicators* (USFWS 1999) and determined that the overall condition of the upper Carbon River watershed is "functioning at risk" due to past and ongoing degradation of aquatic habitats, primarily from roads. The effects of the proposed action includes restoring habitat access, and both short and long term degradation of other habitat elements. Considering all the effects, we conclude that the condition of the upper Carbon River watershed ("functioning at risk") would not significantly change as a result of this action (Table 16).

Table 16. Summary of the effects of the action to aquatic habitat indicators in the action area ("Matrix of Pathways & Indicators").

Pathway	Indicator	Baseline Conditions	Effects of the Action (Restore – Maintain – Degrade)
Local Population Conditions	Local population size	Functioning at Risk	Maintain – the effects of the action are not expected to result in population level effects.
	Growth and Survival	Functioning at Risk	Degrade – short term (1 season) mortality associated with fish handling/dewatering, and substrate scour and deposition in affected stream reaches.
	Life History Diversity and Isolation	Functioning at Risk	Maintain/restore – the effects of the action are neutral to beneficial considering improved access to key floodplain spawning and rearing habitat in Ranger Creek and other tributaries.
	Persistence and Genetic Integrity	Functioning at Risk	Maintain – the effects of the action are neutral.
Water Quality	Temperature	Functioning at Risk	Maintain – effects of the action are neutral.
	Sediment / Turbidity	Functioning at Risk	Degrade - short-term increases associated with project implementation along 2.68 miles. No long term effects.
	Chemical Contamination & Nutrients	Functioning Properly	Maintain – effects of the action are neutral.
Habitat Access	Physical Barriers	Not Properly Functioning	Restore – culvert removals restore access to 1 mile of habitat.
Habitat Elements	Substrate	Functioning at Risk	Degrade – short term effects associated with project implementation along 2.68 miles. Long-term effects associated with chronic road sediments will continue to be delivered to key tributary streams along Carbon River Road – Falls Creek, Ranger Creek.
	Large Woody Debris	Functioning at Risk	Degrade – long-term effects associated with bank protection structures along 0.20 miles that limit future large wood recruitment in affected areas. .
	Pool Frequency / Quality	Functioning At Risk	Maintain – effects of the action are neutral.
	Large Pools	Functioning At Risk	Maintain – loss of deep scour pools at culvert outfalls, but long-term effects are neutral.
	Off-Channel Habitat	Functioning At Risk	Degrade – side channel habitats are constrained or directly impacted by location of Carbon River road in several areas. Future development constrained by proposed bank protection

Pathway	Indicator	Baseline Conditions	Effects of the Action (Restore – Maintain – Degrade)
			structures.
	Refugia	Functioning At Risk	Restore – improved access to important refugia habitat in floodplain tributary streams would be restored.
Channel Conditions & Dynamics	Width/Depth Ratio	Functioning At Risk	Degrade – project impacts associated with drop structures in the Falls Creek/Carbon side channel are likely to degrade the width/depth ratio of the channel.
	Streambank Condition	Functioning At Risk	Degrade –short term habitat impacts from project implementation and long term effects associated with location of Carbon River Road adjacent to stream banks.
	Floodplain Connectivity	Functioning at Risk	Degrade – long-term effects associated with bank protection structures.
Flow / Hydrology	Peak / Base Flows	Functioning at Risk	Maintain – effects of the action are neutral.
	Drainage Network	Functioning at Risk	Maintain – effects of the action are neutral.
Watershed Conditions	Road Density / Location	Not Properly Functioning	Maintain – effects of the action are neutral, and do not significantly improve road location issues in watershed.
	Disturbance History	Functioning at Risk	Maintain – effects of the action are neutral.
	Riparian Areas	Functioning at Risk	Degrade –short term habitat impacts from project implementation and long term effects associated with the continued location of Carbon River Road adjacent to stream banks.
Integration of Species and Habitat		Functioning at Risk	Maintain – The proposed action would result in both short-term and long-term adverse and beneficial effects to bull trout. The adverse effects associated with this action are limited to the affected stream reaches and do not result in a significant alteration of baseline conditions in the subwatershed. Project implementation will occur over a period of 3 to 4 years in dispersed locations, and some key spawning and rearing habitats for this local population will not be affected by the action at all. Restoring fish passage and access to high quality floodplain tributary habitat will contribute to improved survivorship, population growth and potential recovery.

Effects to the Carbon River Bull Trout Local Population

Reiman and McIntyre (1993) analyzed population viability for bull trout local populations under several different scenarios. The minimum egg-to-age 1 juvenile survival rate to sustain a local population ranged from 3 to 5 percent for populations with fast growth rates and early or late maturity (Rieman and McIntyre 1993, p. 9). These life history types may be comparable to the fluvial bull trout population in the Carbon River. The authors found that studies of egg-to-fry survival indicate that a survival rate of 25 to 50 percent likely represent the highest potential values for many bull trout streams. The estimated base survival rate of 3 to 5 percent necessary to sustain a local population is a minimal level likely found only in severely degraded streams (Rieman and McIntyre 1993, p. 9). We do not know what egg-to-fry recruitment levels are in the Carbon River spawning tributaries, but we expect that they are currently above these minimal levels, and that the effects of the action would not reduce fry recruitment to below these minimum levels. Based on the population viability analysis presented by Reiman and McIntyre (1993), we do not expect that the limited mortality anticipated for incubating eggs/alevins would result in a substantial reduction in annual recruitment of bull trout fry into the Carbon River local population because the anticipated effects will occur in dispersed locations over a period of 3 to 4 years, and some key spawning locations will not be affected by the proposed actions.

We anticipate that juvenile and adult bull trout associated with a cumulative total of 0.38 RM of habitat could be exposed to lethal and sublethal effects associated with worksite isolation, dewatering, and fish handling. Most of these effects (0.31 miles) are expected to occur along the margin of the south bank of the Carbon River, which we expect has very low densities of rearing bull trout (relative to tributary streams). Most of the affected area along the Carbon River is dry channel except during high-flow events, so our estimates for dewatering almost certainly over-estimate these effects. The number of bull trout that may be exposed to dewatering and fish handling is unknown, but is expected to be low based on the low numbers of bull trout observed by Park staff during snorkel surveys and redd counts (NPS 2009c). We expect that lethal effects will be limited to a few age-0 fry. In the Rieman and McIntyre (1993, p. 9) bull trout demography analysis, the authors estimated that bull trout survival rates from egg to age 1 are very low (< 10 percent), and that minimal survival rates ranging from 1 to 10 percent are sufficient to sustain bull trout local populations. Based on the limited area that will be subjected to dewatering, we expect that the bull trout local population can sustain the expected low level of mortality of bull trout fry without causing an appreciable reduction in annual recruitment into the local population.

We expect that juvenile and adult bull trout associated with a cumulative total of 2.68 RM of habitat could be exposed to sublethal effects associated with short-term turbidity plumes. A few individual bull trout are likely to be exposed to turbidity plumes, but we do not expect that these exposures will affect bull trout local populations because the effects of the exposure would occur sporadically, be short-term (hours), and sublethal, such as increased respiration, reduced feeding success, and subtle behavioral changes that can increase predation risk to individuals.. None of the potential adverse effects associated with this action are expected to alter local population trends through reduced juvenile to adult survival, significantly reduce reproductive capability, or alter the distribution of bull trout within the local population. The beneficial effects associated with culvert removals will improve the ability of bull trout to use all available spawning and

rearing habitat more effectively. Restoring fish passage and access to high quality floodplain tributary habitat will contribute to improved survivorship, population growth and potential recovery for the local population.

Effects to the Puyallup Core Area

The Puyallup core area supports five local populations that potentially interact as a metapopulation. Despite the current lack of physical migration barriers between the Carbon River local population and other populations in the core area, recent genetic analysis indicates that the Carbon River population may function as a fluvial-resident population with little or no genetic exchange with other populations in the core area. This apparent isolation could be the result of the dams in the basin. Dams on the Puyallup River and White River have limited bull trout migration and genetic exchange in the core area for nearly 100 years, and fish passage has only recently been improved at these facilities (USFWS 2004, p. 193). The number of migratory bull trout returning to the White River basin has increased in recent years, with the a record return of 100 adult fish counted at Buckley Dam in 2009 (NIFC 2009). As bull trout numbers increase in the core area, the likelihood of genetic exchange within the core area will increase. Metapopulation theory suggests that the local populations are likely to exchange individuals over time and therefore have the potential to support each other during periods of disturbance (Rieman and McIntyre 1993, p. 16). Local populations that have the potential to exchange individuals through dispersal are much more likely to persist than populations that are totally isolated (Rieman and McIntyre 1993, p. 16). Based on the metapopulation theory forwarded by Reiman and McIntyre (1993), we expect that the Puyallup core area local populations with improved fish passage facilities at the dams are more resilient to disturbance-related perturbations because the populations have improved connectivity, and the number of migratory adults in the system may increasing as result.

The proposed action will result in a both degradation and improvement of aquatic habitat indicators at the site scale, but these effects (with the exception of improving migration barriers) are not likely to be detectable at the subwatershed scale. Adverse effects to bull trout are limited to approximately 2.78 RM across dispersed locations in the upper reaches of the Carbon River watershed. The adverse effects are restricted to the level of a few individuals within the Carbon River local population. Although this action will result in a further degradation of bull trout habitat, the magnitude and the duration of these effects are limited in scale. Because the effects of the action are limited to a relatively small portion of the Carbon River local population, we do not expect the effects of the action to influence bull trout metapopulation dynamics within the Puyallup core area.

CUMULATIVE EFFECTS: Bull Trout

Under section 7 of the Act (16 U.S.C. 1536, *et seq.*), cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this BA (50 CFR 402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

Forest Practices

In the Carbon River action area, there is a mix of non-Federal timber land and National Forest lands located adjacent to the Park. National Forest lands on the adjacent Mt. Baker-Snoqualmie National Forest in the Carbon River valley are designated as Late-Successional Reserves, or as Wilderness. Non-federal lands in the area are managed primarily for timber production. Private timber harvest in the action area must comply with the Washington Forest Practices Act (RCW 76.09) as well as the Washington Administrative Code with respect to the Washington Forest Practices Rules (WAC 222). The FWS completed formal consultation on the Washington State Forest Practices Rules in 2006 and anticipated that there would be significant adverse effects to bull trout from forest practices activities, but concluded that these effects are not likely to jeopardize the continued existence of bull trout (USFWS 2006). Because these effects have already been addressed through section 7 consultation, they are not considered cumulative effects.

Climate Change

Climate change, and the related warming of global climate, has been well documented in the scientific literature (Bates et al. 2008; ISAB 2007). Evidence includes increases in average air and ocean temperatures, widespread melting of snow and glaciers, and rising sea level. Given the increasing certainty that climate change is occurring and is accelerating (Bates et al. 2008; Battin et al. 2007), we can no longer assume that climate conditions in the future will resemble those in the past.

Climate change has the potential to profoundly alter freshwater habitats through both direct and indirect effects (Bisson et al. 2003). Direct effects are evident in alterations of water yield, timing and volume of peak flows, and stream temperature. Bull trout require very cold water for spawning and incubation. Suitable spawning habitat is often found in accessible higher elevation tributaries and headwaters of rivers. Impacts on hydrology associated with climate change will cause shifts in timing, magnitude, and distribution of peak flows that are also likely to be most pronounced in high elevation stream basins (Battin et al. 2007). As these trends continue, the conservation role of bull trout populations in relatively pristine headwaters habitats (such as the Carbon River tributaries) will likely become more significant. Long-term persistence of bull trout may only be possible in these headwater areas that provide the only suitable habitat refugia.

The ongoing effects of climate change are likely to exacerbate other environmental stressors throughout the Carbon River watershed associated with roads, development, and land management actions. Efforts to reduce sediment input from roads and improve fish passage within the upper Carbon River basin will benefit bull trout populations and habitat in the action area, and may offset some of the adverse cumulative effects. The anticipated cumulative effects clearly indicate the important conservation role of the Park to provide high-quality refugia habitats for bull trout in the action area.

INTEGRATION AND SYNTHESIS OF EFFECTS: Bull Trout

The upper Carbon River supports a small local population of spawning and rearing bull trout. This population is significant because it potentially supports a full array of life history forms including resident, fluvial, and anadromous bull trout, and there are no man-made physical barriers on the Carbon River that isolate these fish from accessing habitat and populations elsewhere in the Puyallup River basin. Although bull trout are known to be present in the Carbon River year-round, we expect that the unstable habitat conditions limit the number of bull trout that actually spawn or rear in the upper Carbon River itself. Recent evidence of increased peak flows and rapid channel widening indicate the Carbon River is becoming increasingly unstable, likely due to ongoing effects from climate change, and these effects could become more severe over time due to recession of the Carbon Glacier. Floodplain tributary streams and side channels provide stable, complex habitats that provide essential spawning and rearing habitats for the Carbon River bull trout local population.

The location of the Carbon River Road in the floodplain has resulted in past and ongoing degradation of bull trout habitat, including passage barriers and chronic deposition of road sediments into key spawning and rearing streams. The Carbon River Road was specifically identified in the draft bull trout recovery plan as a high priority location to minimize or eliminate road-related habitat degradation. The proposed action would result in both short-term and long-term adverse and beneficial effects to bull trout. However, the fundamental problem of the Carbon River Road/Trail is its location within the active floodplain and channel migration zone, which presents a significant challenge to the Park in terms of maintaining access in the corridor while minimizing impacts to bull trout. As long as the Park continues to manage the road for access purposes, there will continue to be ongoing adverse effects to bull trout from long-term habitat degradation associated with the road/trail location in the floodplain.

The Carbon River Access Management Plan will result in significant adverse effects, including direct injury from fish capture and handling in 0.38 miles of streams, and injury or mortality of bull trout and bull trout eggs associated with 2.38 miles of spawning and rearing habitat in the upper Carbon River and associated floodplain tributaries. Disruption of natural fluvial and riparian habitat processes associated the road/trail in locations with a high risk of future flood damage and bank protection represent long-term aquatic habitat degradation that results in a measurable increase in altered stream banks in the upper Carbon River. The short-term adverse effects associated with the construction phase of this action will occur over a period of 3 to 4 years in dispersed locations, and some key spawning habitats will not be affected by the action.

Because the effects of the action are limited to a relatively small portion of the Carbon River local population, we do not expect bull trout metapopulation dynamics within the Puyallup River core area to be appreciably influenced by the action. Restoring fish passage and access to high quality floodplain tributary habitat will also contribute to improved survivorship, population growth and potential recovery. Therefore, we do not expect that the adverse effects associated with the Carbon River Access Management Plan will lead to significant population declines at the scale of the Carbon River local population or the Puyallup River bull trout core area population.

CONCLUSION: Bull Trout

After reviewing the current status of bull trout, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, it is the FWS's Opinion that the Carbon River Access Management Plan, as proposed, is not likely to jeopardize the continued existence of the bull trout. Critical habitat for this species has been designated within the action area. The effects to critical habitat are disclosed in a separate analysis.

We reached our non-jeopardy conclusion for bull trout based on the following rationale:

Adverse effects to bull trout are limited to approximately 2.78 RM across dispersed locations in the upper reaches of the Carbon River watershed. The adverse effects are restricted to the level of a few individuals within the Carbon River local population. Although this action will result in a further degradation of bull trout habitat, the magnitude and the duration of these effects are limited in scale. None of the adverse effects associated with this action are expected to alter local populations trends significantly through reduced juvenile to adult survival, reduced reproductive capability, or alter the distribution of bull trout within the local population. The beneficial effects associated with culvert removals will improve the ability of bull trout to use all available spawning and rearing habitat more effectively.

Although this action will result in a further degradation of bull trout habitat, the magnitude and the duration of these effects are limited in scale. Because the effects of the action are limited to a relatively small portion of the Carbon River local population, we do not expect the effects of the action to influence bull trout populations within the Puyallup core area or within the Coastal-Puget Sound interim recovery unit, or the listed coterminous range of the species.

We conclude that the adverse effects to bull trout from the Carbon River Access Management Plan would not contribute to an appreciable reduction in the likelihood of survival and recovery of bull trout in the wild by appreciably reducing bull trout numbers, reproduction, or distribution.

STATUS OF THE SPECIES: Designated Bull Trout Critical Habitat

Summary of Bull Trout Critical Habitat Status

On October 18, 2010, the FWS issued a final rule that revised designated bull trout critical habitat (75 FR 63898 [Oct. 18, 2010]). The 2010 critical habitat designation includes both freshwater and marine areas that have been identified as essential for the conservation of bull trout. The FWS designated 32 critical habitat units (CHUs) in 6 recovery units as critical habitat. Each CHU is comprised of a number of specific streams, marine shoreline, or reservoir/lake areas, which are identified as critical habitat subunits (CHSUs) in the final rule.

The Puget Sound basin was identified as a bull trout CHU with over 1,500 miles of streams and shorelines designated as bull trout critical habitat (75 FR 63898:63936 [Oct. 18, 2010]). The Puyallup River basin is identified as a CHSU, with approximately 306 miles of rivers and stream habitat identified as essential recovery habitat, including 59.1 miles in the Park (19 percent). The Puyallup River CHSU is essential to bull trout conservation because it represents the southernmost distribution of amphidromous bull trout in Puget Sound, supports multiple life history expressions, and may represent a key climate change refugium for the species due to the extensive glacially influenced habitat (USFWS 2010c, p. 179).

Primary Constituent Elements

Primary constituent elements are the physical and biological features of critical habitat essential to a species' conservation. The PCEs identified in the 2010 revised bull trout critical habitat designation include (75 FR 63898:63931 [Oct. 18, 2010]):

> (1) Springs, seeps, groundwater sources, and subsurface water connectivity (hyporehic flows) to contribute to water quality and quantity and provide thermal refugia.
>
> (2) Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers.
>
> (3) An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.
>
> (4) Complex river, stream, lake, reservoir, and marine shoreline aquatic environments, and processes that establish and maintain these aquatic environments, with features such as large wood, side channels, pools, undercut banks and unembedded substrates, to provide a variety of depths, gradients, velocities, and structure.
>
> (5) Water temperatures ranging from 2 to 15 °C (36 to 59 °F), with adequate thermal refugia available for temperatures at the upper end of this range. Specific temperatures within this range will vary depending on bull trout life-history stage and form; geography; elevation; diurnal and seasonal variation; shading, such as that provided by riparian habitat; streamflow; and local groundwater influence.

(6) In spawning and rearing areas, substrate of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount of fine sediment, generally ranging in size from silt to coarse sand, embedded in larger substrates, is characteristic of these conditions. The size and amounts of fine sediment suitable to bull trout will likely vary from system to system.

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

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

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

In freshwater areas, critical habitat includes the stream channels within the designated stream reaches, and includes a lateral extent as defined by the ordinary high-water line. In areas where ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation. Bankfull elevation is the level at which water begins to leave the channel and move into the floodplain and is reached at a discharge that generally has a recurrence interval of 1 to 2 years on the annual flood series (75 FR 63898:63935 [Oct. 18, 2010]).

For a detailed account of the status of designated bull trout critical habitat refer to Appendix 4 – Status of the Species: Bull Trout and Designated Bull Trout Critical Habitat

ENVIRONMENTAL BASELINE: Designated Bull Trout Critical Habitat

Regulations implementing the Act (50 CFR 402.02) define the environmental baseline as the past and present impacts of all Federal, State, or private actions and other human activities in the action area. Also included in the environmental baseline are the anticipated impacts of all proposed Federal projects in the action area that have undergone section 7 consultation, and the impacts of State and private actions which are contemporaneous with the consultation in progress.

Bull trout critical habitat has been designated from the Carbon River confluence with the Puyallup River, upstream for approximately 32.7 miles, and includes approximately 17 miles of tributary streams and braided river channels above the Park entrance. The project is located in the upper Carbon River watershed from the Park entrance at RM 23 upstream to the Ipsut Creek Campground at approximately RM 28. Critical habitat within the upper Carbon River is essential to maintaining the current distribution, abundance, and productivity of bull trout within the Puyallup CHSU (USFWS 2010c, p. 179).

In the previous section on bull trout, we applied the analytical framework referred to as the Matrix of Pathways and Indicators (USFWS 1999) to describe the environmental baseline conditions within the action area. The scale of this analysis is at the upper Carbon River 6th-field watershed (Table 10). The overall ranking for the watershed is "functioning at risk" due to past and ongoing aquatic habitat degradation associated with roads, stream crossings, and increased peak flows and bedload from the Carbon Glacier. For a more detailed description of the environmental baseline for bull trout habitat, refer to the previous section on bull trout.

EFFECTS OF THE PROPOSED ACTION: Designated Bull Trout Critical Habitat

The proposed action includes several projects that will require the use of heavy equipment below the bankfull elevation in the Carbon River and its tributaries. These projects will result in both direct and indirect effects to designated critical habitat. Some of these effects will be temporary, construction-related and limited in both physical extent and duration. Others will be long-term, lasting for the functional life of the proposed stream bed and stream bank stabilization measures.

Effects to Bull Trout Critical Habitat Primary Constituent Elements

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

The effects of the action are neutral to this PCE. Evidence of springs, seeps, and hyporehic flow is common in the action area. None of the proposed bank protection structures or the location of the Carbon River Road/Trail are expected to significantly alter water quality or quantity associated with springs, seeps, groundwater sources, and subsurface water connectivity.

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

The action will remove road culverts that currently act as full or partial barriers to fish passage in Carbon River tributary streams. Culverts will be replaced with trail bridges that will be designed to span the bankfull channel width of streams. Bull trout access to approximately 0.5 miles of critical habitat will be restored in Ranger Creek. Therefore, the effects of the action will improve and restore migration habitat (Table 17). There is a potential risk that the modified check dam structures proposed in the Falls Creek washout could create partial or full barriers to upstream fish passage in Falls Creek/Carbon River side channel, but this outcome is uncertain. These structures will be monitored annually to ensure that fish passage is maintained.

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

The effects of the action will result in a general degradation of aquatic and riparian habitat features that support an abundant food base, including terrestrial and aquatic invertebrates and fall-spawning salmonids such as bull trout, brook trout, coho salmon, and mountain whitefish. The scale (magnitude) of the effect is limited to the immediate project footprint of direct streambank disturbance associated with bank protections structures (0.72 miles); permanent loss

of riparian vegetation associated with the new bypass trail segment at Falls Creek (0.7 acres); and, downstream sediment and substrate impacts associated with short-term turbidity plumes and subsequent channel scour and deposition below bank protection and culvert removal sites (2.68 miles). The duration of the effects is limited to 1 season for substrate scour and deposition effects which will potentially impact aquatic invertebrate communities and reduce salmonid spawning success and fry recruitment, approximately 4 to 5years for short-term loss of riparian vegetation associated with bank protection sites on the Carbon River, and long-term (decades) for loss of riparian vegetation associated with the new bypass trail location along the Falls Creek washout (Table 17).

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

We expect both short-term (1 season) and long-term (decades) adverse effects that will degrade habitat complexity and future recruitment of large wood to the Carbon River. The proposed action includes multiple bank protection structures that are intended to halt lateral scour and natural channel migration. The effect is the disruption of natural fluvial processes associated with bank erosion. Bank erosion recruits sediment and large wood to the stream, creates and maintains in-stream and floodplain habitats (e.g., side channels), maintains overall aquatic habitat diversity within the stream corridor, and enables the stream to respond to changing conditions within its watershed (SHRG 2004). Much of the large wood that enters the upper Carbon River is transported downstream during flood events and contributes to formation of logjams and fish habitat features in the lower watershed. The ecological function that large wood provides in habitat structure and nutrients for salmonids and a variety of other aquatic organisms is well documented (Everest and Reeves 2007, p.19). Any reduction of large wood recruitment due to bank protection potentially reduces habitat complexity and productivity for bull trout and their associated prey species.

The total length of bank protection proposed by the Park is 1,060 ft. (0.20 mile). This represents about four percent of the bank along the south side of the river, or two percent of the total river bank in the action area considering both the north and south banks. The existing bank armoring with rip-rap in this section of the river is estimated at 0.7 miles along the south bank, so the combined total of existing bank protection and new structures will equal approximately 0.9 miles or about 18 percent of the south bank of the Carbon River between the Park entrance and Ipsut Creek Campground. These bank treatments will function to directly armor or reinforce eroding banks and deflect flows away from the river bank to protect threatened sections of the Carbon River Road. Long-term impacts associated with bank protection structures are anticipated along 0.72 miles of critical habitat streams in the action area (Table 17).

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

The effects of the action are neutral to this PCE. None of the proposed bank protection structures or the location of the Carbon River Road/Trail are expected to result in a significant loss of shade to streams or result in increased water temperatures or loss of thermal refugia within the action area.

PCE 6: In spawning and rearing areas, substrate of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount of fine sediment, generally ranging in size from silt to coarse sand, embedded in larger substrates, is characteristic of these conditions. The size and amounts of fine sediment suitable to bull trout will likely vary from system to system.

We expect both short term and long term adverse effects that will result in degradation of stream substrate conditions. Following construction of bank protection structures and removal of culverts, both fine and coarse sediments at the project sites will be subject to scouring and deposition which can result in short-term (1 season) impacts to stream substrate composition in the immediate vicinity of the project footprint. The effect is not a permanent degradation of habitat associated with chronic deposition of road sediments, but rather a short-term impact associated with mobilization of stream channel sediments at construction sites. In total, we expect effects associated with stream substrate scouring and sediment deposition along 2.68 miles of streams. Over half of these estimated impacts (1.37 miles) are located in floodplain tributary streams and side channels that provide important spawning and rearing habitat for bull trout (Table 17).

There are long-term impacts associated with potential road/trail surface erosion and deposition of road sediment into spawning and rearing streams. The new by-pass trail in the Falls Creek washout has a high risk of trail failure during future flood events. There is a high probability that this section of the trail will be subjected to frequent flood damage and delivery of the trail surface materials to the channel, resulting in local aggradation of sediments in this reach. Trail humps installed throughout this section would reduce the severity of this impact, but adverse impacts to stream substrates are likely to continue along 0.5 miles in the Falls Creek/Carbon River side channel from this trail section (Table 17).

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

The effects of the action are neutral to this PCE. None of the proposed bank protection structures or the location of the Carbon River Road/Trail are expected to alter the natural hydrograph of the Carbon River or its tributaries. Climate change and the apparent recession of the Carbon Glacier will continue to be a major influence on peak and base flow conditions in the Carbon River.

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

We expect short-term adverse effects that will result in degradation of water-quality conditions from construction-related turbidity plumes. Construction of bank protection structures and

culvert removal will cause increased transport of suspended sediment and turbidity, at and below a project site. Worksite isolation and erosion control measures will greatly reduce these impacts. However, once onsite construction is completed and a worksite is exposed to flowing water, there will be increased levels of turbidity released in the project vicinity. These project-related sediment plumes will be of short duration (hours to 1 day), but may occur more than once per project site depending upon stream flow. In total, we expect adverse effects associated with increased turbidity along 2.68 miles of streams. Over half of these estimated impacts (1.37 miles) are located in floodplain tributary streams and side channels that provide important spawning and rearing habitat for bull trout (Table 17).

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

The effects of the action are neutral to this PCE. Brook trout are known to be present in the upper Carbon River basin. Improving fish passage at Ranger Creek, may improve access of brook trout to the approximately 0.5 miles of habitat located above the culvert. Whether brook trout are currently present above the Ranger Creek culvert is unknown, as this area has not been extensively surveyed for fish presence. The culvert presently is a partial barrier to fish passage, and under certain flow conditions, adult bull trout are able to pass the culvert to access upstream spawning habitat. We expect that brook trout could also be present above the culvert as well, based on the presence of spawning bull trout documented in 2009 (NPS 2009c). Because brook trout have been present in the basin for decades, we do not expect the improved fish passage will result in a new introduction of brook trout into previously unoccupied habitats.

Summary of Effects to Designated Bull Trout Critical Habitat

Project impacts will occur over a period of 3 to 4 years, depending on funding and the logistics of project implementation. The effects to designated critical habitat include:

- Long-term adverse effects to bull trout critical habitat structure, function, and diversity. The project will construct bank protections structures that will inhibit natural channel migration, degrade riparian vegetation, and inhibit the recruitment of large wood to stream channels in the affected areas along 0.72 miles of stream channels. Most of these impacts are located in the Falls Creek area (0.49 mile), and along the margins of the Carbon River (0.20 mile). The cumulative effect of proposed structures and existing structures would be 0.9 miles of bank protection structures along the Carbon River. Future flood damage to bank protection structures and road/trail surfaces will result in continued adverse impacts from turbidity and substrate effects that are similar to initial construction impacts (Table 17).

- Long-term beneficial effects associated with restored habitat access to approximately 1 mile of floodplain tributary streams, including Ranger Creek. Removal of Ranger Creek culvert will restore access to approximately 0.5 miles of high quality spawning and rearing habitat (Table 17).

Table 17. Summary of effects to bull trout critical habitat along the Carbon River Access Corridor.

Location	Long-term adverse stream bank impacts	Extent of adverse turbidity/ substrate impacts	Beneficial effects from restored habitat access
Carbon River Effects limited to channel margin along south bank.	1,060 ft.	6,920 ft. 1.31 miles	NA
Falls Creeks, Falls Creek tributaries, and Carbon side channel	2,650 ft.	4,500 ft. 0.85 mile	0.25 mile
Ranger Creek	25 ft.	630 ft.	0.5 mile
Unnamed tributary stream at Chenuis Falls trailhead	25 ft.	660 ft. in Carbon River side channel	0.25 mile
Ipsut Creek/Carbon side channel	155 ft.	1,460 ft. 0.28 mile	NA
Total Estimated Adverse Impacts for Project	3,815 ft. 0.72 mile	14,170 ft. 2.68 miles	-
Total Estimated Beneficial Effects for Project	-	-	1 mile

Long-term adverse stream bank impacts are associated with the bank protection structures, reconstruction of the by-pass trail through the Falls Creek washout, and 25 ft. for each trail bridge location.

Effects to the Puyallup CHSU and Puget Sound CHU

The Puget Sound basin was identified as a bull trout CHU with over 1,500 miles of streams and shorelines designated as bull trout critical habitat (75 FR 63898:63936 [Oct. 18, 2010]). The Puyallup River basin is identified as a CHSU, with approximately 306 miles of rivers and stream habitat identified as essential recovery habitat, including 59.1 miles in the Park (19 percent). Bull trout critical habitat has been designated from the Carbon River confluence with the Puyallup River, upstream for approximately 32.7 miles, and includes approximately 17 miles of tributary streams and braided river channels above the Park entrance. Critical habitat within the

upper Carbon River is essential to maintaining the current distribution, abundance, and productivity of bull trout within the Puyallup CHSU (USFWS 2010c, p. 179).

The proposed Carbon River Access Management Plan will result in both short-term and long-term adverse effects to bull trout critical habitat PCEs, including water quality, stream substrates, prey species abundance, and complex stream habitats and processes. The project will also have beneficial effects to critical habitat associated with of restoring fish passage. Although the project will result in a general degradation of critical habitat PCEs in the action area, the magnitude, severity, and duration of the effects are low to moderate, and do not result in a net loss of critical habitat essential for the conservation and recovery of bull trout at the scale of the Carbon River watershed, the Puyallup CHSU, the Puget Sound CHU, or the coterminous range of the species.

CUMULATIVE EFFECTS: Designated Bull Trout Critical Habitat

Forest Practices

Private timber harvest in the action area must comply with the Washington Forest Practices Act (RCW 76.09) as well as the Washington Administrative Code with respect to the Washington Forest Practices Rules (WAC 222). The FWS completed formal consultation on the Washington State Forest Practices Rules in 2006 and anticipated that there would be significant adverse effects to bull trout critical habitat PCEs from forest practices activities, but concluded that these effects are not likely to adversely modify bull trout critical habitat (USFWS 2006). Because these effects have already been addressed through section 7 consultation, they are not considered as cumulative effects.

Climate Change

Climate change, and the related warming of global climate, has been well documented in the scientific literature (Bates et al. 2008; ISAB 2007). Evidence includes increases in average air and ocean temperatures, widespread melting of snow and glaciers, and rising sea level. Given the increasing certainty that climate change is occurring and is accelerating (Bates et al. 2008; Battin et al. 2007), we can no longer assume that climate conditions in the future will resemble those in the past.

Climate change has the potential to profoundly alter freshwater habitats through both direct and indirect effects (Bisson et al. 2003). Direct effects are evident in alterations of water yield, timing and volume of peak flows, and stream temperature. Impacts on hydrology associated with climate change will cause shifts in timing, magnitude, and distribution of peak flows that are also likely to be most pronounced in high elevation stream basins (Battin et al. 2007). As these trends continue, the conservation role of relatively pristine headwaters habitats (such as the Carbon River tributaries) will likely become more significant. Long-term persistence of bull trout may only be possible in these headwater areas that provide the only suitable habitat refugia.

The ongoing effects of climate change are likely to exacerbate other environmental stressors throughout the Carbon River watershed associated with roads, development, and land

management actions. Efforts to reduce sediment input from roads and improve fish passage within the upper Carbon River basin will benefit bull trout populations and critical habitat in the action area, and may offset some of the adverse cumulative effects. The anticipated cumulative effects clearly indicate the important conservation role of the Park to provide high-quality PCEs and refugia habitats for bull trout in the action area.

CONCLUSION: Designated Bull Trout Critical Habitat

After reviewing the current status of bull trout critical habitat, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, it is the FWS's Opinion that the Carbon River Access Management Plan, as proposed, is not likely to destroy or adversely modify designated critical habitat.

We reached our conclusion for bull trout critical habitat based on the following rationale:

Critical habitat within the upper Carbon River is essential to maintaining the current distribution, abundance, and productivity of bull trout within the Puyallup CHSU. Adverse effects to bull trout critical habitat are limited to approximately 2.78 RM dispersed across multiple locations in the upper reaches of the Carbon River watershed. Although this action will result in a further degradation of bull trout critical habitat PCEs, the magnitude and the duration of these effects are limited in scale. None of the adverse effects associated with this action are expected to alter the essential role that designated critical habitat serves for the conservation and recovery of bull trout in the Coastal recovery unit.

Because the effects of the action are limited to a relatively small portion of the upper Carbon River basin, we do not expect the effects of the action to influence bull trout critical habitat function within the Puyallup CHSU, the Coastal recovery unit, or within the listed coterminous range of the species. Critical habitat at these scales would remain functional to serve its intended conservation role for bull trout.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. Harm is defined by the FWS as an act which actually kills or injures wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering (50 CFR 17.3). Harass is defined by the FWS as an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering (50 CFR 17.3). Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by the Park so that they become binding conditions of any grant or permit issued to any applicant, as appropriate, for the exemption in section 7(o)(2) to apply. The Park has a continuing duty to regulate the activity covered by this incidental take statement. If the Park 1) fails to assume and implement the terms and conditions or 2) fails to require applicants to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Park must report the progress of the action and its impact on the species to the FWS as specified in the incidental take statement [50 CFR 402.14(i)(3)].

AMOUNT OR EXTENT OF TAKE

The FWS anticipates that spotted owls, marbled murrelets, and bull trout could be taken as a result of the proposed action.

Spotted Owl

In the accompanying Opinion, we determined that noise and activity associated with use of motorized equipment along the Carbon River Road/Trail will result in the incidental take of one pair of spotted owls associated with the June Creek activity center. The take is in the form of harassment, because disturbance could disrupt the spotted owls' normal nesting behaviors and cause an owl to flush away from the nest. A flush response creates the likelihood of injury by increasing the risk of predation, e.g., through the advertisement of the nest's location, advertisement of the adult and juvenile, or the premature departure of a nestling from a nest. Under a reasonable worst-case scenario, the harassment would indirectly result in a failed nesting attempt.

Spotted owls typically nest in alternate years. For this analysis, we assumed that harassment will occur during 1 breeding cycle during the 4-year implementation of the project, because

harassment is only anticipated to occur during trail construction and bank protection work in the Falls Creek washout, which is expected to occur during a single work season, most likely in 2011.

Marbled Murrelet

We anticipate that incidental take of murrelets will be difficult to detect because the species is cryptic, and actual murrelet nest locations are rarely located. However, based on the documented history of murrelet occupancy behaviors in the upper Carbon River watershed, we assume that all suitable murrelet nesting habitat in the project area is occupied habitat. Therefore we estimated the amount of nesting habitat that would be exposed to actions that could result in take as a surrogate measure for this species.

In the accompanying Opinion, we determined that noise and activity associated with use of motorized equipment along the Carbon River Road/Trail will result in the incidental take of murrelets nesting in close proximity to the road/trail. This take is in the form of harassment, through the significant disruption of normal nesting behaviors. The disturbance from these activities is anticipated to create a likelihood of injury by increasing the risk of predation, or decreasing the fitness of chicks through missed feedings. Under a reasonable worst-case scenario, the harassment would indirectly result in a failed nesting attempt. Due to the prolonged exposure to construction activities during the early nesting season, we expect murrelets associated with 110 acres of nesting habitat adjacent to the Carbon River Road will have an increased likelihood of nest failure for a period of 4 years.

We anticipate that the noise and activity associated with helicopter use will result in harassment of murrelets. All murrelets associated with approximately 400 acres of nesting habitat adjacent to the Carbon River Road/Trail corridor will be subjected to helicopter noise disturbance for a period of 3 to 6 days during one nesting season (possibly 2012 or 2013). Under a reasonable worst-case scenario, the harassment would indirectly result in a failed nesting attempt.

We also anticipated that exposure to hazardous helicopter rotor wash would cause take of murrelets in the form of harm through direct injury or mortality of murrelet eggs or nestlings. All murrelets associated with approximately 10 acres of nesting habitat adjacent to helicopter drop points will be exposed to hazardous rotor wash conditions for a period of 3 to 6 days during one nesting season (possibly 2012 or 2013).

Bull Trout

We are not able to accurately predict the number of bull trout that will be incidentally taken by the proposed action because we do not have data that would allow us to predict bull trout densities in the various habitats affected by the action. However, based on the documented occurrence of bull trout in the upper Carbon River watershed, we assume that all accessible fish habitat associated with the Carbon River and its tributaries is occupied by bull trout. Therefore we estimated the amount of habitat that would be exposed to actions that could result in take as a surrogate measure for the species.

In the accompanying Opinion, we determined that the proposed action will result in incidental take of bull trout. The take is in the form of harm and harassment. Take of bull trout will be temporary and limited in both physical extent and duration. Project impacts will occur over a period of four years, depending on funding and the logistics of project implementation:

Harm (direct injury and/or mortality) resulting from fish capture and handling operations associated with work site isolation and dewatering is anticipated along 0.38 miles of streams. Most of these effects (0.30 mile) are located along the margin of the Carbon River channel (Table 18). We expect that adult, subadult, and juvenile (age 0) bull trout will be exposed to harm from fish capture and handling. Fish salvage operations are expected to minimize the incidental take of individual bull trout from stream diversion/dewatering activities.

Harassment (i.e., stress, altered behavior) resulting from short-term exposures (hours to 1 day per site) to construction-related turbidity plumes is anticipated along 2.68 miles of streams. Over half of these estimated impacts (1.37 miles) are located in floodplain tributary streams and side channels (Table 18). We expect that adult, subadult, and juvenile (age 0) bull trout will be exposed to harassment from short-term exposure to turbidity plumes.

Harm associated with stream substrate scouring and deposition in fish spawning and rearing areas that result from changes in channel configuration is anticipated along 2.68 miles of streams. The effect is mortality and reduced incubation success for 1 season in the affected areas. Over half of these estimated impacts (1.37 miles) are located in floodplain tributary streams and side channels that provide important spawning and rearing habitat (Table 18). We expect that bull trout eggs and alevins will be exposed to harm from substrate scour and deposition effects.

Table 18. Summary of incidental take of bull trout.

Location	Harm Associated with short-term worksite isolation / dewatering and fish handling	Harm/harassment associated turbidity and substrate scour and deposition impacts (short term and long-term effects)
Carbon River Effects limited to channel margin along south bank.	1,590 ft. 0.30 mile	6,920 ft. 1.31 miles
Falls Creeks, Falls Creek tributaries, and Carbon side channel	30 ft.	4,500 ft. 0.85 mile
Ranger Creek	100 ft.	630 ft.
Unnamed tributary stream at Chenuis Falls trailhead	100 ft.	660 ft. in Carbon River side channel
Ipsut Creek/Carbon side channel	195 ft.	1,460 ft. 0.28 mile
Total Estimated Extent of Incidental Take	**2,015 ft.** **0.38 mile**	**14,170 ft.** **2.68 miles**

Note: The habitat areas used to estimate take of bull trout are based on reasoned assumptions, and are not considered to be absolute values. Some project sites may not require any dewatering or fish handling because the sites may be dry at the time of project implementation.

EFFECT OF THE TAKE

In the accompanying Opinion, the FWS determined that this level of anticipated take is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

REASONABLE AND PRUDENT MEASURES

The Park Service in cooperation with the FWS has incorporated all practicable conservation and minimization measures into the project design to minimize incidental take. However, the FWS believes the following reasonable and prudent measures (RPMs) are necessary and appropriate to minimize take of spotted owls, murrelets, and bull trout:

1. Minimize impacts to murrelets associated with helicopter noise and rotor wash and monitor helicopter use during the nesting season.
2. Minimize and monitor incidental take of bull trout caused by fish handling and turbidity.
3. Monitor spotted owl territories in project area.

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, the Park Service must comply with the following terms and conditions, which implement the reasonable and prudent

measures, described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

The following terms and conditions are required for the implementation of RPM 1:

1. The Park Service shall work with the helicopter contractor to define the helicopter flight route. The helicopter flight path should follow the course of the Carbon River as much as practicable to avoid flights directly over old-growth forest habitat. Minimize helicopter operations below 500 feet above ground level to the maximum extent practicable. Transport flights should maintain a minimum altitude of 1000 ft. above ground level as much as practicable. Submit a report of the total hours of helicopter flight time and the flight paths used during the nesting season by November 30 of the same year.

The following terms and conditions are required for the implementation of RPM 2:

1. The Park Service shall ensure that fish capture and removal operations are conducted by a qualified biologist, and that all staff participating in the operation have the necessary knowledge, skills, and abilities to ensure safe handling of fish. Fish capture and removal operations shall take all appropriate steps to minimize the amount and duration of handling.

2. The Park Service shall document and report all bull trout or other salmonids encountered during fish capture and removal operations. The report should also specify the location and provide an estimate of the area that was isolated and dewatered. The Park Service shall submit a monitoring report to the FWS's consulting biologist (Vince Harke, 360-753-9529) at the Washington Fish and Wildlife Office in Lacey, Washington, by November 30 following each in-water construction season.

The Park Service in coordination with the Service shall develop a plan to monitor turbidity levels in Ranger Creek during culvert removal and along the Carbon River below the Maintenance Area ELJ site. This monitoring plan shall be submitted to the FWS for approval by May 1, 2011.

3. The Park Service shall annually monitor all check dams installed in Falls Creek and at culvert removal sites to ensure that these structures are in compliance with the minimum fish passage guidelines established in the project design criteria. The Park Service shall document any obvious signs of channel bed or bank instability (e.g., headcutting) resulting from the work, and any additional actions taken to correct problem areas, and the final condition of the work area.

4. The Park Service shall submit a monitoring report to the FWS' consulting biologist by November 30 following each in-water construction season, to include at a minimum, the following: (a) dates and times of construction activities, (b) monitoring results, sample times, locations, and measured turbidities (in NTUs), (c) summary of all annual construction activities, and, (d) summary of corrective actions taken to maintain fish passage at stream crossing sites.

The following terms and conditions are required for the implementation of RPM 3:

1. Continue to monitor spotted owl activity centers in the Carbon River valley. If an actual nest tree is located for the June Creek activity center (or any other site), report this location to the FWS, and determine if the nest tree is located within the defined harassment distances of project activities. If monitoring indicates the spotted owls are not actively nesting, or that the nest is located beyond the harassment distances, we will acknowledge in writing that the incidental take anticipated in this Opinion did/did not occur. The Park Service shall submit a monitoring report to the FWS's consulting biologist at the Washington Fish and Wildlife Office in Lacey, Washington, by November 30 following each in-water construction season.

The RPMs, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the RPMs provided. The Park Service must immediately provide an explanation of the causes of the taking and review with the FWS the need for possible modification of the RPMs.

The Service is to be notified within three working days upon locating a dead, injured or sick endangered or threatened species specimen. Initial notification must be made to the nearest U.S. Fish and Wildlife Service Law Enforcement Office. Notification must include the date, time, precise location of the injured animal or carcass, and any other pertinent information. Care should be taken in handling sick or injured specimens to preserve biological materials in the best possible state for later analysis of cause of death, if that occurs. In conjunction with the care of sick or injured endangered or threatened species or preservation of biological materials from a dead animal, the finder has the responsibility to ensure that evidence associated with the specimen is not unnecessarily disturbed. Contact the U.S. Fish and Wildlife Service Law Enforcement Office at (425) 883-8122, or the Service's Washington Fish and Wildlife Office at (360) 753-9440.

CONSERVATION RECOMMENDATIONS

Section 7(a) (1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

1. Consider alternative designs that avoid using gabions in erosion protection structures. Avoiding the use of gabions for bank protection structures would reduce the level of river rock excavation needed from the Carbon River channel, and would further reduce impacts to fish habitat associated with channel excavation and the long-term impacts associated with the placement of non-biodegradable structures in the Carbon River floodplain.

2. Consider implementing as much of the project as practicable in the fall months, after the murrelet nesting season.

3. Continue to conduct bull trout spawning surveys in Carbon River tributaries. Consider standardizing these surveys by identifying specific monitoring reaches and documenting the dates and numbers of fish and/or redds counted.

4. Continue monitoring marbled murrelet populations in the upper Carbon River valley via ornithological radar surveys and audio/visual surveys.

In order for the FWS to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, the FWS requests notification of the implementation of any conservation recommendations.

REINITIATION NOTICE

This concludes formal consultation on the Carbon River Access Management Plan. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: 1) the amount or extent of incidental take is exceeded; 2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this Opinion; 3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this Opinion; or 4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

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APPENDIX A – CONCEPTUAL DESIGNS OF PROPOSED BANK PROTECTION STRUCTURES

Proposed Location of Flood Protection Structures in Carbon River Historic Road Corridor March 2010

The following flood protection measures are for alternatives 1-5 of the Carbon River EA. All actions unless otherwise noted will be described for the preferred alternative (Alternative 2) maintain existing Carbon River Road for a 6 to 10 foot hiking, bicycle path 1.2 miles from the Park Boundary to Ipsut Campground approximately 5 miles from the Park Boundary. The first 1.2 miles of the road will be open to public vehicle traffic and used for parking.

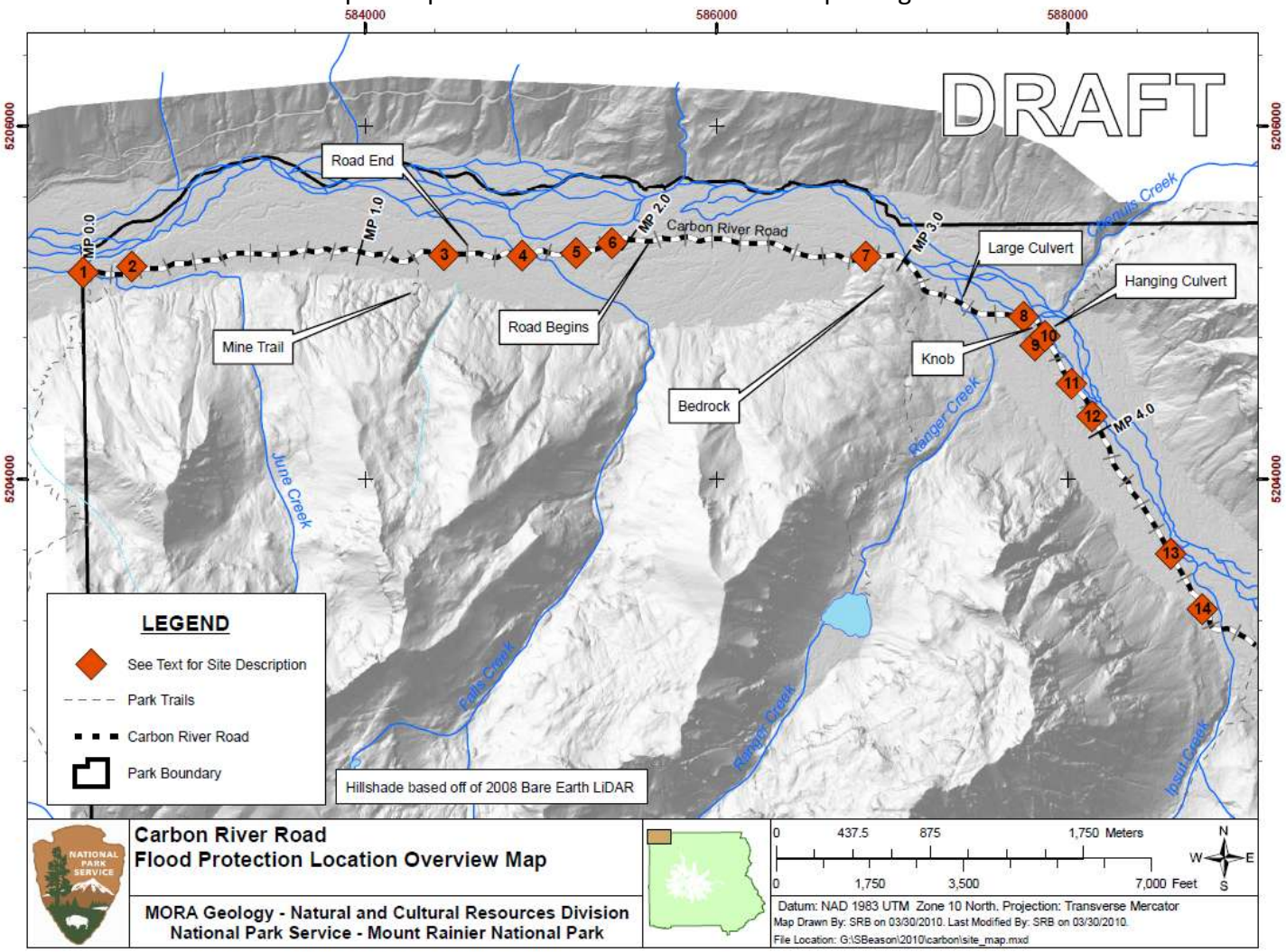


Figure 1: Carbon River Road Flood Protection Location Map. Please cross reference 6 sheet overview map of road corridor.

Proposed action

The park will build or contract out to be built several flood control and bank erosion prevention structures along 5 miles of the Carbon River Road. Several of the structures would be built in the Carbon River and/or associated side channels. All structures in the river will use significant amounts of wood to reduce impacts to and improve habitat for fish and other aquatic invertebrates. The wood will be harvested from within the river bottom and/or along the banks of the river as directed by Park Biologists. If additional wood is needed, the park will purchase

wood from local sources. In some locations, the Carbon River and its tributaries would have to be temporarily diverted so construction could take place in a dry channel. Some structures will be built in the existing road to transport flood water from tributaries of creeks that run across the road. In some locations, check dams would be built across tributaries of creeks running across the road to channel them into existing culverts or under bridges. In the two locations where the Carbon River captured the road, we would cut existing logs in the channel to create check dams that will allow the channel to naturally aggrade (fill back in).

Risk assessment overview

The risk assessment shows the relative hazard along the entire Carbon River Road/Trail corridor from the park boundary uphill 5.04 miles to Ipsut Campground. These threats include: flooding, river avulsion (complete change in channel), aggradation, bank erosion and other geomorphic forces. The risk analysis is based on aerial photos, LiDAR, available damage maps, prior field reconnaissance, digitized maps of bank erosion, ground photos and professional judgment. Each segment of the road was assigned a category that relates to its potential risk of the previously mentioned geologic forces. The scale is: Low, Low-Medium, Medium, Medium-High, High and Extreme. A rating of "extreme" indicates that significant damages have already occurred at this location and there is a significant risk for damage to occur during another flood. A rating of "low," on the other hand, means that little to no damage has occurred in the past and the risk of damage to that segment of road/trail is significantly lower, but not completely risk-free. These road segments were digitized in ArcGIS and the total length of the segments were calculated (Figure 2). Each segment and its justification are included in Appendix A. Detail Maps are included in Appendix B.

Results of the risk assessment indicate that approximately 37.1% of the road corridor is categorized as Low; 12.5% is Low-Medium; 10.3% is Medium; 7.2% is Medium-High; 12.1% is High; and the remaining 20.8% of the road corridor is categorized as Extreme (Table 1). It is important to note that these delineations are based on spatial data and have not been field checked. A field check will occur in April to confirm and improve the draft risk assessment.

Hazard Class	Length			Percentage
	(m)	(ft)	(mi)	
Low	3,006.03	9,862.31	1.87	37.09%
Low-Medium	1,011.47	3,318.47	0.63	12.48%
Medium	838.37	2,750.55	0.52	10.34%
Medium-High	582.96	1,912.61	0.36	7.19%
High	981.59	3,220.44	0.61	12.11%
Extreme	1,684.27	5,525.81	1.05	20.78%
Total	**8,104.69**	**26,590.19**	**5.04**	

Table 1: Totals for each Hazard Class in DRAFT Relative Risk Assessment for the Carbon River Road

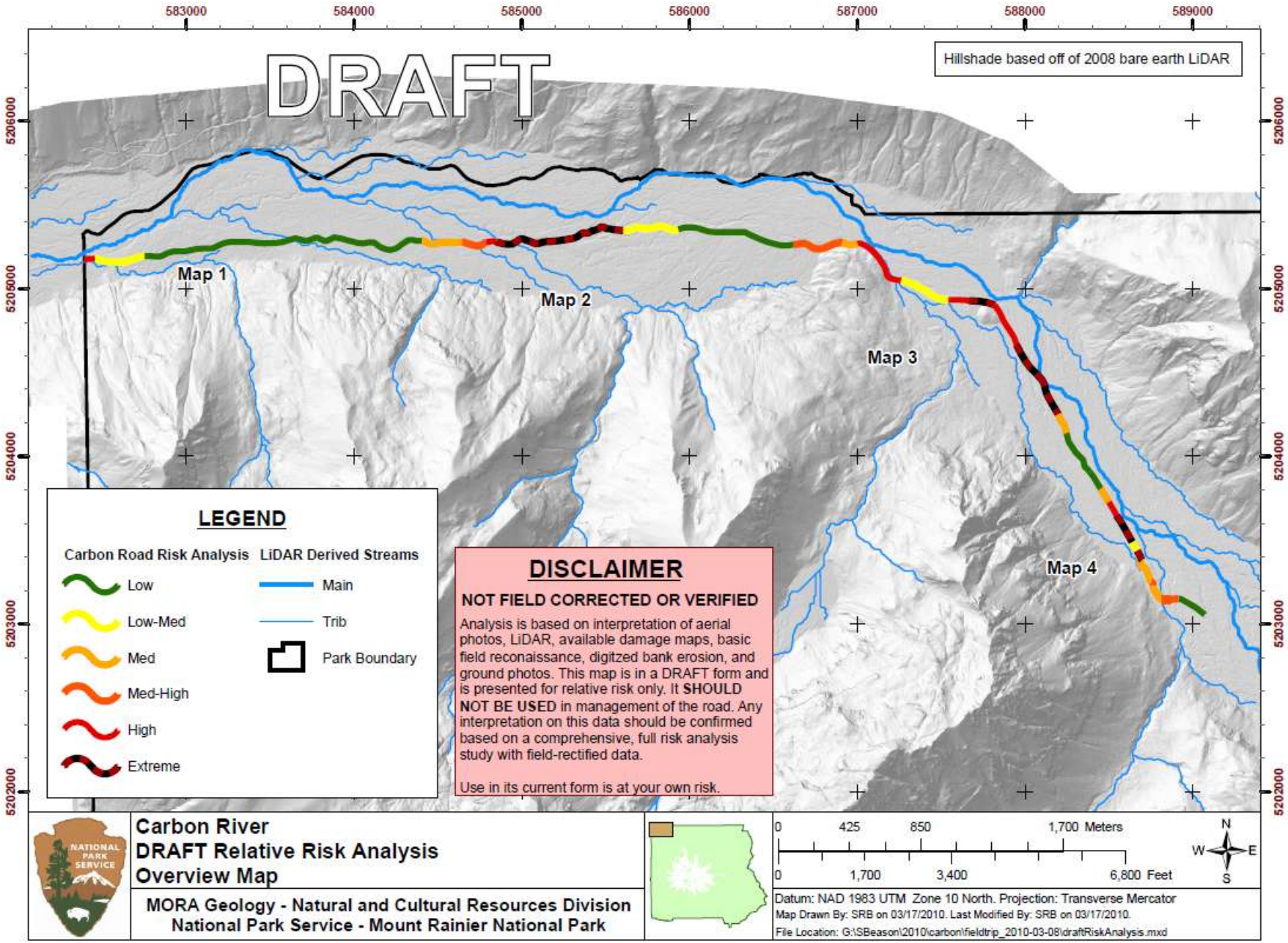


Figure 2: DRAFT Relative Risk Analysis on the Carbon River Corridor.

Site #1: Park boundary

Figure 3: View of bank at toe of rip rap about 40 feet from Carbon River Road

Risk: Bank Erosion threatening Carbon River Road.
Proposed flood protections: Augmentation of existing natural logjam.
Size of structure: Length: 40-60 feet; Width: 20 feet; Height: approximately 4 feet.
Duration of project: 5 days.
Materials needed: Approximately 10 pieces of wood 20 to 40 feet long, 18 to 24 inches dbh. Additional wood taken from immediate area and approximately 20 yards of large cobble from river.
Construction methods: Work would be timed to take place during low flow or no flow. If needed flow would be diverted from the area by building a diversion dam out of existing river material upstream of work site. Excavator would be used to place additional logs and wood in and upstream of existing log jam, cobble would be placed over the wood to add weight. No excavation would be necessary for this work. Access to this site is from the road at the site.
Equipment needed: Excavator dB 81-85 at 50 feet (Data taken from EPA Report - EPA 550/9-76-004)
Expected outcome: Deposition of river aggregate and wood in front of log jam to deflect river flows away from bank. Scour pools in the vicinity of the logjam (especially along the front of the structure) would be developed and be fish- and aquatic invertebrate-friendly.
Environmental issues and river impact:
100 year flood plain: Yes
OHWM: Below
Diversion: Potential
Excavate River Bed: No
Excavate River Bank: No
Use of River Materials: Yes
Fish T&E: Bull trout
Bird T&E: Spotted Owl and Marbled Murrelet

Site #2: Maintenance area at Carbon River Entrance

Figure 4: View of bank looking upstream from river bed towards Maintenance Area

Risk: Bank Erosion threatening Carbon River entrance area, road and parking area.
Proposed flood protections: Flow Deflection Engineered Log Jams (ELJ's) (Figure 5).
Size of structure: 4 ELJ's - Length 60 feet by 60 feet approximately 4 to 10 feet high
Duration of project: 90 days on site
Materials needed: For each log jam we would need approximately 104 logs ranging in length from 8 to 45 feet long, diameter of logs ranges from 8 to 24 inches. Each ELJ requires 30 CY of slash for infill and river cobble for ballast and topping material. Total number of logs for 4, 60 X 60 foot ELJ equals 416, total slash equals 120 CY, total ballast and rock and dirt ballast and topping 60 CY.

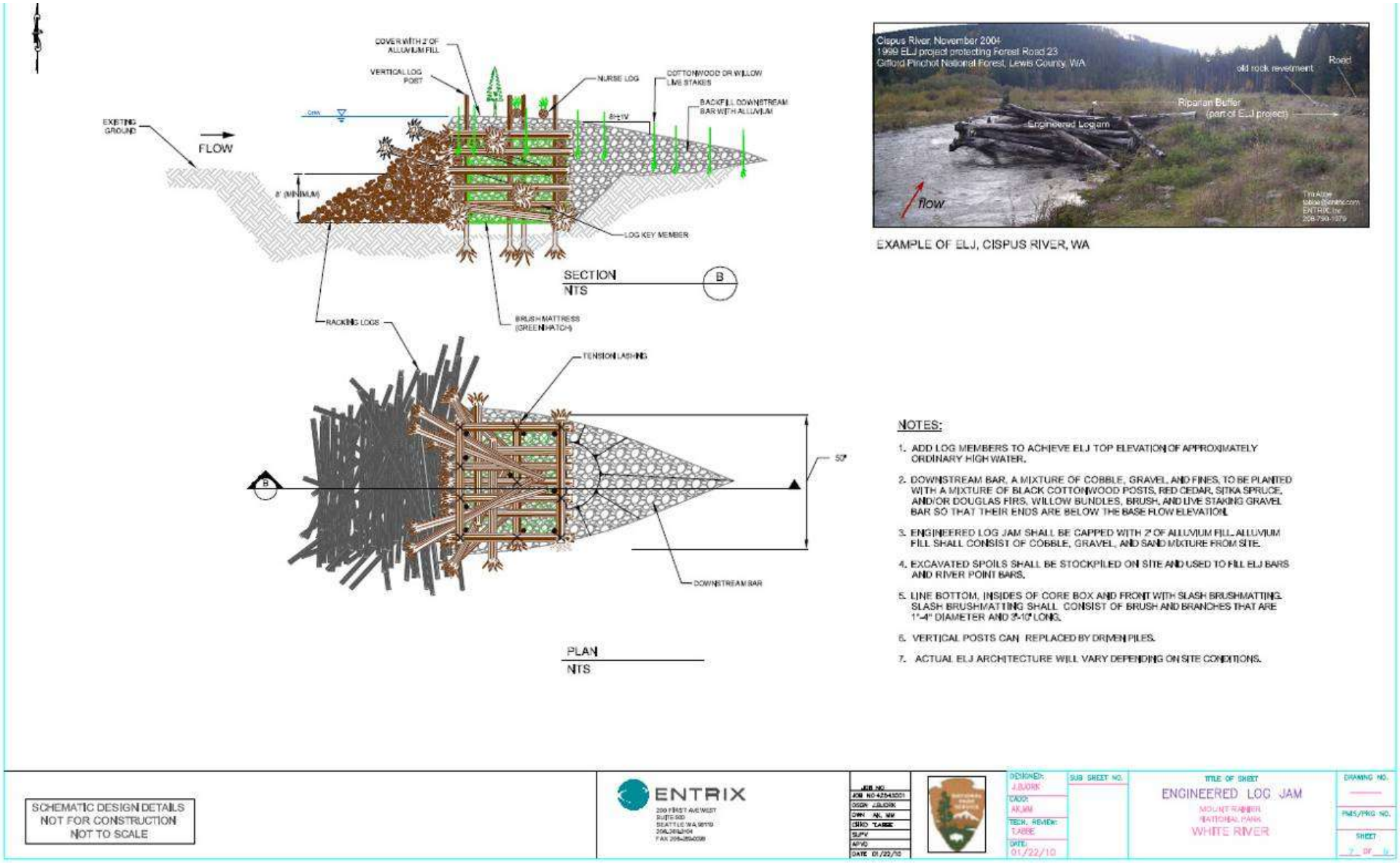


Figure 5: Typical design of Flow Deflection Engineered Log Jams (ELJ's)

Construction methods: Work would be timed to take place during low flow or no flow. The majority of the site has been in the dry since the flooding in November 2008. Wood from the immediate site and existing natural log jam would be used to construct ELJ's; additional wood if needed would be purchased locally and brought to the site. Access to the site would be from river bank at Maintenance Area. A large excavator would be used to excavate holes for pilings; depth of hole is below bottom of scour level, exact design of ELJ's to be determined by A&E. Water from excavation would be pumped onto the forest floor far enough away from the river edge to allow sediment to filter out before water returns naturally to river. River cobble from immediate area would be used for infill and topping of ELJ as needed. One end of the ELJ's would be buried in and anchored to the river bank as shown in Figure 5.

Equipment used: Excavator dB level at 50 feet of equipment 85-81, Front end loader db at 50 feet of equipment 82 , Portable pump dB at 50 feet < 85.(EPA Report - EPA 550/9-76-004), (WLF Lessons Learned Portable Pump Operations and Hearing Protection, 7-2009) Dump truck 81 dB at 50 feet , Log Truck 80-90 dB at 50 feet.

Expected outcome: ELJ's would deflect river flows away from bank. Area directly below ELJ would create eddy providing fish habitat. Slash and log structure of the ELJ would be both fish- and aquatic invertebrate-friendly.

Environmental issues and river impact:

100 year flood plain: Yes
OHWM: Above
Diversion: Potential
Excavate River Bed: Yes
Excavate River Bank: Yes
Use of River Materials: Yes
Fish T&E: Bull trout
Bird T&E: Spotted Owl and Marbled Murrelet

Site #3: Falls Creek tributaries approximately 1.2 miles before road end (MP 0.2 to MP 1.4)

Figure 6: Tributary crossing road/trail in the Falls Creek Fan Area.

Risk: Falls Creek tributary migration and road capture of stream. This area will be repaired remain open to vehicle traffic.

Proposed flood protections: Rock -cored log cribs with pilings, rock-cored cribs no pilings, rock-cored road hump with large rock, gravel covered log hump. Check dams would be installed in woods at tributaries flowing across road with sufficient size to allow fish passage in tributaries.

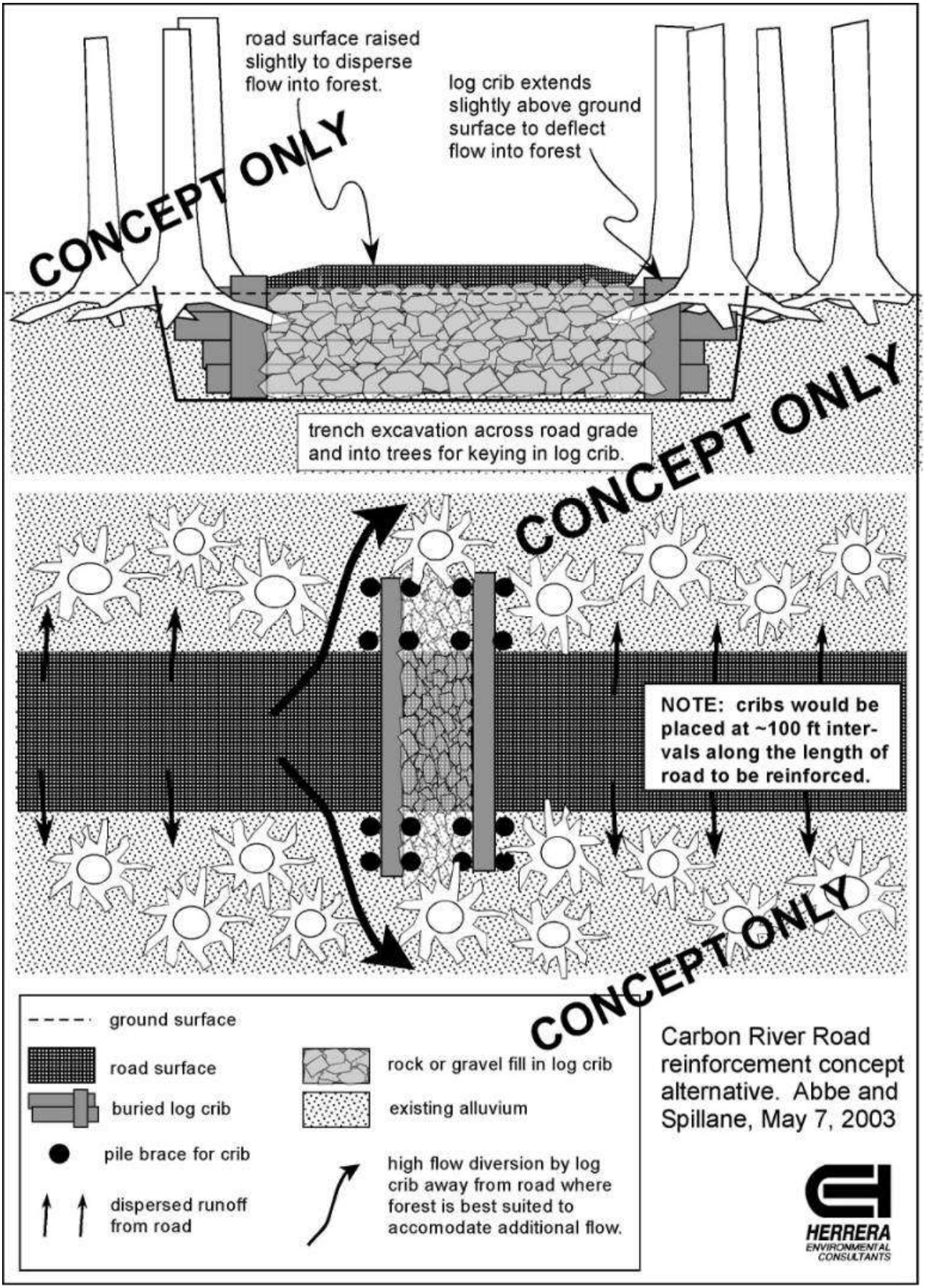


Figure 7: Rock-cored log cribs with pilings

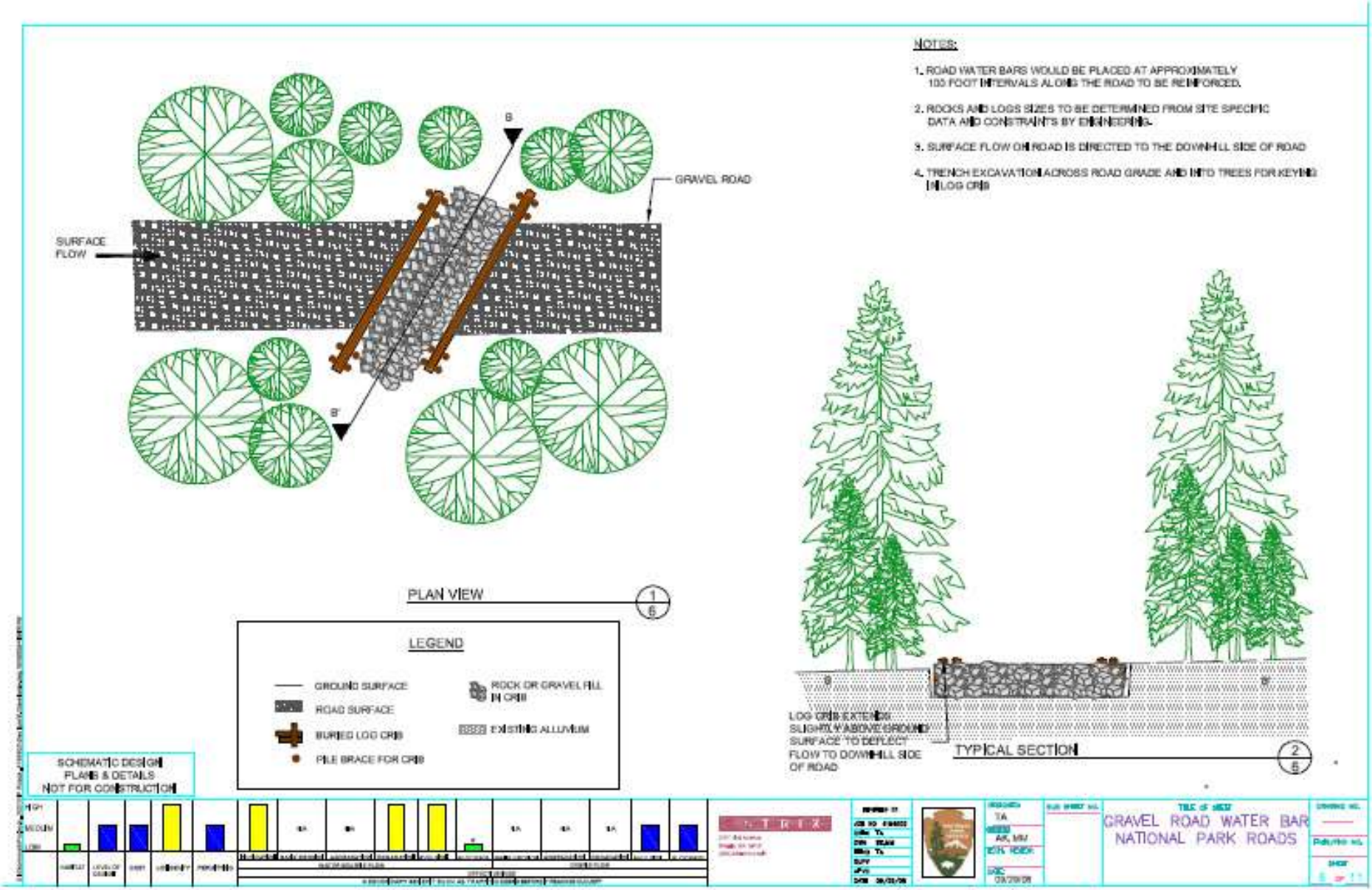


Figure 8: Gravel road water bar design

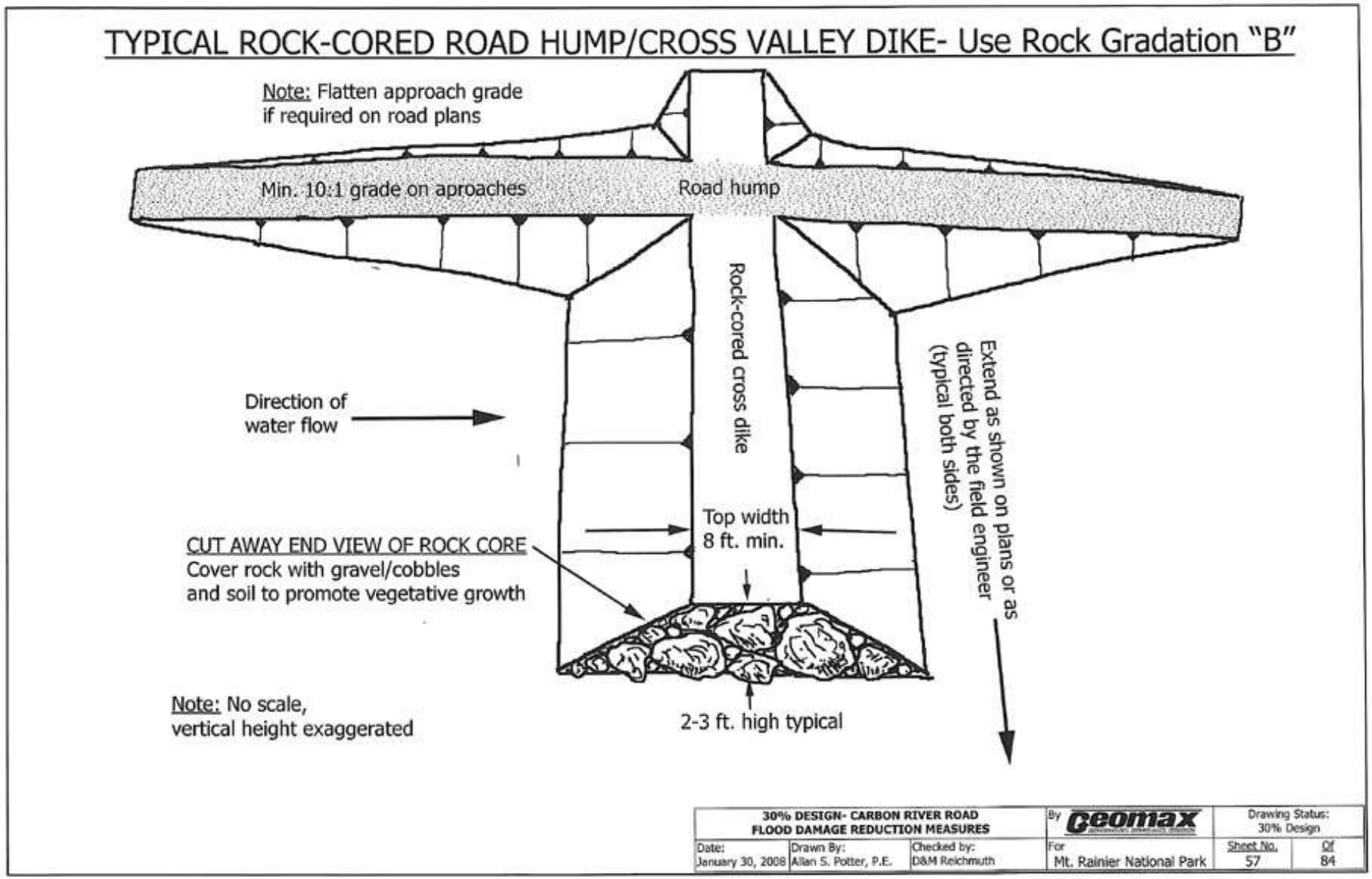


Figure 9: Rock-cored road hump with large rock

Figure 10: Gravel covered log hump

Size of structure: 5 to 9 structures 12 to 15 feet long , exact length and width would be determined by A&E.
Duration of project: 5 to 7 days for each hump or crib. 1 day for each check dam, 1 day for each Gravel covered hump. Size and location of cribs, humps and check dams would be determined by engineer and constructed as needed.
Materials needed: 18 Logs and 10 to 15 feet of rock fill as needed for each crib. Large 2-3 foot imported rock and native soil would be used for rock-cored hump, location length and width would be determined by engineer. Log hump requires 1-2 logs covered with native cobble rock and gravel.
Construction methods: All materials would be gathered on site except large rock for rock-cored hump and crushed gravel for surface. If logs are not available logs would be purchased and brought to site.
Equipment used: Equipment used: Excavator 81-85 dB at 50 feet , Front end loader 82dB at 50 feet , Dump truck 81dB at 50 feet , Log Truck 80-90db at 50 feet, Chainsaw 102-110 dB at 10 feet.
Expected outcome: Cribs, humps, gravel covered logs and check dams would capture water running over the road and channel it across the road.
Environmental Issues and River Impact:
100 year flood plain: Yes
OHWM: Above
Diversion: No
Excavate River Bed: No
Excavate River Bank: No
Use of River Materials: No
Fish T&E: Bull trout
Bird T&E: Spotted Owl and Marbled Murrelet

Sites #4 to 6: Falls Creek/Carbon Side Channel (approximately MP 1.4 to MP 2.0)

Figure 11: Developing side channel of the Carbon River in the former Carbon River Road Prism. Current hiking trail is not shown but out of frame to the left of the photo.

Risk: Carbon River migration and road capture and bank erosion. Leakage across vegetated island between Carbon River and new channel is pervasive along length of island.

Proposed flood protections (Alternative 2): The area considered for treatment includes only the portion of the flood channel next to the trail, and not the part from the trail to the Carbon River.

We propose to make check/spanner dams from existing spanning wood. No heavy equipment will be used in the stream channel, but can be used from the trail right-of-way. Details of the construction include (Figure 12):

1) The river-side end of the log is cut and dropped into the channel. If the log end can be moved, the length of the log should be slightly longer than the channel width, and the river-side end of the log dropped slightly upstream of its original location. The (raised) trail-side part of the log is chocked with woody debris.
2) It is preferable that the trail-side end of the log, which remains on the stream bank, is the root-wad.
3) Wood can be brought in for additional check-dams, if possible, by equipment on the trail.
4) All work will be supervised by a geomorphologist or geologist.
5) All actions should be documented, so adaptive management can be applied to future work.

The rationale is that lower end of the spanner will provide fish passage. If the lower end of the spanner has a greater diameter than that possible for fish passage, the end can be notched, at the direction of the Fish Biologist (Figure 12, step 5). The chocked side of the spanning log will increase channel roughness, reduce trail-side bank erosion, and promote stream deposition.

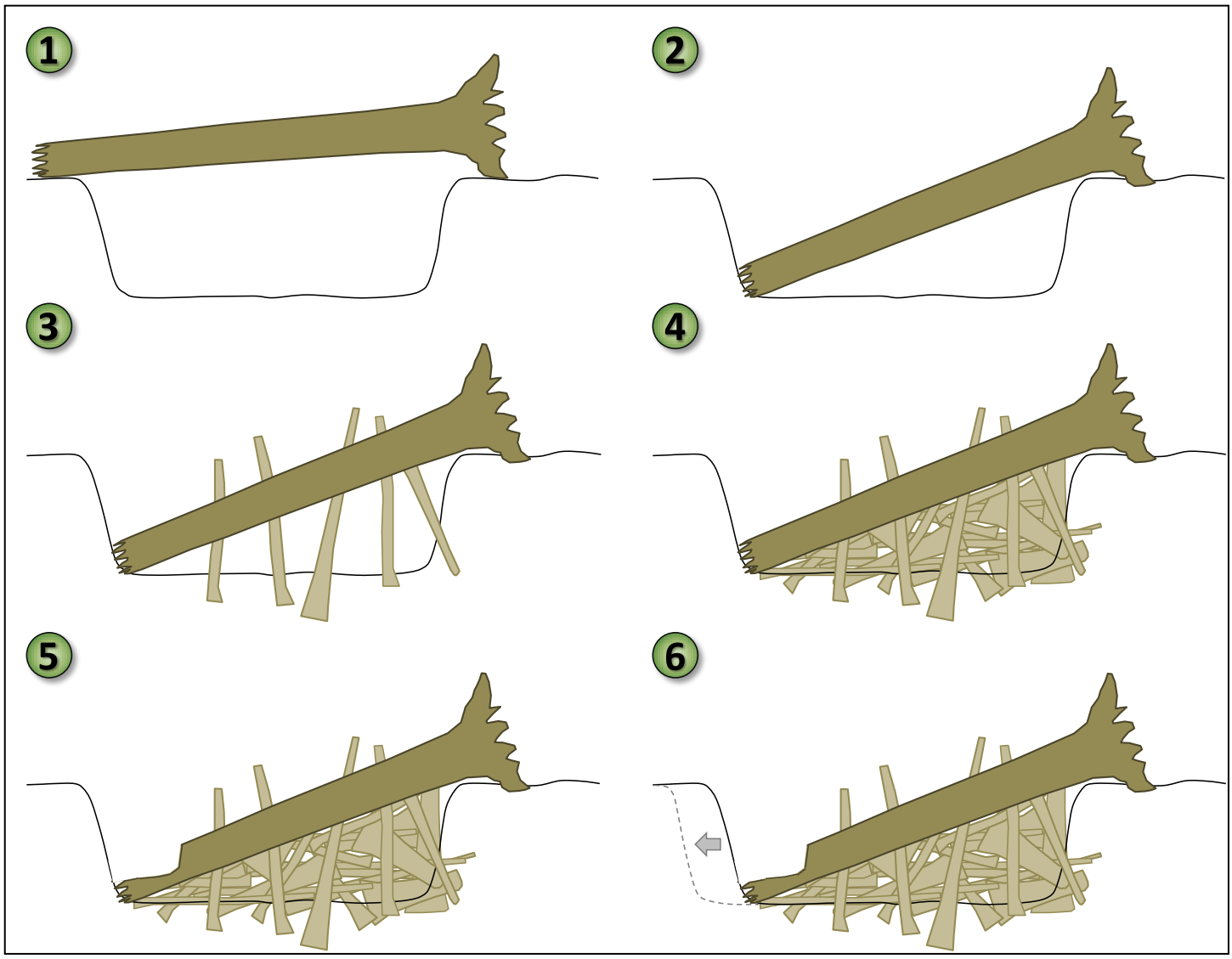


Figure 12: Construction of the Log Spanner for Alternative 2. 1) Spanning tree shown in profile view, facing upstream. Bank to be protected is the side with the intact rootwad; 2) Tree is preferably cut to a width just greater than current channel and pulled into channel with the top portion of the fallen tree facing upstream; 3-4) upstream side of spanner is chocked with large woody debris; 5) if necessary for larger dbh trees, a notch is cut in the tree to encourage fish passage; and 6) the goal of the spanner is to encourage aggradation behind structure, allow fish passage over top of structure, discourage bank erosion on the rootwad side of the structure and encourage bank erosion on the opposite bank.

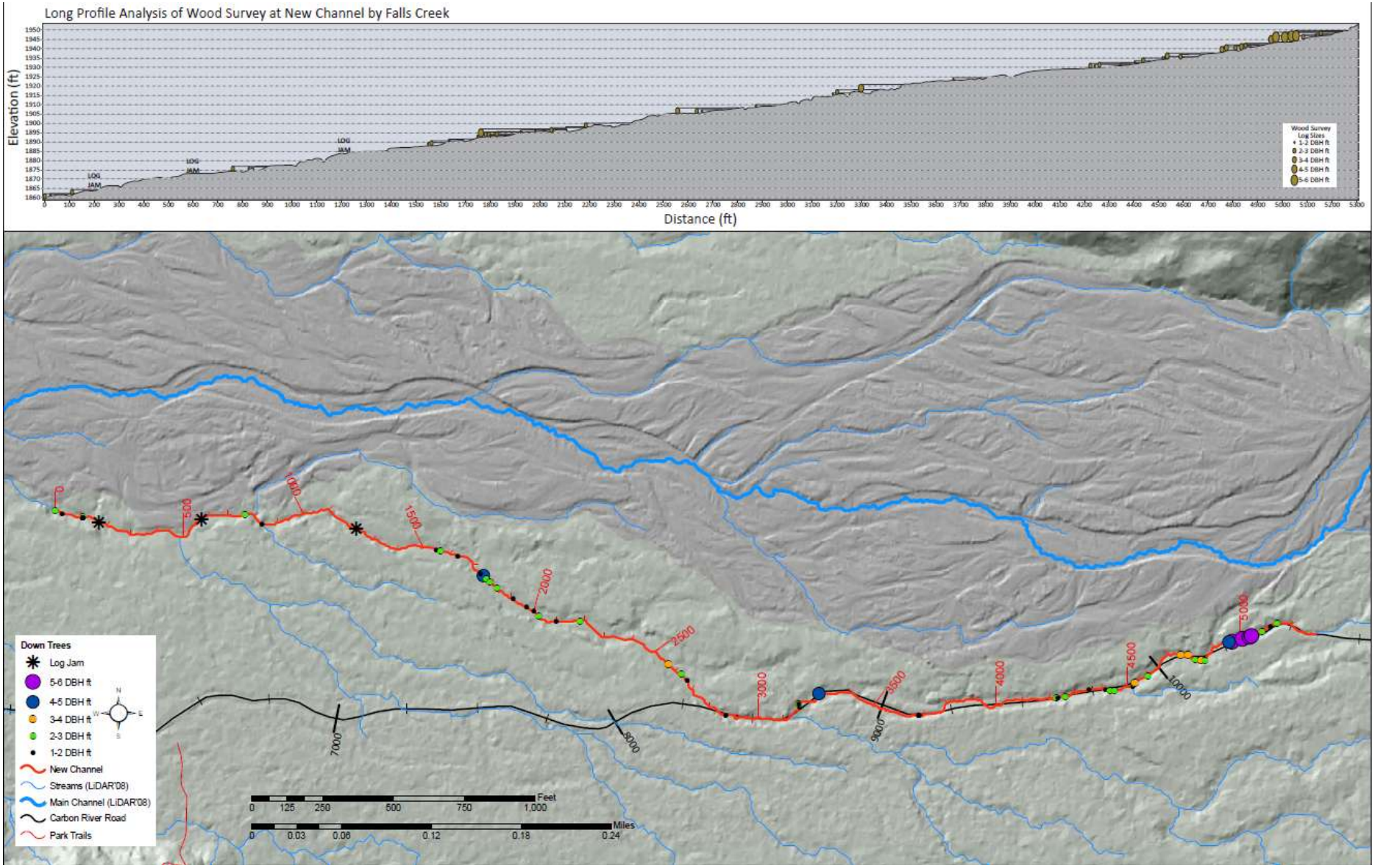


Figure 13: Longitudinal profile of the Falls Creek/Carbon River new side channel. Alternatives 2, 3 and 4 require flood protection structures between the 8000 and 10,500 foot mark on the Carbon River Road.

Proposed flood protections (Alternatives 3 and 4): Reconstruct one lane road in new channel protecting edge with toe roughened rip rap (Figure 14) or a complex crib wall (Figure 15). There would be road access to this site under alternatives 3 and 4 and large rock could be hauled to the site. Additionally, check/spanner dams could be constructed as described previously (Figure 12).
Size of structure: Check dams would be one log high and span the width of the channel. Structures would vary with size of available wood. The number of structures depends on availability of wood and depth of aggradation during flood events. Due to the possibility of a river end-run around the structures, toe roughened rip rap or complex crib walls would need to protect the entire length of the affected area, approximately 2,600 linear feet.
Duration of project: Alternative 2: 10 to 20 days; Alternatives 3 and 4: 30 to 60 days.
Materials needed: Alternative 2 would use existing logs. Alternatives 3 and 4 would need a significant number of trucked-in trees (up to 15 per 40 foot section of protection), large rock and crushed gravel for road surface.
Construction methods: Described previously in this section.
Equipment used: Equipment used: Excavator dB level at 50 feet of equipment 85-81, Bull Dozer D-5 or D-6 85 dB at 50 feet, Chainsaw 103-110 dB at 10 feet. For Alternatives 3 and 4, a dump truck 81dB at 50 feet and all Alternative 2 equipment.
Environmental Issues and River Impact:
100 year flood plain: Yes
OHWM: No
Diversion: No
Excavate River Bed: No
Excavate River Bank: Yes
Use of River Materials: Yes
Fish T&E: Bull trout
Bird T&E: Spotted Owl and Marbled Murrelet

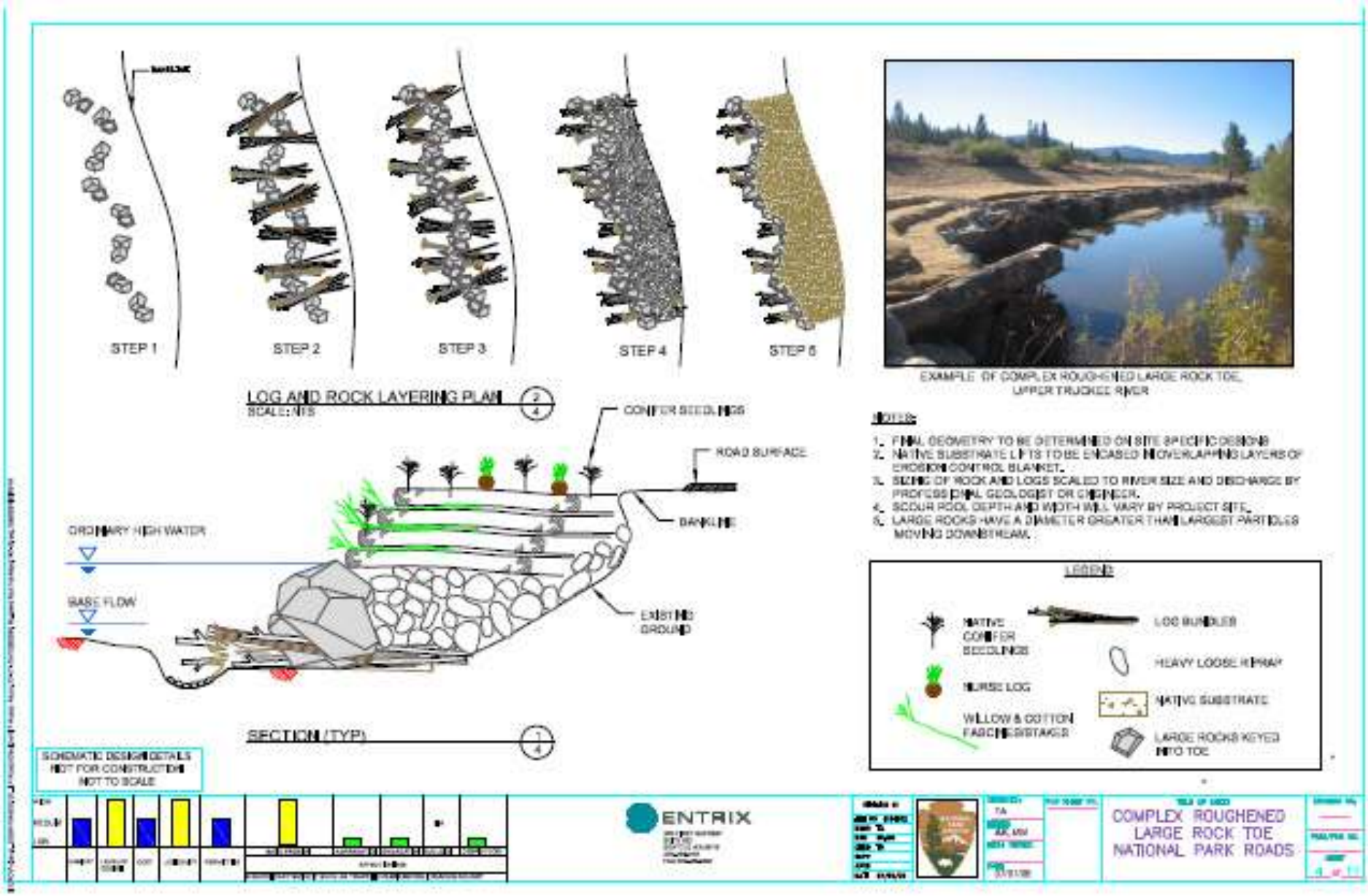


Figure 14: Typical design for toe-roughened rip rap

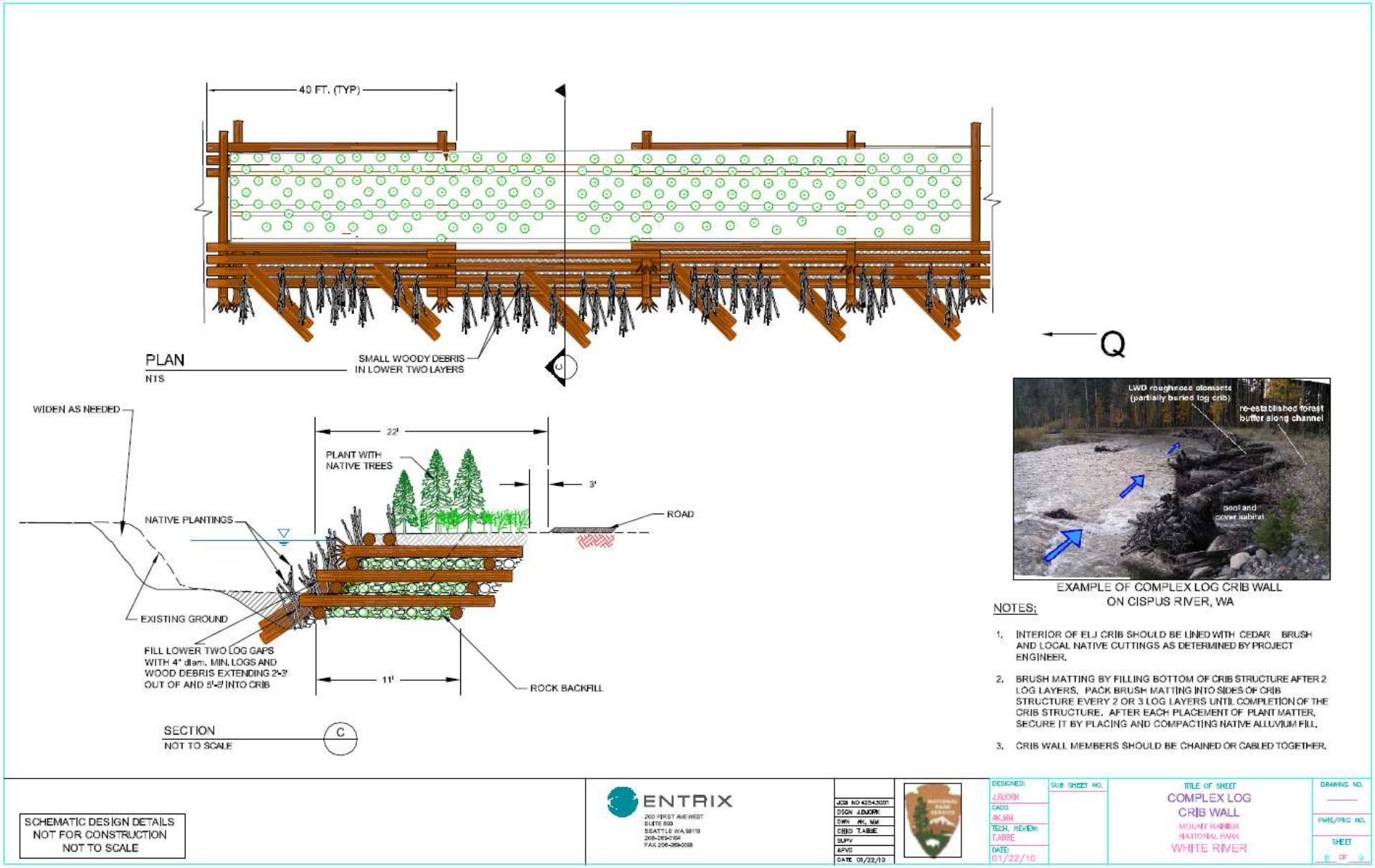


Figure 15: Complex crib wall

Site #7: Just downstream of a bedrock knob at approximately MP 2.9

Figure 16: Expanding channel near road edge. Carbon River mainstem is visible through woods.

Risk: Carbon River migration, road capture of stream, and bank erosion.
Proposed flood protections: (1) Check/spanner dams from dropping existing spanners (as described at sites 4-6; Figure 12); (2) Repair or move trail as needed; and (3) Leave all future windfall to channel and trail.
Size of structure: Size of structure is dependent on size of spanning wood. However, all structures would allow for adequate fish passage at the direction of a Fish Biologist. If necessary, structures could be notched on the far end to allow for adequate fish passage (Figure 12 step 5).
Duration of project: 5-10 days
Materials needed: Logs
Construction methods: Similar construction methods for Alternative 2 on Sites 4-6.
Equipment used: Small excavator 81-85 dB level at 50 feet, Bull Dozer D-5 or D-6 85 dB at 50 feet, Chainsaw 103-110 dB at 10 feet.
Expected outcome: River rock and sediment would accumulate behind check dams eventually filling in the new channel, and reducing threat of bank erosion.
Environmental issues and river impact:

100 year flood plain: Yes
OHWM: Below
Diversion: No
Excavate River Bed: No
Excavate River Bank: Yes
Use of River Materials: Yes
Fish T&E: Bull trout
Bird T&E: Spotted Owl and Marbled Murrelet

Site #8: Washout at milepost 3.5
See Sites #11-13 for discussion.

Site #9: "Magirl channel" near Chenuis Falls trail

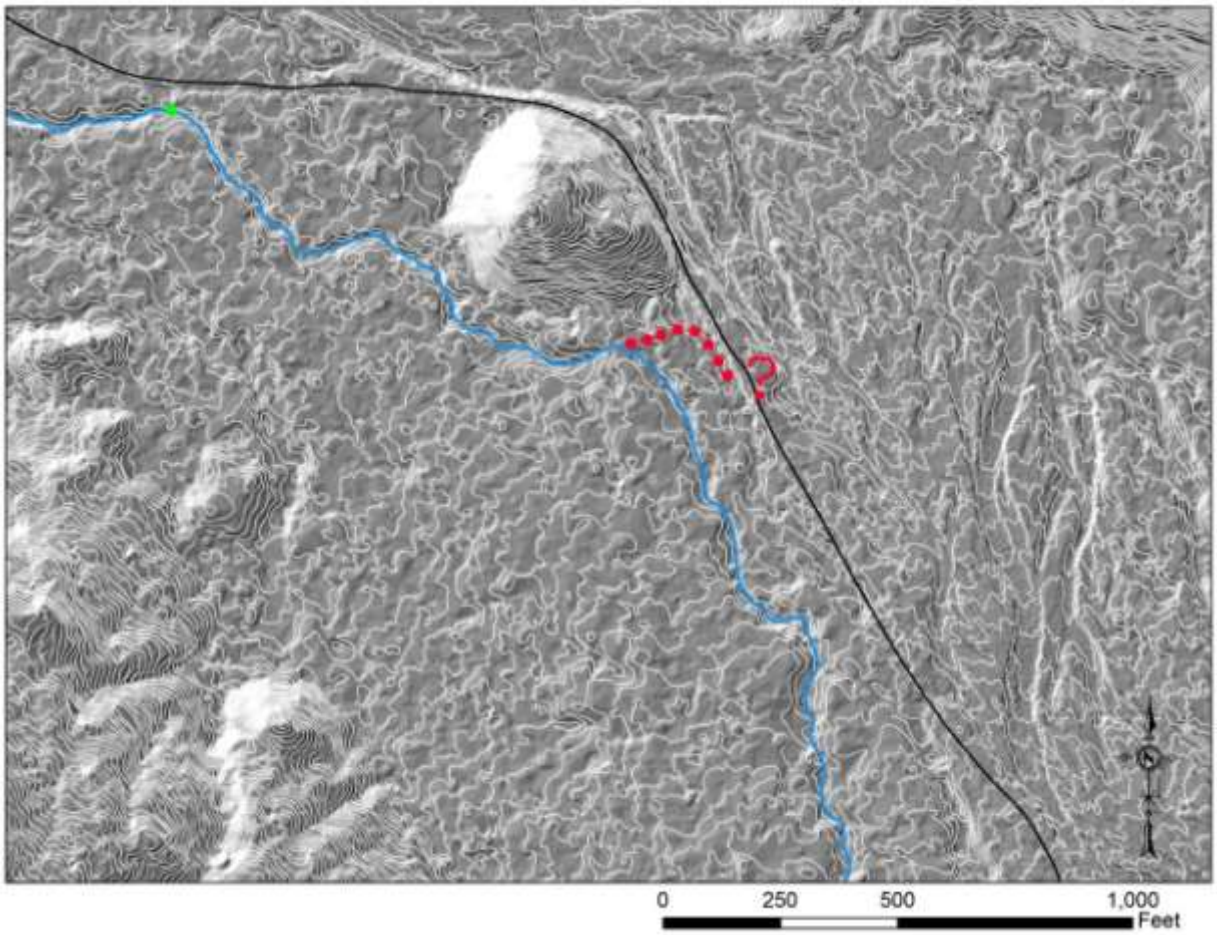


Figure 17: "Magirl channel" intersecting road upstream of rock knob.

Risk: Aggradation in Magirl Channel causes water to flow across Carbon River Road in various places below knob. Head cut of channel may incise and cause road capture by mainstream of Carbon.
Proposed Flood Protections: Install grade control structures downstream of knob.

Figure 18: "Magirl channel" near the Carbon River Road.

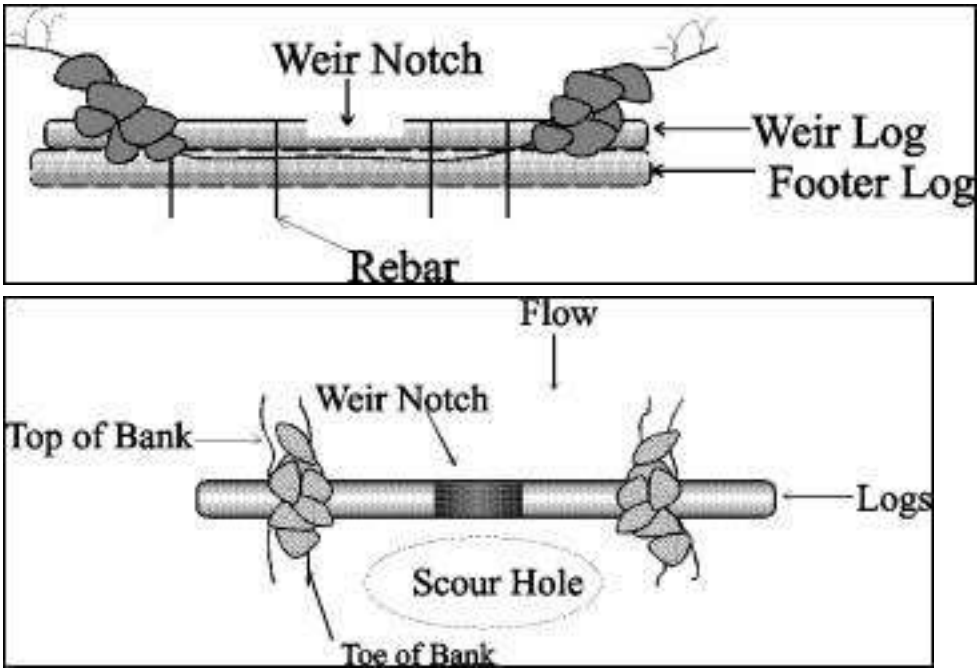


Figure 19. Notched log grade control. 3 logs proposed per structure, with off-set, notched logs for fish passage.

Size of structure: Two grade control structures. Structure size depends on site conditions
Duration of project: 5 to 8 days
Materials Needed: Logs
Construction methods: Two grade controls are recommended just upstream of a large, hanging culvert which is due to be removed (Site 10). This is because headward erosion can be propagated up both Ranger creek and from the tributary which flows to the hanging culvert. Grade controls will consist of a series of 3 logs, with off-set fish passage notches (Figure 19). Headcut erosion, subsequent to culvert removal, may cause the culvert tributary to capture upper Ranger creek, eliminating the need for 1 grade control. Please see the discussion in Site 10.
Equipment used: Equipment used: Small Excavator 81-85 dB at 50 feet, Chainsaw 103-110 dB at 10 feet. Some logs may be put in place by hand with a come-along.
Expected Outcome: Reduce or eliminate head cut.
Environmental issues and river impact:
100 year flood plain: Yes
OHWM: Above
Diversion: No
Excavate River Bed: No
Excavate River Bank: No
Use of River Materials: No
Fish T&E: Bull trout
Bird T&E: Spotted Owl and Marbled Murrelet

Site #10: Large hanging culvert near the "Magirl channel"

Figure 20: Hanging culvert near "Magirl channel"

Risk: The "Magirl Channel" flows to a hanging culvert that is approximately 6 ft off of the bed of the Carbon River. This presents a serious fish passage concern and the culvert is scheduled to be removed. When this occurs, a large sediment bulge which has been accumulating behind the culvert will be head cut and mobilized downstream (Figure 21) unless check dams are installed. An analysis of the longitudinal profile shows that there is approximately 650 cubic yards of material that could be supplied to the river if the channel is allowed to headcut without grade control structures.
Proposed action: Removing hanging culvert and install check dams as described at Site 9. Also includes removal of other large and hanging culverts along the road.
Duration of project: 1 to 3 days for each culvert.

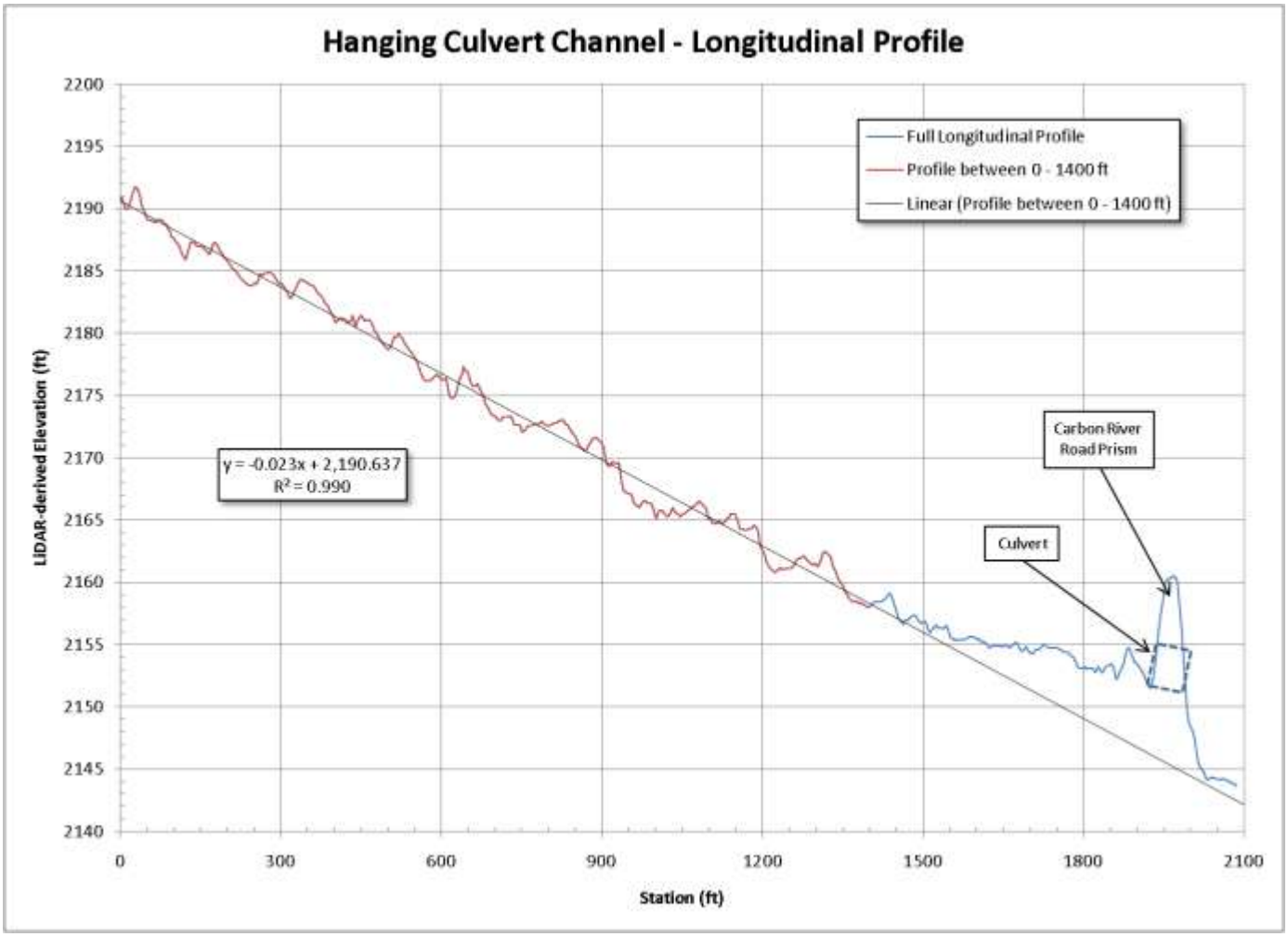


Figure 21: Longitudinal profile of the "hanging culvert" channel near the Magirl channel showing a sediment bulge behind the culvert and Carbon River Road prism.

Materials Needed: Logs

Construction methods: Under Alternative 2, a small excavator would be used excavate around each culvert. Some of the larger culverts would have to be cut into smaller pieces using a cutting torch before the small excavator could lift it out of the stream. If the pieces were cut small enough they could be hauled out of the area using an ATV , larger pieces could be hauled out with the excavator or by helicopter. Alternative 3 describes construction of a one lane vehicle road to Chenuis Falls Trail or 0.5 miles from Ipsut Campground respectively. Under Alternative 4 we would construct a 15 foot single lane road through all three bites. A small dumptruck could be used to haul out culverts under these alternatives.

Equipment used: Small excavator 81-85 dB level at 50 feet , ATV 350CC 80 dB level at 50 feet, Helicopter (Huey and Chinook) 101-102 dB in helicopter.

Expected outcome: Stream passage would revert to natural state, reduced impediment to fish passage.

Environmental issues and river impact:

100 year flood plain: Yes

OHWM: Below
Diversion: No
Excavate River Bed: No
Excavate River Bank: Yes
Use of River Materials: No
Fish T&E: Bull trout other?Bird T&E: Spotted Owl and Marbled Murrelet

Sites #11, 12 and 13 (including #8): Bank erosion and road washout at MP 3.5, 3.8, 3.9 and 4.5

Figure 22: Bank erosion sites. (a) Site 8, MP 3.5; (b) Site 11, MP 3.8; (b) Site 12, MP 3.9; (c) Site 13, MP 4.5.

Risk: Continued bank erosion, heavy aggradation in river next to cut pushing river into bank during flooding. In order to determine the relative risk for the "bite" sites, bank erosion rates were calculated. See Appendix C for maps showing the bank erosion at each washout site. Aerial photos from 2002 and 2007 and LiDAR data from 2008 were analyzed to determine the bank position during each time frame. The area of bank loss was determined in ArcGIS and shown in Table 2. Overall, bank erosion is a serious concern at each site, averaging 5-15 ft per year during the analysis period. It is likely that the most erosion occurred in the 2006 flood; however, bank erosion did occur between 2007 and 2008 which indicates the erosive forces of small to moderate floods are actively eroding banks at and in the vicinity of the bite sites. The risk for future bank erosion has been previously calculated (in the Risk Analysis) and is listed as "Extreme." It is anticipated that without further protection, bank erosion and damage to the extant portions of the Carbon River Road will continue.

Area	Time Period			Length		Area loss by Bank Erosion		Avg Loss in Period		Average Loss Per Year	
	From	To	Total	m	ft	sq m	sq ft	m	ft	m	ft
Washout MP 3.5	2002	2007	5	302.543	992.596	6,831.467	73,533.303	22.580	74.082	4.516	14.816
	2007	2008	1	302.543	992.596	1,901.160	20,463.911	6.284	20.617	6.284	20.617
	2002	2008	6	302.543	992.596	8,732.627	93,997.214	28.864	94.698	4.811	15.783
Washout MP 3.8	2002	2007	5	207.114	679.509	1,439.654	15,496.307	6.951	22.805	1.390	4.561
	2007	2008	1	207.114	679.509	620.496	6,678.965	2.996	9.829	2.996	9.829
	2002	2008	6	207.114	679.509	2,060.150	22,175.272	9.947	32.634	1.658	5.439
Washout MP 3.9	2002	2007	5	151.942	498.498	1,273.894	13,712.083	8.384	27.507	1.677	5.501
	2007	2008	1	151.942	498.498	469.215	5,050.593	3.088	10.132	3.088	10.132
	2002	2008	6	151.942	498.498	1,743.110	18,762.676	11.472	37.638	1.912	6.273
Washout MP 4.5	2002	2007	5	253.390	831.333	5,380.565	57,915.923	21.234	69.666	4.247	13.933
	2007	2008	1	253.390	831.333	730.396	7,861.915	2.882	9.457	2.882	9.457
	2002	2008	6	253.390	831.333	6,110.961	65,777.837	24.117	79.123	4.019	13.187

Table 2: Bank erosion rates at the washout locations between 2002, 2007 and 2008.

Proposed Flood Protections: Toe roughened gabion (adaptive management), toe-roughened rip rap (Figure 14), or complex crib wall (Figure 15).

Size of structure: Structure size depends on site conditions. Approximate lengths of the washouts are: 240 ft at MP 3.8; 200 ft at MP 3.8; 200 ft at MP 3.9; and 380 ft at MP 4.5 Height of cut bank varies from 3 to 12 feet.

Duration of project: 10 to 20 days for each bite.

Materials needed: Logs, wire "baskets" and river cobble. The number and size of logs would depend on length and height of structure. For a 100 foot long by 15 foot high by 15 foot wide structure we would need 28 -35 logs with branches for the toe structure. The amount of cobble needed to fill 3 foot square gabions for a 100 foot long structure would be approximately 1628 square feet or 542 CY. We would need and additional 400 plus feet of log for the cribbing for a 100 foot long structure.

Construction methods: Gabion baskets would be filled on site using cobble from river. A small excavator would be used to fill and place gabions as shown in design. If logs are available near the site they would be cut to length, moved with excavator or with come-along and laid in place. If logs aren't available on site they would be purchased locally and flown by helicopter to the site. There isn't access to this location for large vehicles or equipment, hauling logs or rock in by truck is not an option being considered under Alternative 2. Alternative 3 describes construction of a one lane vehicle road to Chenuis Falls Trail or 0.5 miles from Ipsut Campground respectively. Under Alternative 4 we would construct a 15 foot single lane road through all the washouts. In addition to the toe-roughened gabions, we also consider crib structures (figure 15). Due to equipment limitations, relatively small wood (estimated maximum of about 2 foot dbh, 30 feet length) wood will be used. At most times of the year all three sites are dry, if necessary we would have to divert water away from the site to work in the wet. To do this we would excavate a temporary channel reinforced with river bed material.
Equipment used: Alternative 2, a small Excavator dB level at 50 feet of equipment 85-81, Chainsaw 103-110 dB at 10 feet, helicopter (Huey and Chinook) 101-102 dB in helicopter.
Expected Outcome: Eliminate bank erosion to protect remaining hiking, bicycling trail.
Environmental issues and river impact:
100 year flood plain: Yes
OHWM: Below
Diversion: Potential
Excavate River Bed: No
Excavate River Bank: No
Use of River Materials: Yes
Fish T&E: Bull trout other?
Bird T&E: Spotted Owl and Marbled Murrelet

Site #14: New channel in Ipsut Campground access road approximately 1620 feet long.

Figure 23: New Channel Ipsut Road at Campground Entrance Looking Down Stream

Risk: The Carbon augmented Ipsut creek, locally known as Ca-put creek, is about 40 feet average (20 to 60 feet) from the current trail. Because of this relatively large vegetation buffer, erosion risk to most of the trail is not considered high. There is a 20 ft section of trail (Figure 24) Check dams are no longer being considered.

Duration of project: One of the proposed structures would take 20-30 days. Construction of a diversion channel without structure would take about 5 days.

Materials Needed: Would use existing logs, river bed material and native plants.

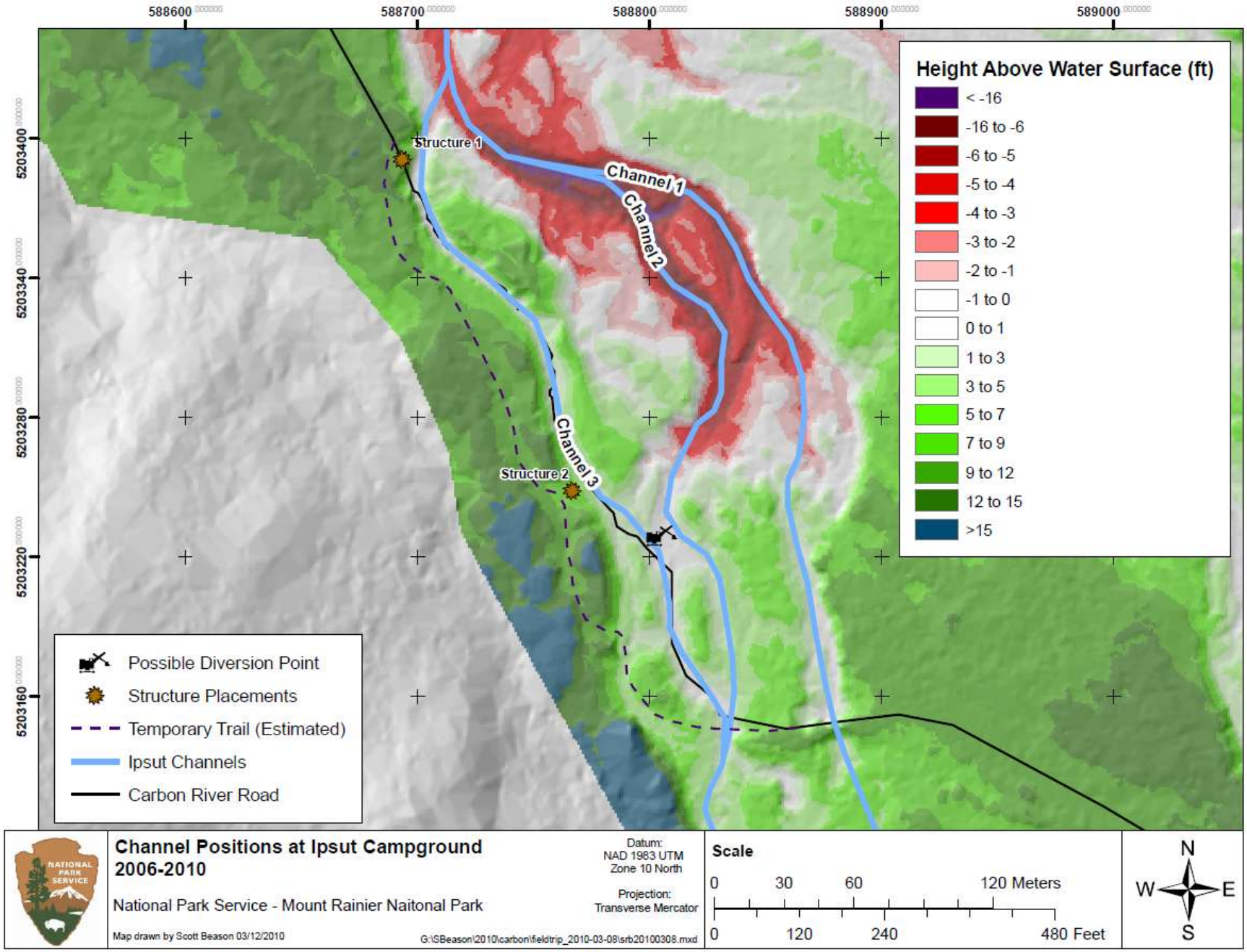


Figure 24. Location of proposed Ca-put (Ipsut) creek structures, and diversion. Channel 1 is the pre-2006 Ipsut Creek alignment, Channel 2 is the post-2006 Ca-put alignment and Channel 3 is the current Ca-put creek alignment.

Construction methods: For compliance purposes, 2 areas for protection are submitted. The 1st is the current road end (figure 24), and 2 structure-types are considered: launch-able (buried) groins (figure 25) and a toe-roughened crib wall (figure 26). The former will not require any diversion of Ca-put creek, as the infrastructure will be buried in the existing (dry) road, and exhumed by flood waters. Please note, that this structure will potentially protect only 590 feet of road (from Ca-put creek to the washout at MP 4.5), and cost/benefits should be considered.

The 2nd area for potential protection (Figure 24) is where the trail is only about 20 feet from the channel. A crib (figure 26) is considered here. A temporary diversion of Ca-put is likely required. A small excavator would be used to place logs and fill structure as shown in design. If logs are available near the site they would be cut to length, moved with excavator or with come-along and laid in place. If logs aren't available on site they would be purchased locally and flown by helicopter to the site. There isn't access to this location for large vehicles or equipment, hauling logs or rock in by truck is not an option being considered under Alt. 2. Alt. 3 describes construction of a one lane vehicle road to Chenuis Falls Trail or 0.5 miles from Ipsut Campground respectively. Under Alt. 4 we would construct a 15 foot single lane road through all three bites to the end of the road at the Ipsut washout.

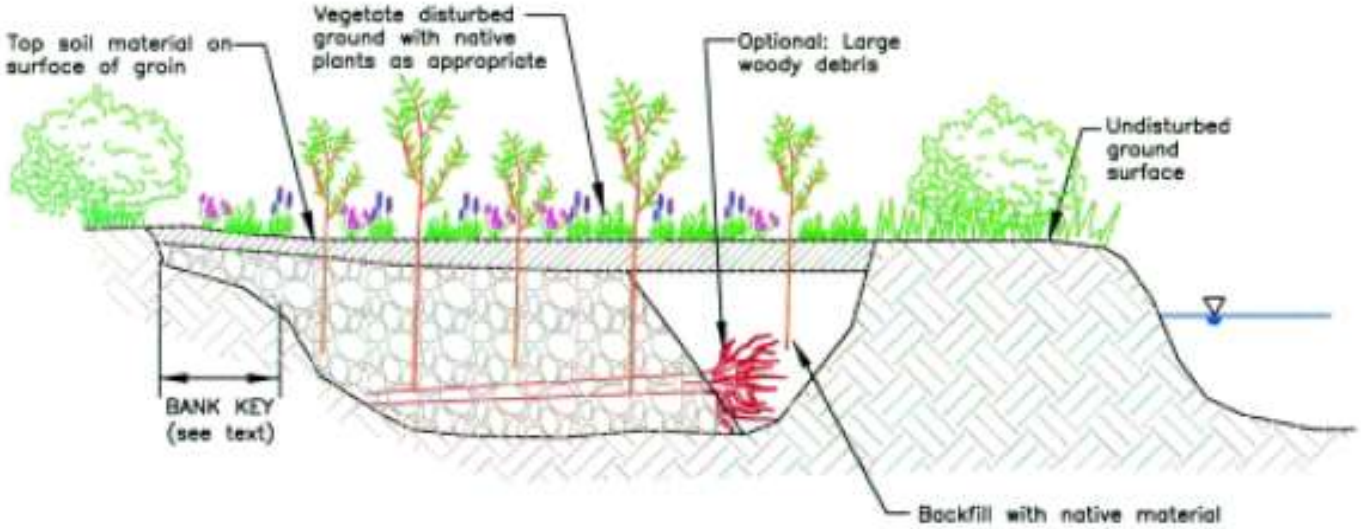
Another alternative, to increase the distance between the channel and the trail, is to permanently divert the current stream to its immediately previous (last winter) location (Channel 2 in Figure 24). A diversion channel could be constructed using a small excavator and bull dozer. The diversion point could be reinforced with a log crib structure. (Figure 26.)

Equipment used: Small excavator 81-85 dB level at 50 feet, Bull Dozer D-5 or D-6 85 dB at 50 feet, Chainsaw 103-110 dB at 10 feet

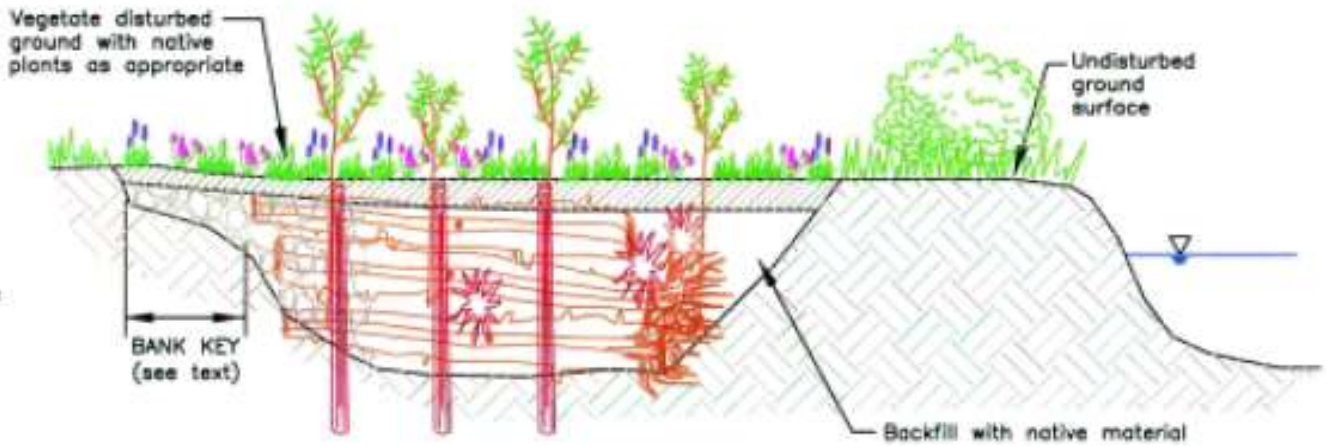
Expected Outcome: Groins and crib wall would dissipate energy and or deflect flow away from river bank and trail. Diversion channel would channel flow away from river bank and trail.

Environmental issues and river impact:

100 year flood plain: Yes
OHWM: Below
Diversion: Yes
Excavate River Bed: No
Excavate River Bank: Yes
Use of River Materials: Yes
Fish T&E: Bull trout
Bird T&E: Spotted Owl and Marbled Murrelet



SECTION VIEW OF BURIED ROCK GROIN (W/ OPTIONAL WOOD)



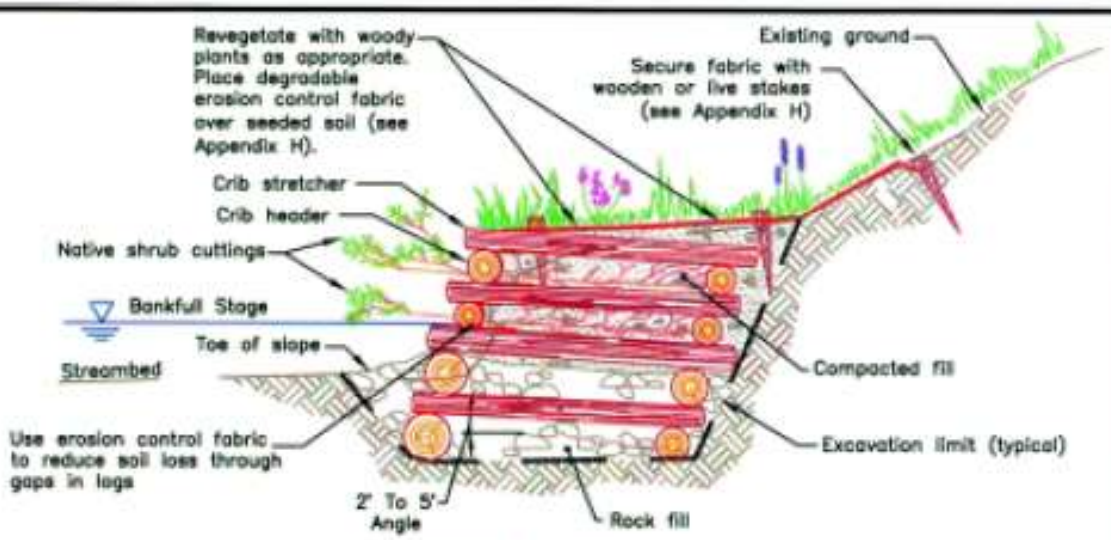
Note:
Bank key, height, and length of groins are site dependent. See text of groins and buried groins for more information.

SECTION VIEW OF BURIED WOOD GROIN

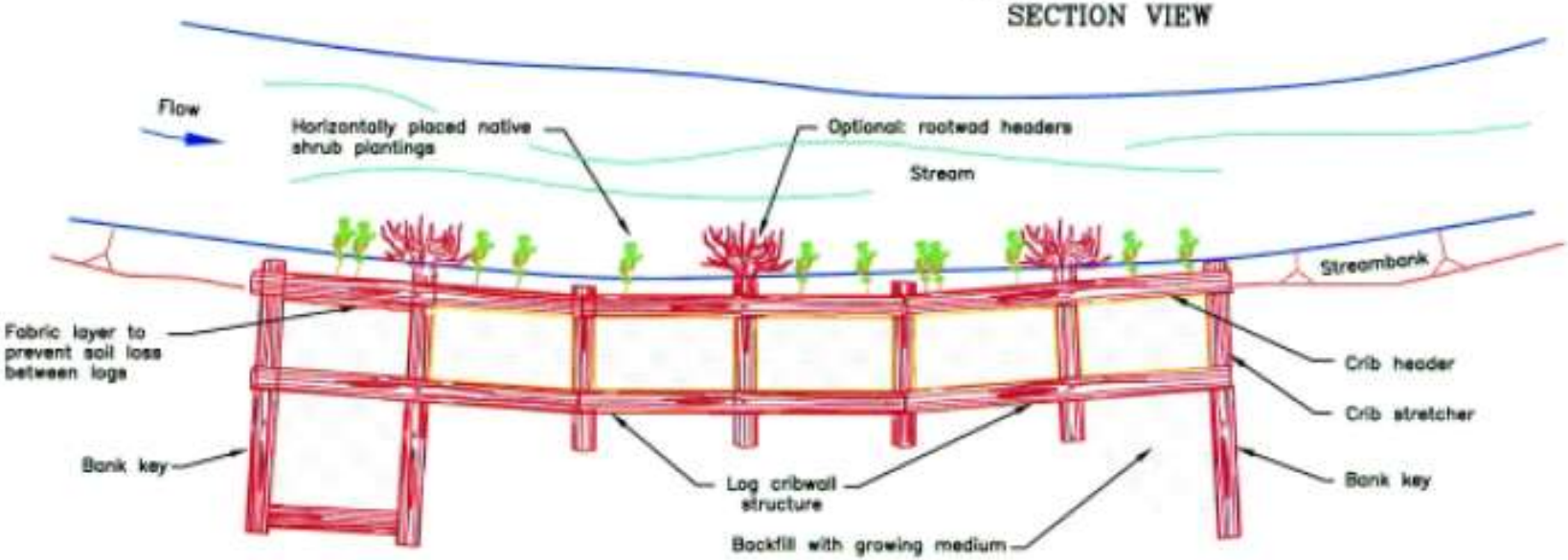
NOT TO SCALE

FIGURE 6–5	BURIED GROINS CONCEPTUAL DESIGN	INTEGRATED STREAMBANK PROTECTION GUIDELINES www.ecy.gov/wdfw/hab/eslguide/strmbank.htm

Note:
Crib header and crib stretcher anchored together



SECTION VIEW



PLAN VIEW

NOT TO SCALE

FIGURE 6–29	LOG CRIBWALL CONCEPTUAL DESIGN	INTEGRATED STREAMBANK PROTECTION GUIDELINES www.wa.gov/wdfw/hab/solguide/strmbank.htm

APPENDIXES

APPENDIX A: Road Segments and Justifications for DRAFT Relative Risk Assessment – Carbon River Road.
APPENDIX B: Detail maps for DRAFT Relative Risk Assessment – Carbon River Road (B-1 – B-4).
APPENDIX C: Bank erosion maps at road washouts (C-1 – C-4).

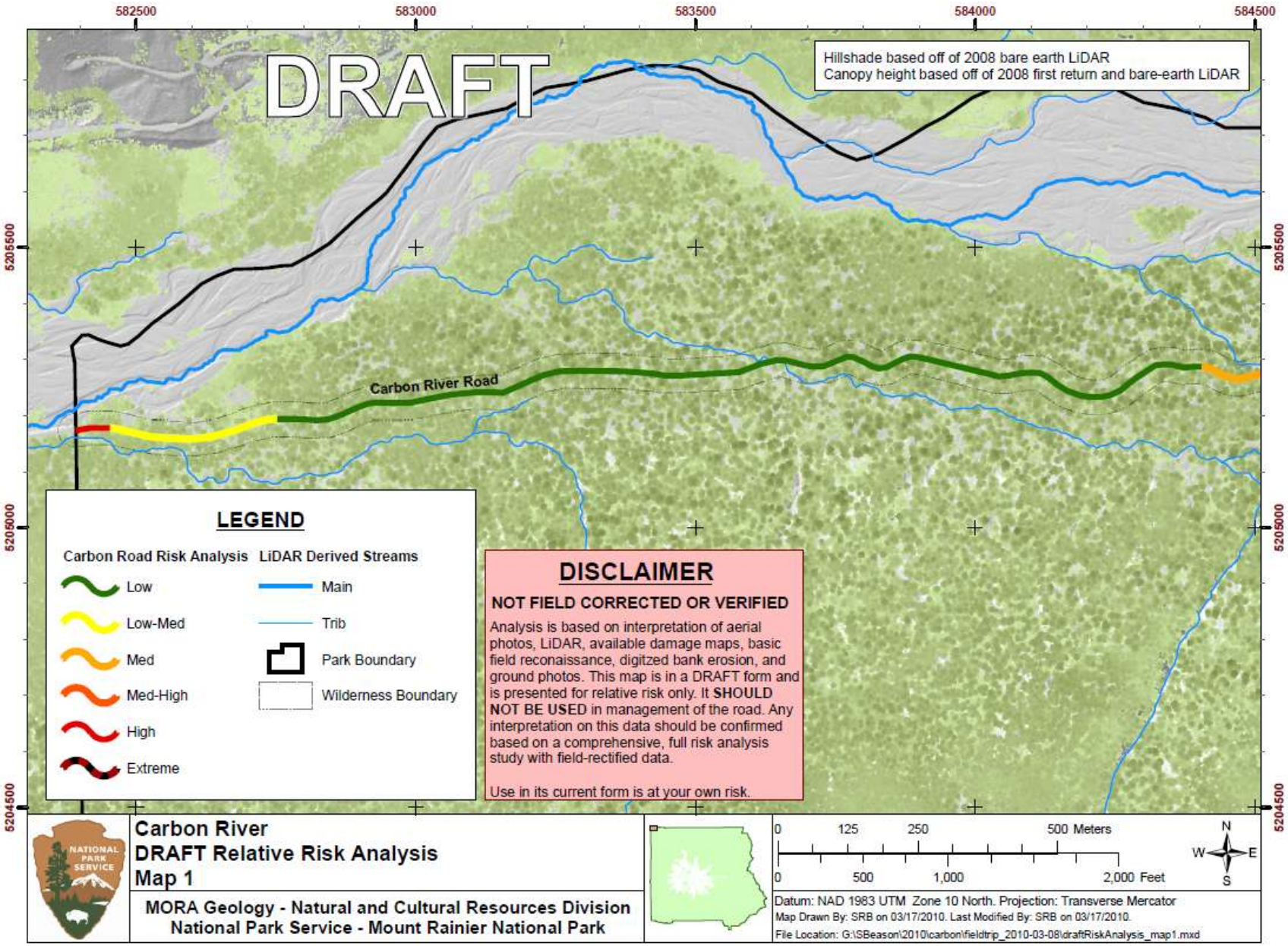
APPENDIX A: Road Segments and Justifications for DRAFT Relative Risk Assessment – Carbon River Road.

Name	Ft Along Road		Milepost		Length	Risk Category	Justification
	Start	End	Start	End	(m)		
Carbon River Road	0	200	0	0.038	61.448	High	Bank Erosion, Bank within 10 m of road, danger to park infrastructure
Carbon River Road	200	1,200	0.038	0.227	306.441	Low-Med	Bank Erosion, Bank w/in 50 m of road, danger to park infrastructure
Carbon River Road	1,200	6,800	0.227	1.288	1717.653	Low	Road on terrance, >500m to river
Carbon River Road	6,800	7,600	1.288	1.439	245.737	Med	Avulsion hazard, Possible Bank Erosion, Road falling off of terrace
Carbon River Road	7,600	8,100	1.439	1.534	153.095	Med-High	Avulsion, Bank Erosion, Lower Terrace
Carbon River Road	8,100	8,300	1.534	1.572	61.718	High	Avulsion, Bank Erosion, Little Terrace, Side Channel in proximity of road
Carbon River Road	8,300	10,900	1.572	2.064	797.010	Extreme	In Side Channel, Avulsion, Current surface is below Main Stem elevation, Bank Erosion, Side Channel Widening
Carbon River Road	10,900	11,100	2.064	2.102	61.710	Low-Med	Avulsion, Bank Erosion, Side Channel on south side
Carbon River Road	11,100	12,000	2.102	2.273	275.665	Low-Med	Relict Side Channel, lower elevation on south side
Carbon River Road	12,000	14,300	2.273	2.708	705.421	Low	High terrace, Presence of Side Channel on north side
Carbon River Road	14,300	15,300	2.708	2.898	307.110	Med-High	Side Channel just north, Bank Erosion, Spillover from Main stem. Risk is between Medium and Medium-High here.
Carbon River Road	15,300	15,600	2.898	2.955	91.727	Med	Bank Erosion, Spillover from Main Stem, Presence of Side Channel. Needs to be field checked
Carbon River Road	15,600	16,800	2.955	3.182	367.919	High	Active Bank Erosion, Carbon River main stem aimed at bank, High relief above main stem presents hazard. Variable risk through section.
Carbon River Road	16,800	17,800	3.182	3.371	306.630	Low-Med	Active Bank Erosion, Main Stem near Bank, Lower Terrace

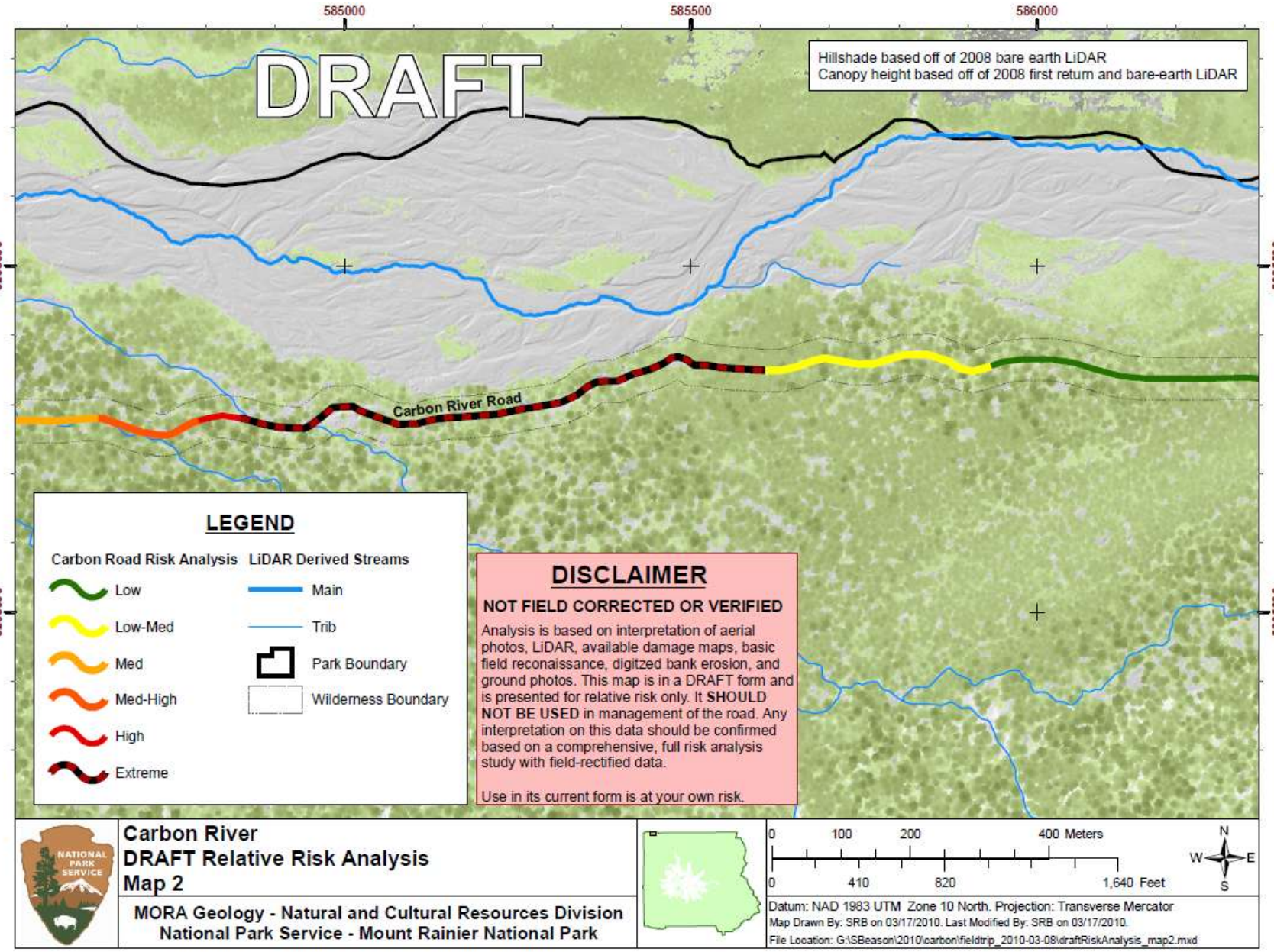
Name	Ft Along Road		Milepost		Length	Risk Category	Justification
	Start	End	Start	End	(m)		
Carbon River Road	17,800	18,200	3.371	3.447	122.893	High	Active Bank Erosion, Main Stem near Bank, Side Channel in proximity to road.
Carbon River Road	18,200	18,700	3.447	3.542	153.797	Extreme	Active Bank Erosion, Loss of road, "Bite Me" Location,Risk of main stem Avulsion
Carbon River Road	18,700	19,600	3.542	3.712	275.083	High	Active Bank erosion, Main Stem very near road along section, Side Channels to the west.
Carbon River Road	19,600	20,400	3.712	3.864	246.223	Extreme	Active Bank Erosion and river overtopping, Loss of road, "Natty Lite" location, Main stem avulsion hazard
Carbon River Road	20,400	21,200	3.864	4.015	244.612	Extreme	Active Bank Erosion, Loss of road, "Little Bite" location, MS Avulsion
Carbon River Road	21,200	21,600	4.015	4.091	122.758	Med	Proximity of Main stem, Avulsion hazard, Bank Erosion, Low Relief to river channel
Carbon River Road	21,600	22,500	4.091	4.261	275.872	Low	Slight Bank erosion, Main stem within 100 m of Road
Carbon River Road	22,500	22,900	4.261	4.337	123.060	Low	High Terrace, significant Bank Erosion in MS >100 m away from road
Carbon River Road	22,900	23,200	4.337	4.394	91.591	Med	Significant Bank Erosion near road, Low relief between road and river.
Carbon River Road	23,200	23,500	4.394	4.451	92.529	High	Significant Bank erosion within Wilderness, downstreamof Bite
Carbon River Road	23,500	24,100	4.451	4.564	184.024	Extreme	Loss of Road @ "Big Bite", Active Bank Erosion, Main Stem Avulsion
Carbon River Road	24,000	25,300	4.545	4.792	54.890	Med-High	Complete loss of Road, Extensive Bank erosion, Avulsion of Carbon River and Ipsut Creek.
Carbon River Road	24,100	24,300	4.564	4.602	61.025	Low-Med	Road bookended by Bites, Bank Erosion, Possible Erosion starting at Ipsut side moving downstream on road prism.
Carbon River Road	24,300	24,000	4.602	4.545	58.601	Extreme	Complete loss of Road, Extensive Bank Erosion, Main stem Carbon River and Ipsut Creek Avulsion

Name	Ft Along Road		Milepost		Length	Risk Category	Justification
	Start	End	Start	End	(m)		
Carbon River Road	25,300	26,300	4.792	4.981	184.026	Low	Possible Long Term Road Damage from Main Stem Avulsion
Rerouted Trail by Ipsut	0	375	0.000	0.071	114.040	Med	Bank Erosion, High Relief
Rerouted Trail by Ipsut	375	450	0.071	0.085	22.734	Med-High	Bank Erosion, Ca-put channel within 20 ft of trail
Rerouted Trail by Ipsut	450	1000	0.085	0.189	172.514	Med	Bank Erosion, High Relief
Rerouted Trail by Ipsut	1000	1150	0.189	0.218	45.135	Med-High	Possible damage due to Carbon River diversion upstream into Ipsut Creek Channel

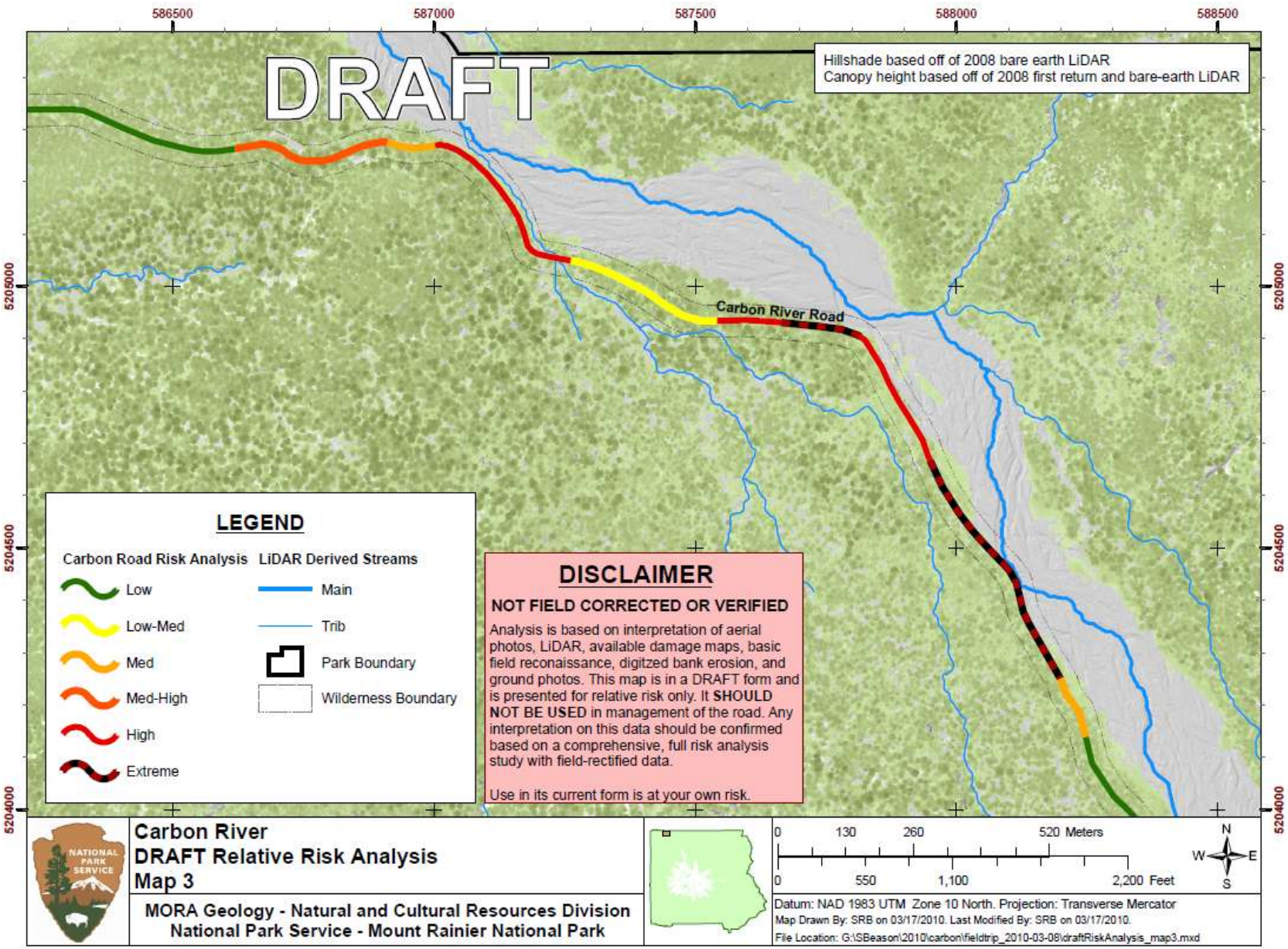
APPENDIX B-1: Detail maps for DRAFT Relative Risk Assessment – Carbon River Road.


582500
583000
583500
584000
584500
5205500
5205000
5204500
DRAFT
Hillshade based off of 2008 bare earth LiDAR
Canopy height based off of 2008 first return and bare-earth LiDAR
Carbon River Road
LEGEND
Carbon Road Risk Analysis
Low
Low-Med
Med
Med-High
High
Extreme
LiDAR Derived Streams
Main
Trib
Park Boundary
Wilderness Boundary
DISCLAIMER
NOT FIELD CORRECTED OR VERIFIED
Analysis is based on interpretation of aerial photos, LiDAR, available damage maps, basic field reconaissance, digitzed bank erosion, and ground photos. This map is in a DRAFT form and is presented for relative risk only. It SHOULD NOT BE USED in management of the road. Any interpretation on this data should be confirmed based on a comprehensive, full risk analysis study with field-rectified data.
Use in its current form is at your own risk.
NATIONAL PARK SERVICE
Carbon River
DRAFT Relative Risk Analysis
Map 1
MORA Geology - Natural and Cultural Resources Division
National Park Service - Mount Rainier National Park
0 125 250 500 Meters
0 500 1,000 2,000 Feet
N
W
E
S
Datum: NAD 1983 UTM Zone 10 North. Projection: Transverse Mercator
Map Drawn By: SRB on 03/17/2010. Last Modified By: SRB on 03/17/2010.
File Location: G:\SBeason\2010\carbon\fieldtrip_2010-03-08\draftRiskAnalysis_map1.mxd

APPENDIX B-2: Detail maps for DRAFT Relative Risk Assessment – Carbon River Road.


585000
585500
586000
5205500
5205000
DRAFT
Hillshade based off of 2008 bare earth LiDAR
Canopy height based off of 2008 first return and bare-earth LiDAR
Carbon River Road
LEGEND
Carbon Road Risk Analysis
Low
Low-Med
Med
Med-High
High
Extreme
LiDAR Derived Streams
Main
Trib
Park Boundary
Wilderness Boundary
DISCLAIMER
NOT FIELD CORRECTED OR VERIFIED
Analysis is based on interpretation of aerial photos, LiDAR, available damage maps, basic field reconaissance, digitzed bank erosion, and ground photos. This map is in a DRAFT form and is presented for relative risk only. It SHOULD NOT BE USED in management of the road. Any interpretation on this data should be confirmed based on a comprehensive, full risk analysis study with field-rectified data.
Use in its current form is at your own risk.
NATIONAL PARK SERVICE
Carbon River
DRAFT Relative Risk Analysis
Map 2
MORA Geology - Natural and Cultural Resources Division
National Park Service - Mount Rainier National Park
0 100 200 400 Meters
0 410 820 1,640 Feet
N
W
E
S
Datum: NAD 1983 UTM Zone 10 North. Projection: Transverse Mercator
Map Drawn By: SRB on 03/17/2010. Last Modified By: SRB on 03/17/2010.
File Location: G:\SBeason\2010\carbon\fieldtrip_2010-03-08\draftRiskAnalysis_map2.mxd

APPENDIX B-3: Detail maps for DRAFT Relative Risk Assessment – Carbon River Road.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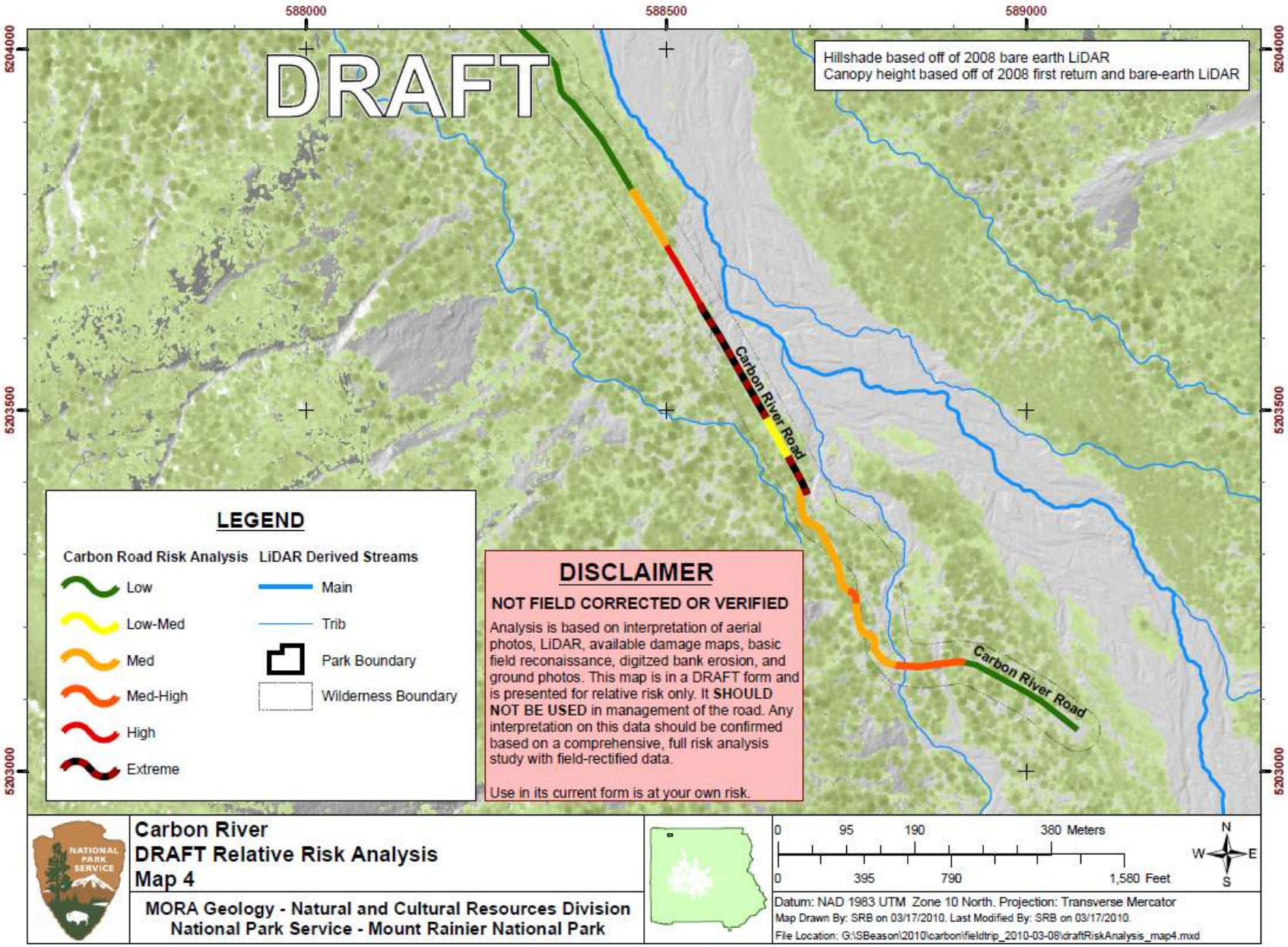
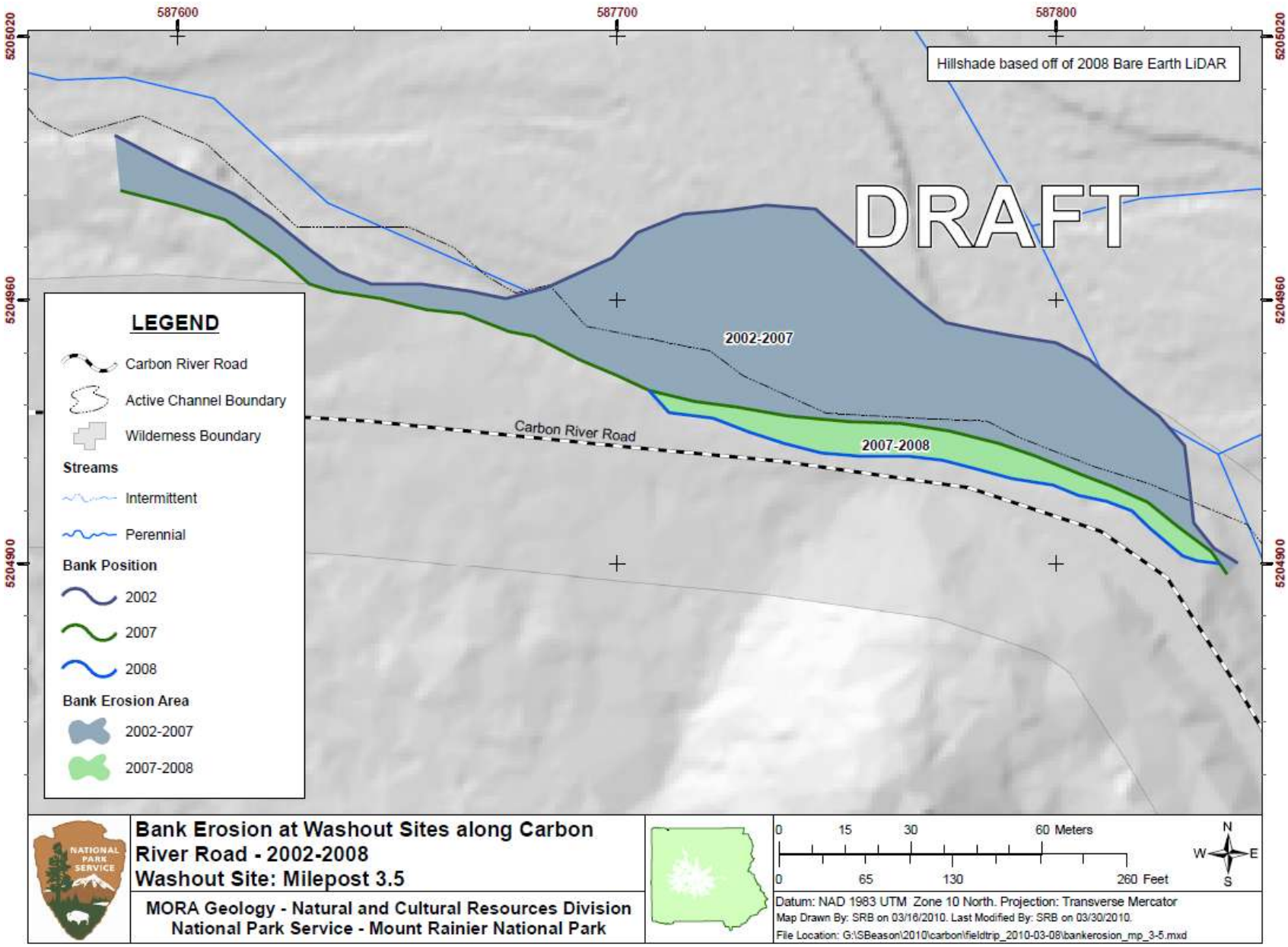
587000
587500
588000
588500
5205000
5204500
5204000
DRAFT
Hillshade based off of 2008 bare earth LiDAR
Canopy height based off of 2008 first return and bare-earth LiDAR
Carbon River Road
LEGEND
Carbon Road Risk Analysis
Low
Low-Med
Med
Med-High
High
Extreme
LiDAR Derived Streams
Main
Trib
Park Boundary
Wilderness Boundary
DISCLAIMER
NOT FIELD CORRECTED OR VERIFIED
Analysis is based on interpretation of aerial photos, LiDAR, available damage maps, basic field reconaissance, digitzed bank erosion, and ground photos. This map is in a DRAFT form and is presented for relative risk only. It SHOULD NOT BE USED in management of the road. Any interpretation on this data should be confirmed based on a comprehensive, full risk analysis study with field-rectified data.
Use in its current form is at your own risk.
NATIONAL PARK SERVICE
Carbon River
DRAFT Relative Risk Analysis
Map 3
MORA Geology - Natural and Cultural Resources Division
National Park Service - Mount Rainier National Park
0 130 260 520 Meters
0 550 1,100 2,200 Feet
N
W
E
S
Datum: NAD 1983 UTM Zone 10 North. Projection: Transverse Mercator
Map Drawn By: SRB on 03/17/2010. Last Modified By: SRB on 03/17/2010.
File Location: G:\SBeason\2010\carbon\fieldtrip_2010-03-08\draftRiskAnalysis_map3.mxd

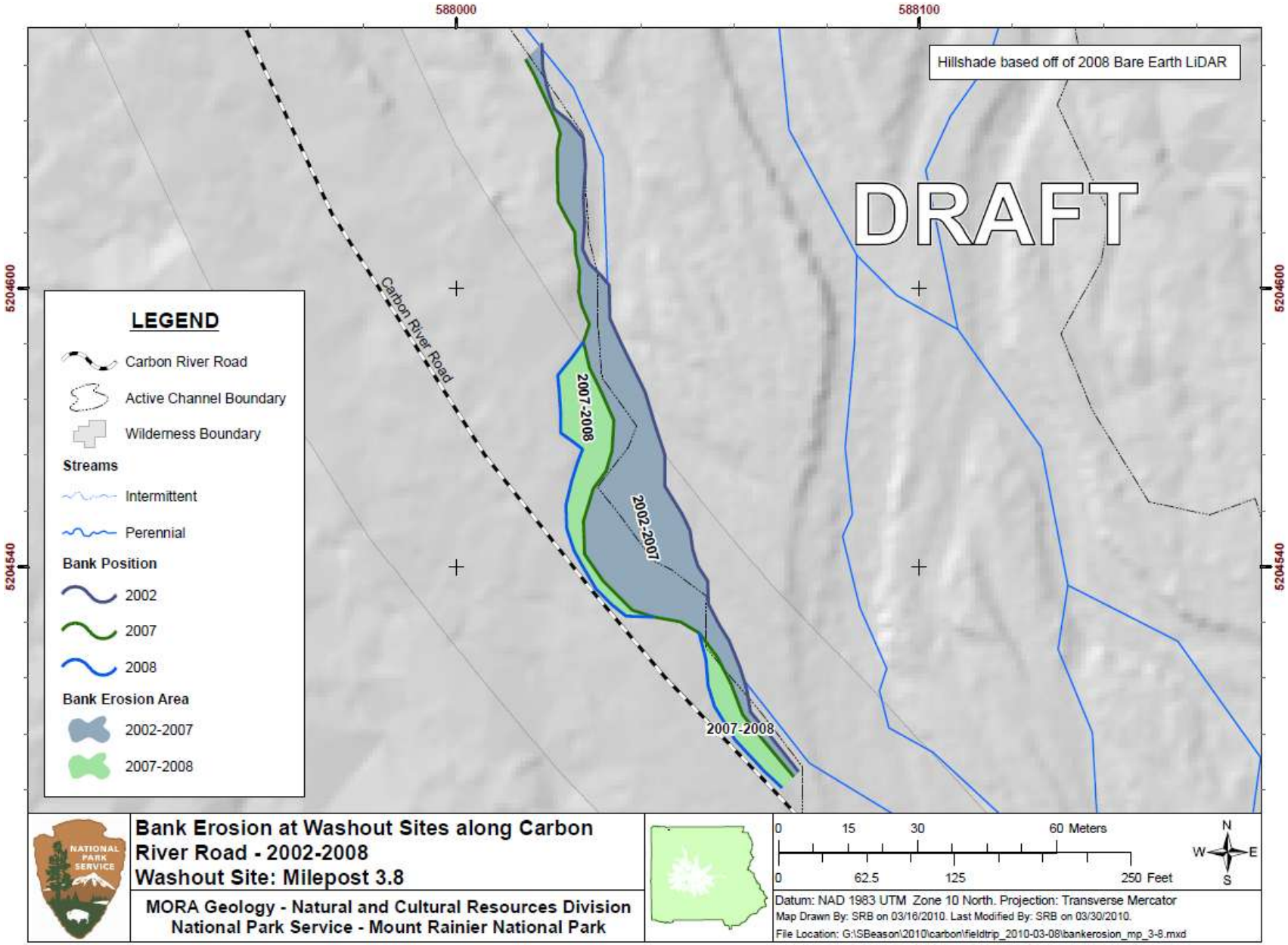
APPENDIX B-4: Detail maps for DRAFT Relative Risk Assessment – Carbon River Road.


588000
588500
589000
5204000
5203500
5203000
DRAFT
Hillshade based off of 2008 bare earth LiDAR
Canopy height based off of 2008 first return and bare-earth LiDAR
Carbon River Road
Carbon River Road
LEGEND
Carbon Road Risk Analysis
Low
Low-Med
Med
Med-High
High
Extreme
LiDAR Derived Streams
Main
Trib
Park Boundary
Wilderness Boundary
DISCLAIMER
NOT FIELD CORRECTED OR VERIFIED
Analysis is based on interpretation of aerial photos, LiDAR, available damage maps, basic field reconaissance, digitzed bank erosion, and ground photos. This map is in a DRAFT form and is presented for relative risk only. It SHOULD NOT BE USED in management of the road. Any interpretation on this data should be confirmed based on a comprehensive, full risk analysis study with field-rectified data.
Use in its current form is at your own risk.
NATIONAL PARK SERVICE
Carbon River
DRAFT Relative Risk Analysis
Map 4
MORA Geology - Natural and Cultural Resources Division
National Park Service - Mount Rainier National Park
0 95 190 380 Meters
0 395 790 1,580 Feet
N
W
E
S
Datum: NAD 1983 UTM Zone 10 North. Projection: Transverse Mercator
Map Drawn By: SRB on 03/17/2010. Last Modified By: SRB on 03/17/2010.
File Location: G:\SBeason\2010\carbon\fieldtrip_2010-03-08\draftRiskAnalysis_map4.mxd

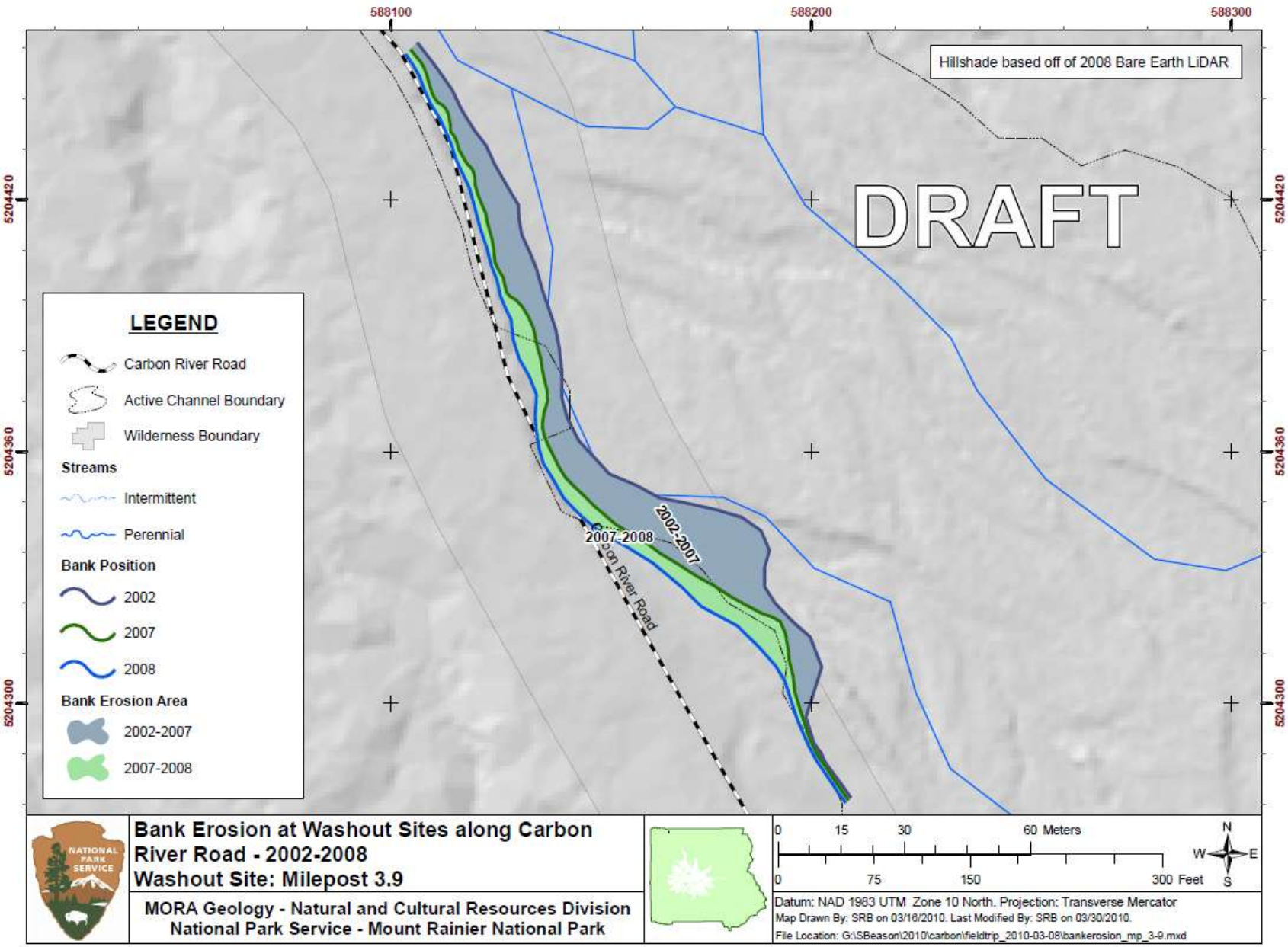
APPENDIX C-1: Bank erosion maps at road washouts.


587600
587700
587800
5205020
5204960
5204900
Hillshade based off of 2008 Bare Earth LiDAR
DRAFT
2002-2007
2007-2008
Carbon River Road
LEGEND
Carbon River Road
Active Channel Boundary
Wilderness Boundary
Streams
Intermittent
Perennial
Bank Position
2002
2007
2008
Bank Erosion Area
2002-2007
2007-2008
Bank Erosion at Washout Sites along Carbon River Road - 2002-2008
Washout Site: Milepost 3.5
MORA Geology - Natural and Cultural Resources Division
National Park Service - Mount Rainier National Park
0 15 30 60 Meters
0 65 130 260 Feet
N
W
E
S
Datum: NAD 1983 UTM Zone 10 North. Projection: Transverse Mercator
Map Drawn By: SRB on 03/16/2010. Last Modified By: SRB on 03/30/2010.
File Location: G:\SBeason\2010\carbon\fieldtrip_2010-03-08\bankerosion_mp_3-5.mxd

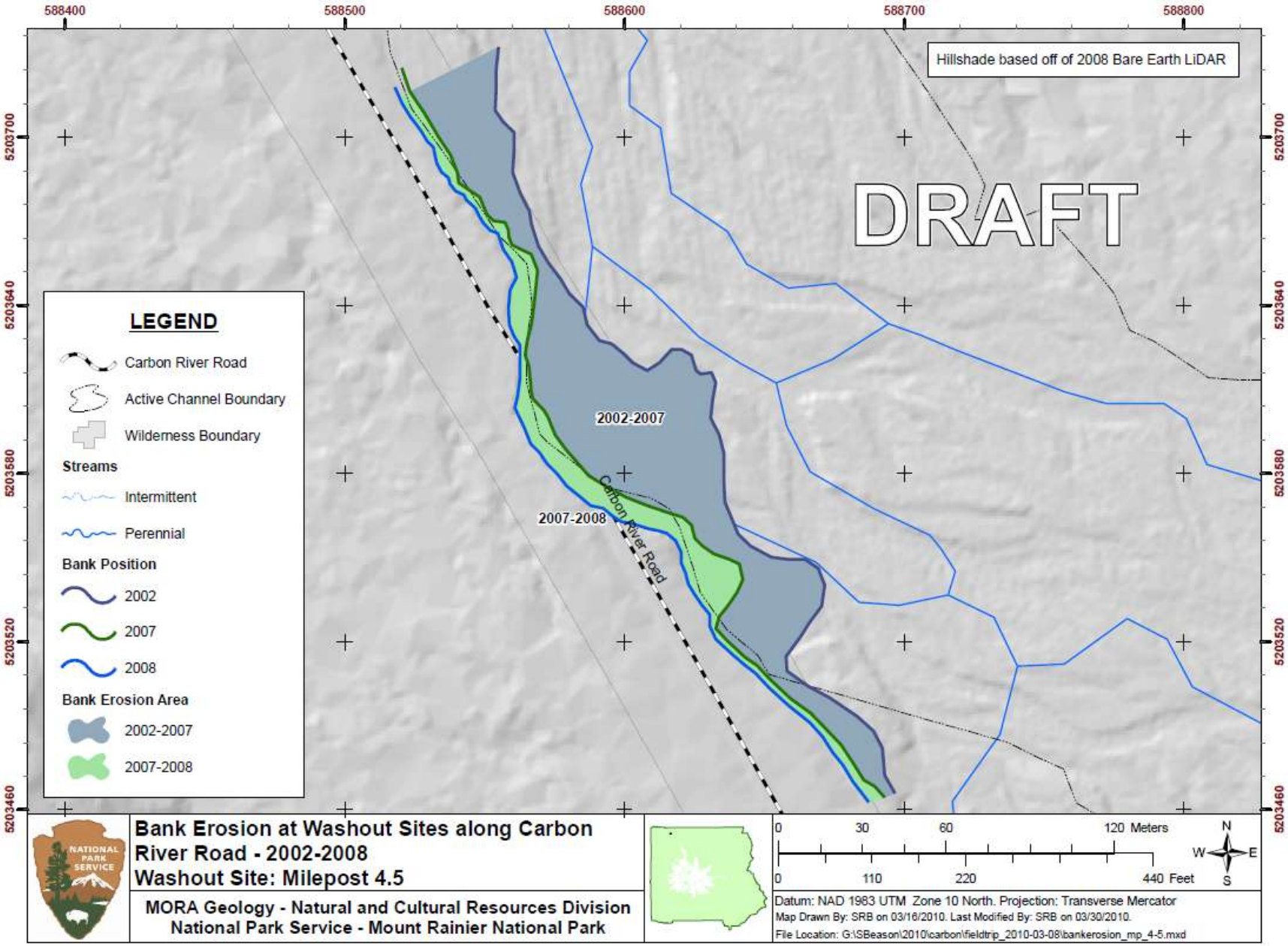
APPENDIX C-2: Bank erosion maps at road washouts.


588000
588100
5204600
5204540
Hillshade based off of 2008 Bare Earth LiDAR
DRAFT
Carbon River Road
2007-2008
2002-2007
2007-2008
LEGEND
Carbon River Road
Active Channel Boundary
Wilderness Boundary
Streams
Intermittent
Perennial
Bank Position
2002
2007
2008
Bank Erosion Area
2002-2007
2007-2008
Bank Erosion at Washout Sites along Carbon River Road - 2002-2008
Washout Site: Milepost 3.8
MORA Geology - Natural and Cultural Resources Division
National Park Service - Mount Rainier National Park
0 15 30 60 Meters
0 62.5 125 250 Feet
N
W
E
S
Datum: NAD 1983 UTM Zone 10 North. Projection: Transverse Mercator
Map Drawn By: SRB on 03/16/2010. Last Modified By: SRB on 03/30/2010.
File Location: G:\SBeason\2010\carbon\fieldtrip_2010-03-08\bankerosion_mp_3-8.mxd

APPENDIX C-3: Bank erosion maps at road washouts.


588100
588200
588300
5204420
5204360
5204300
Hillshade based off of 2008 Bare Earth LiDAR
DRAFT
LEGEND
Carbon River Road
Active Channel Boundary
Wilderness Boundary
Streams
Intermittent
Perennial
Bank Position
2002
2007
2008
Bank Erosion Area
2002-2007
2007-2008
2007-2008
2002-2007
Carbon River Road
Bank Erosion at Washout Sites along Carbon River Road - 2002-2008
Washout Site: Milepost 3.9
MORA Geology - Natural and Cultural Resources Division
National Park Service - Mount Rainier National Park
0 15 30 60 Meters
0 75 150 300 Feet
N
W
E
S
Datum: NAD 1983 UTM Zone 10 North. Projection: Transverse Mercator
Map Drawn By: SRB on 03/16/2010. Last Modified By: SRB on 03/30/2010.
File Location: G:\SBeason\2010\carbon\fieldtrip_2010-03-08\bankerosion_mp_3-9.mxd

APPENDIX C-4: Bank erosion maps at road washouts.


588400
588500
588600
588700
588800
5203700
5203640
5203580
5203520
5203460
Hillshade based off of 2008 Bare Earth LiDAR
DRAFT
LEGEND
Carbon River Road
Active Channel Boundary
Wilderness Boundary
Streams
Intermittent
Perennial
Bank Position
2002
2007
2008
Bank Erosion Area
2002-2007
2007-2008
2002-2007
2007-2008
Carbon River Road
Bank Erosion at Washout Sites along Carbon River Road - 2002-2008
Washout Site: Milepost 4.5
MORA Geology - Natural and Cultural Resources Division
National Park Service - Mount Rainier National Park
0 30 60 120 Meters
0 110 220 440 Feet
N
W
E
S
Datum: NAD 1983 UTM Zone 10 North. Projection: Transverse Mercator
Map Drawn By: SRB on 03/16/2010. Last Modified By: SRB on 03/30/2010.
File Location: G:\SBeason\2010\carbon\fieldtrip_2010-03-08\bankerosion_mp_4-5.mxd

APPENDIX B – STATUS OF THE SPECIES – NORTHERN SPOTTED OWL

Appendix B – Status of the Species – Northern Spotted Owl

Legal Status

The northern spotted owl (spotted owl) was listed as threatened on June 26, 1990 due to widespread loss and adverse modification of suitable habitat across the owl's entire range and the inadequacy of existing regulatory mechanisms to conserve the owl (55 FR 26114 [June 26, 1990]). The U.S. Fish and Wildlife Service (Service) recovery priority number for the spotted owl is 12C (USFWS 2010, p. 55) on a scale of 1C (highest) to 18 (lowest). This number reflects a moderate degree of threat, a low potential for recovery, the spotted owl's taxonomic status as a subspecies and inherent conflicts with development, construction, or other economic activity given the economic value of older forest spotted owl habitat. A moderate degree of threat equates to a continual population decline and threat to its habitat, although extinction is not imminent. While the Service is optimistic regarding the potential for recovery, there is uncertainty regarding our ability to alleviate the barred owl impacts to spotted owls and the techniques are still experimental, which matches our guidelines' "low recovery potential" definition (48 FR 43098 [1983]). The spotted owl was originally listed with a recovery priority number of 3C, but that number was changed to 6C in 2004 during the 5-year review of the species (USFWS 2004, p. 55) and to 12C in the 2010 Draft Revised Recovery Plan for the Northern Spotted Owl (USFWS 2010, p. 22).

Life History

Taxonomy

The northern spotted owl is one of three subspecies of spotted owls currently recognized by the American Ornithologists' Union. The taxonomic separation of these three subspecies is supported by genetic (Barrowclough and Gutiérrez 1990, pp. 741-742; Barrowclough et al. 1999, p. 928; Haig et al. 2004, p. 1354), morphological (Gutierrez et al. 1995, p. 2), and biogeographic information (Barrowclough and Gutiérrez 1990, pp. 741-742). The distribution of the Mexican subspecies (*S. o. lucida*) is separate from those of the northern and California (*S. o. occidentalis*) subspecies (Gutierrez et al. 1995, p. 2). Recent studies analyzing mitochondrial DNA sequences (Barrowclough et al. 2005, p. 1117; Chi et al. 2004, p. 3; Haig et al. 2004, p. 1354) and microsatellites (Henke et al. 2005, p. 15) confirmed the validity of the current subspecies designations for northern and California spotted owls. The narrow hybrid zone between these two subspecies, which is located in the southern Cascades and northern Sierra Nevadas, appears to be stable (Barrowclough et al. 2005, p. 1116).

Physical Description

The spotted owl is a medium-sized owl, approximately 18-19 in (46-48 cm) in length and approximately 1.1-1.9 lbs. (490-850 gm.) in weight (Gutierrez et al. 1995, p. 2), and is the largest of the three subspecies (Gutierrez et al. 1995, p. 2). It is dark brown with a barred tail and white spots on the head and breast, and has dark brown eyes that are surrounded by prominent facial disks. Three age classes can be distinguished on the basis of plumage characteristics (Moen et al. 1991, p. 493). The spotted owl superficially resembles the barred owl (*Strix varia*), a species

with which it occasionally hybridizes (Kelly and Forsman 2004, p. 807). Hybrids exhibit characteristics of both species (Hamer et al. 1994, p. 488).

Current and Historical Range

The current range and distribution of the spotted owl extends from southern British Columbia through western Washington, Oregon, and California as far south as Marin County (55 FR 26115 [June 26, 1990]). The southeastern boundary of its range is the Pit River area of Shasta County, California. The range of the spotted owl is partitioned into 12 physiographic provinces (provinces), based upon recognized landscape subdivisions exhibiting different physical and environmental features (Figure 1) (USFWS 1992, p. 31). These provinces are distributed across the range as follows:

- Four provinces in Washington: Eastern Washington Cascades, Olympic Peninsula, Western Washington Cascades, Western Washington Lowlands

- Five provinces in Oregon: Oregon Coast Range, Willamette Valley, Western Oregon Cascades, Eastern Oregon Cascades, Oregon Klamath

- Three provinces in California: California Coast, California Klamath, California Cascades

The spotted owl has been extirpated or is uncommon in certain areas. For instance, there have only been a few nesting pairs in southwestern Washington for a number of years, although they have persisted there for the past decade. Timber harvest activities have eliminated, reduced, or fragmented spotted owl habitat and decreased overall population densities across its range, particularly within the coastal provinces where habitat reduction has been concentrated (USFWS 1992, p. 1799).

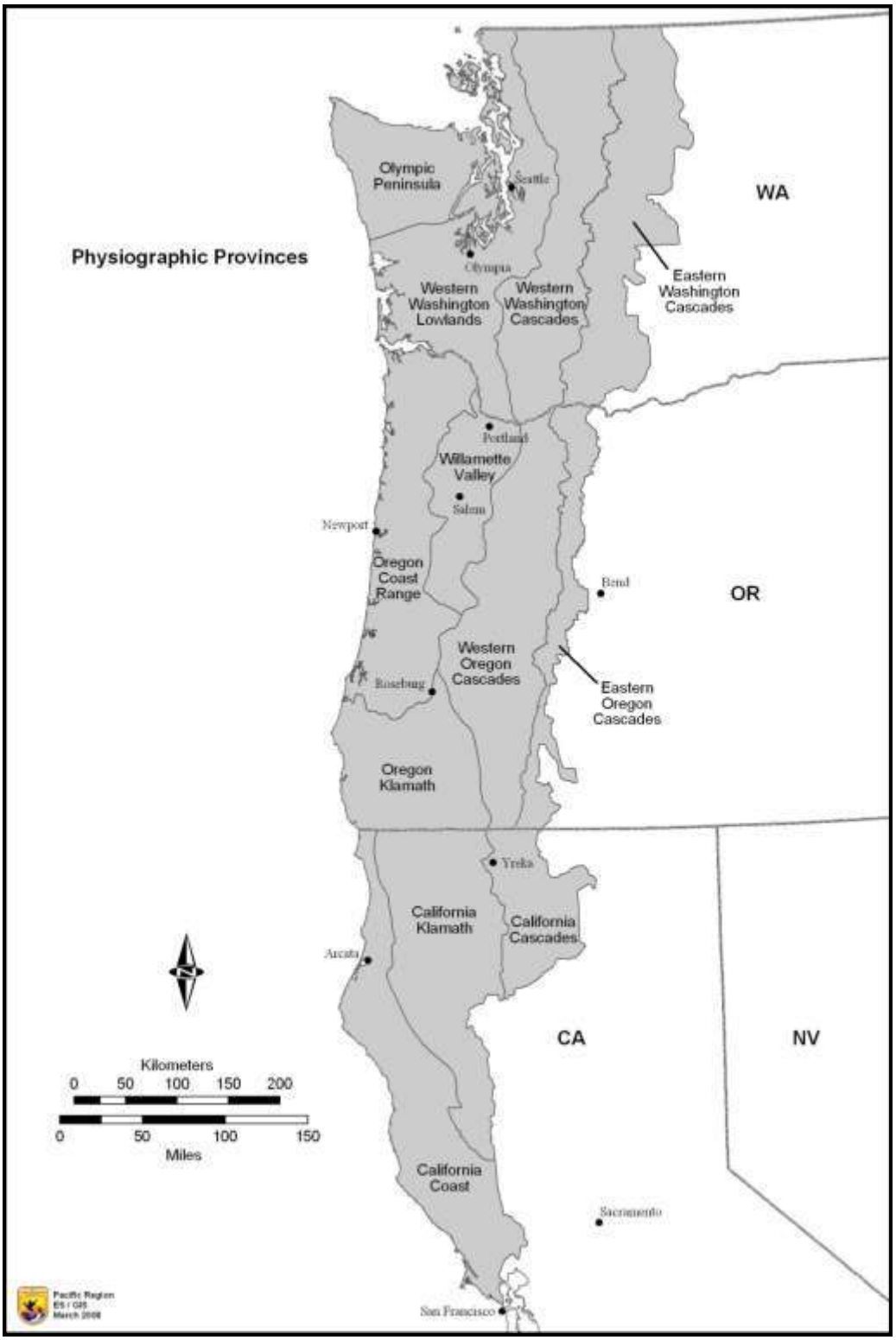


Figure 1. Physiographic provinces in the range of the spotted owl in the United States.

Behavior

Spotted owls are territorial. However, home ranges of adjacent pairs overlap (Forsman et al. 1984, p. 22; Solis and Gutiérrez 1990, p. 746) suggesting that the area defended is smaller than the area used for foraging. Territorial defense is primarily effected by hooting, barking and whistle type calls. Some spotted owls are not territorial but either remain as residents within the territory of a pair or move among territories (Gutierrez 1996, p. 4). These birds are referred to as "floaters." Floaters have special significance in spotted owl populations because they may buffer the territorial population from decline (Franklin 1992, p. 822). Little is known about floaters other than that they exist and typically do not respond to calls as vigorously as territorial birds (Gutierrez 1996, p. 4).

Spotted owls are monogamous and usually form long-term pair bonds. "Divorces" occur but are relatively uncommon. There are no known examples of polygyny in this owl, although associations of three or more birds have been reported (Gutierrez et al. 1995, p. 10).

Habitat Relationships

Home Range

Home-range sizes vary geographically, generally increasing from south to north, which is likely a response to differences in habitat quality (55 FR 26114:26117 [June 26, 1990]). Estimates of median size of their annual home range (the area traversed by an individual or pair during their normal activities (Thomas et al. 1993, p. IX-15) vary by province and range from 2,955 acres in the Oregon Cascades (Thomas et al. 1990, p. 194) to 14,271 acres on the Olympic Peninsula (USFWS 1992, p. 23). Zabel et al. (1995, p. 436) showed that these provincial home ranges are larger where flying squirrels are the predominant prey and smaller where wood rats are the predominant prey. Home ranges of adjacent pairs overlap (Forsman et al. 1984, p. 22; Solis and Gutiérrez 1990, p. 746), suggesting that the defended area is smaller than the area used for foraging. Within the home range there is a smaller area of concentrated use during the breeding season (~20 percent of the homerange), often referred to as the core area (Bingham and Noon 1997, pp. 133-135). Spotted owl core areas vary in size geographically and provide habitat elements that are important for the reproductive efficacy of the territory, such as the nest tree, roost sites and foraging areas (Bingham and Noon 1997, p. 134) Spotted owls use smaller home ranges during the breeding season and often dramatically increase their home range size during fall and winter (Forsman et al. 1984, pp. 21-22; Sisco 1990, p. iii).

Although differences exist in natural stand characteristics that influence provincial home range size, habitat loss and forest fragmentation effectively reduce habitat quality in the home range. A reduction in the amount of suitable habitat reduces spotted owl abundance and nesting success (Bart and Forsman 1992, pp. 98-99; Bart 1995, p. 944).

Habitat Use

Forsman et al. (1984, pp. 15-16) reported that spotted owls have been observed in the following forest types: Douglas-fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*), grand

fir (*Abies grandi*s), white fir (*Abies concolor*), ponderosa pine (*Pinus ponderosa*), Shasta red fir (*Abies magnifica shastensis*), mixed evergreen, mixed conifer hardwood (Klamath montane), and redwood (*Sequoia sempervirens*). The upper elevation limit at which spotted owls occur corresponds to the transition to subalpine forest, which is characterized by relatively simple structure and severe winter weather(Forsman 1975, p. 27; Forsman et al. 1984, pp. 15-16).

Roost sites selected by spotted owls have more complex vegetation structure than forests generally available to them (Barrows and Barrows 1978, p. 3; Forsman et al. 1984, pp. 29-30; Solis and Gutiérrez 1990, pp. 742-743). These habitats are usually multi-layered forests having high canopy closure and large diameter trees in the overstory.

Spotted owls nest almost exclusively in trees. Like roosts, nest sites are found in forests having complex structure dominated by large diameter trees (Forsman et al. 1984, p. 30; Hershey et al. 1998, p. 1402). Even in forests that have been previously logged, spotted owls select forests having a structure (i.e., larger trees, greater canopy closure) different than forests generally available to them (Buchanan et al. 1995, p.1402; Folliard 1993, p. 40; Hershey et al. 1998, p. 1404).

Foraging habitat is the most variable of all habitats used by territorial spotted owls (USFWS 1992, p. 20). Descriptions of foraging habitat have ranged from complex structure (Solis and Gutiérrez 1990, pp. 742-744) to forests with lower canopy closure and smaller trees than forests containing nests or roosts (Gutierrez 1996, p. 5).

Habitat Selection

Spotted owls generally rely on older forested habitats because they contain the structures and characteristics required for nesting, roosting, foraging, and dispersal. These characteristics include the following: 1) a multi-layered, multi-species canopy dominated by large overstory trees, 2) moderate to high canopy closure, 3) a high incidence of trees with large cavities and other types of deformities, especially dwarf mistletoe brooms, 4) numerous large snags, 5) an abundance of large, dead wood on the ground, and 6) open space within and below the upper canopy for spotted owls to fly (Thomas et al. 1990, p. 19). Forested stands with high canopy closure also provide thermal cover, as well as protection from predation (Weathers et al. 2001, p. 686).

Foraging habitat for spotted owls provides a food supply for survival and reproduction. Foraging activity is positively associated with tree height diversity (North et al. 1999, p. 524), canopy closure (Courtney et al. 2004, pp. 5-15; Irwin et al. 2000, p. 180), snag volume, density of snags greater than 20 in (50 cm) dbh (Courtney et al. 2004, p. 5-15; Irwin et al. 2000, pp. 179-180; North et al. 1999, p. 524), density of trees greater than or equal to 31 in (80 cm) dbh (North et al. 1999, p. 524), volume of woody debris (Irwin et al. 2000, pp. 179-180), and young forests with some structural characteristics of old forests (Carey et al. 1992, pp. 245-247; Irwin et al. 2000, pp. 178-179). Northern spotted owls select old forests for foraging in greater proportion than their availability at the landscape scale (Carey et al. 1992, pp. 236-237; Carey and Peeler 1995, p. 235; Forsman et al. 2005, pp. 372-373), but will forage in younger stands with high prey

densities and access to prey (Carey et al. 1992, p. 247; Rosenberg and Anthony 1992, p. 165; Thome et al. 1999, pp. 56-57).

Dispersal habitat is essential to maintaining stable populations by filling territorial vacancies when resident spotted owls die or leave their territories, and to providing adequate gene flow across the range of the species. Dispersal habitat, at a minimum, consists of stands with adequate tree size and canopy closure to provide protection from avian predators and at least minimal foraging opportunities. Dispersal habitat may include younger and less diverse forest stands than foraging habitat, such as even-aged, pole-sized stands, but such stands should contain some roosting structures and foraging habitat to allow for temporary resting and feeding for dispersing juveniles (USFWS 1992, p. 1798). Forsman et al. (2002, p. 222) found that spotted owls could disperse through highly fragmented forest landscapes. However, the stand-level and landscape-level attributes of forests needed to facilitate successful dispersal have not been thoroughly evaluated (Buchanan 2004, p. 1341).

Spotted owls may be found in younger forest stands that have the structural characteristics of older forests or retained structural elements from the previous forest. In redwood forests and mixed conifer-hardwood forests along the coast of northwestern California, considerable numbers of spotted owls also occur in younger forest stands, particularly in areas where hardwoods provide a multi-layered structure at an early age (Diller and Thome 1999, p. 275; Thomas et al. 1990, p. 158). In mixed conifer forests in the eastern Cascades in Washington, 27 percent of nest sites were in old-growth forests, 57 percent were in the understory reinitiation phase of stand development, and 17 percent were in the stem exclusion phase (Buchanan et al. 1995, p. 304). In the western Cascades of Oregon, 50 percent of spotted owl nests were in late-seral/old-growth stands (greater than 80 years old), and none were found in stands of less than 40 years old (Irwin et al. 2000, p. 41) .

In the Western Washington Cascade Mountains, spotted owls used mature/old forests dominated by trees greater than 20 in (50 cm) diameter-at-breast height with greater than 60 percent canopy closure more often than expected for roosting during the non-breeding season and used young forest trees 8 to 20 in (20 to 50 cm) diameter-at-breast height with greater than 60 percent canopy closure) less often than expected based on availability (Herter et al. 2002, p. 437).

In the Coast Ranges, Western Oregon Cascades and the Olympic Peninsula, radio-marked spotted owls selected for old-growth and mature forests for foraging and roosting and used young forests less than predicted based on availability (Carey et al. 1990, pp. 14-15; Forsman et al. 1984, pp. 24-25; Forsman et al. 2005, pp. 372-373). Glenn et al. (2004, pp. 46-47) studied spotted owls in young forests in western Oregon and found little preference among age classes of young forest.

Habitat use is influenced by prey availability. Ward (1990, p. 62) found that spotted owls foraged in areas that had lower variance in prey densities (prey were more predictable in occurrence) within older forests and near ecotones of old forest and brush seral stages. Zabel et al. (1996, p. 436) showed that spotted owl home ranges are larger where flying squirrels are the predominant prey and, conversely, are smaller where woodrats (*Neotoma* spp.) are the predominant prey.

Recent landscape-level analyses in portions of Oregon Coast and California Klamath provinces suggest that a mosaic of late-successional habitat interspersed with other seral conditions may benefit spotted owls more than large, homogeneous expanses of older forests (Franklin et al. 2000, pp. 573-579; Meyer et al. 1998, p. 43; Zabel et al. 2003, p. 1038). In Oregon Klamath and Western Oregon Cascade provinces, Dugger et al. (2005, p. 876) found that apparent survival and reproduction was positively associated with the proportion of older forest near the territory center (within 730 meters) (2,395 feet). Survival decreased dramatically when the amount of non-habitat (non-forest areas, sapling stands, etc.) exceeded approximately 50 percent of the home range (Dugger et al. 2005, pp. 873-874). The authors concluded that they found no support for either a positive or negative direct effect of intermediate-aged forest—that is, all forest stages between sapling and mature, with total canopy cover greater than 40 percent—on either the survival or reproduction of spotted owls.

It is unknown how these results were affected by the low habitat fitness potential in their study area, which Dugger et al. (2005, p. 876) stated was generally much lower than those in Franklin et al. (2000) and Olson et al. (2004), and the low reproductive rate and survival in their study area, which they reported were generally lower than those studied by Anthony et al. (2006). Olson et al. (2004, pp. 1050-1051) found that reproductive rates fluctuated biennially and were positively related to the amount of edge between late-seral and mid-seral forests and other habitat classes in the central Oregon Coast Range. Olson et al. (2004, pp. 1049-1050) concluded that their results indicate that while mid-seral and late-seral forests are important to spotted owls, a mixture of these forest types with younger forest and non-forest may be best for spotted owl survival and reproduction in their study area.

Reproductive Biology

The spotted owl is relatively long-lived, has a long reproductive life span, invests significantly in parental care, and exhibits high adult survivorship relative to other North American owls (Gutierrez et al. 1995, p. 5). Spotted owls are sexually mature at 1 year of age, but rarely breed until they are 2 to 5 years of age (Forsman et al. 2002, p. 17; Franklin 1992, p. 821; Miller et al. 1985, p. 93). Breeding females lay one to four eggs per clutch, with the average clutch size being two eggs; however, most spotted owl pairs do not nest every year, nor are nesting pairs successful every year(Anthony et al. 2006, p. 28; Forsman et al. 1984, pp. 32-34), and renesting after a failed nesting attempt is rare (Gutierrez 1996, p. 4). The small clutch size, temporal variability in nesting success, and delayed onset of breeding all contribute to the relatively low fecundity of this species (Gutierrez 1996, p. 4).

Courtship behavior usually begins in February or March, and females typically lay eggs in late March or April. The timing of nesting and fledging varies with latitude and elevation (Forsman et al. 1984, p. 32). After they leave the nest in late May or June, juvenile spotted owls depend on their parents until they are able to fly and hunt on their own. Parental care continues after fledging into September (Forsman et al. 1984, p. 38). During the first few weeks after the young leave the nest, the adults often roost with them during the day. By late summer, the adults are rarely found roosting with their young and usually only visit the juveniles to feed them at night (Forsman et al. 1984, p. 38). Telemetry and genetic studies indicate that close inbreeding

between siblings or parents and their offspring is rare (Forsman et al. 2002, p. 18; Haig et al. 2001, p. 35).

Dispersal Biology

Natal dispersal of spotted owls typically occurs in September and October with a few individuals dispersing in November and December (Forsman et al. 2002, p. 13). Natal dispersal occurs in stages, with juveniles settling in temporary home ranges between bouts of dispersal (Forsman et al. 2002, pp. 13-14; Miller et al. 1997, p. 143). The median natal dispersal distance is about 10 miles for males and 15.5 miles for females (Forsman et al. 2002, p. 16). Dispersing juvenile spotted owls experience high mortality rates, exceeding 70 percent in some studies (Miller 1989, pp. 32-41). Known or suspected causes of mortality during dispersal include starvation, predation, and accidents (Forsman et al. 2002, pp. 18-19; Miller 1989, pp. 41-44). Parasitic infection may contribute to these causes of mortality, but the relationship between parasite loads and survival is poorly understood (Forsman et al. 2002, pp. 18-19; Gutierrez 1989, pp. 616-617; Hoberg et al. 1989, p. 249). Successful dispersal of juvenile spotted owls may depend on their ability to locate unoccupied suitable habitat in close proximity to other occupied sites (LaHaye et al. 2001, pp. 697-698).

There is little evidence that small openings in forest habitat influence the dispersal of spotted owls, but large, non-forested valleys such as the Willamette Valley apparently are barriers to both natal and breeding dispersal (Forsman et al. 2002, p. 22). The degree to which water bodies, such as the Columbia River and Puget Sound, function as barriers to dispersal is unclear although radio telemetry data indicate that spotted owls move around large lakes rather than cross them (Forsman et al. 2002, p. 22). . Analysis of genetic structure of spotted owl populations suggests adequate rates of gene flow may occur across the Puget Trough between the Olympic Mountains and Washington Cascades and across the Columbia River between the Olympic Mountains and the Coast Range of Oregon (Haig et al. 2001, p. 35).

Breeding dispersal occurs among a small proportion of adult spotted owls; these movements were more frequent among females and unmated individuals (Forsman et al. 2002, pp. 20-21). Breeding dispersal distances were shorter than natal dispersal distances and also apparently random in direction (Forsman et al. 2002, pp. 21-22).

Food Habits

Spotted owls are mostly nocturnal, although they also forage opportunistically during the day (Forsman et al. 1984, p. 51; Sovern et al. 1994, p. 202). The composition of the spotted owl's diet varies geographically and by forest type. Generally, flying squirrels (*Glaucomys sabrinus*) are the most prominent prey for spotted owls in Douglas-fir and western hemlock (*Tsuga heterophylla*) forests (Forsman et al. 1984, pp. 40-41; Hamer et al. 2001, p. 224) in Washington and Oregon, while dusky-footed wood rats (*Neotoma fuscipes*) are a major part of the diet in the Oregon Klamath, California Klamath, and California Coastal provinces (Forsman et al. 1984, pp. 40-42; Forsman et al. 2004, p. 218; Ward et al. 1998, p. 84). Depending on location, other important prey include deer mice (*Peromyscus maniculatus*), tree voles (*Arborimus longicaudus, A. pomo*), red-backed voles (*Clethrionomys* spp.), gophers (*Thomomys* spp.), snowshoe hare

(*Lepus americanus*), bushy-tailed wood rats (*Neotoma cinerea*), birds, and insects, although these species comprise a small portion of the spotted owl diet (Forsman et al. 1984, pp. 40-43; Forsman et al. 2004, p. 218; Hamer et al. 2001, p. 224; Ward et al. 1998, p. 84).

Other prey species such as the red tree vole (*Arborimus longicaudus*), red-backed voles (*Clethrionomys gapperi*), mice, rabbits and hares, birds, and insects) may be seasonally or locally important (Courtney et al. 2004, p. 4-27). For example, Rosenberg et al. (2003, p. 1720) showed a strong correlation between annual reproductive success of spotted owls (number of young per territory) and abundance of deer mice (*Peromyscus maniculatus*) (r2 = 0.68), despite the fact they only made up 1.6±0.5 percent of the biomass consumed. However, it is unclear if the causative factor behind this correlation was prey abundance or a synergistic response to weather (Rosenberg et al. 2003, p. 1723). Ward (1990, p. 55) also noted that mice were more abundant in areas selected for foraging by owls. Nonetheless, spotted owls deliver larger prey to the nest and eat smaller food items to reduce foraging energy costs; therefore, the importance of smaller prey items, like *Peromyscus*, in the spotted owl diet should not be underestimated (Forsman et al. 2001, p. 148; Forsman et al. 2004, pp. 218-219).

Population Dynamics

The spotted owl is relatively long-lived, has a long reproductive life span, invests significantly in parental care, and exhibits high adult survivorship relative to other North American owls (Gutierrez 1996, p. 5). The spotted owl's long reproductive life span allows for some eventual recruitment of offspring, even if recruitment does not occur each year (Franklin et al. 2000, p. 576).

Annual variation in population parameters for spotted owls has been linked to environmental influences at various life history stages (Franklin et al. 2000, p. 581). In coniferous forests, mean fledgling production of the California spotted owl *(Strix occidentalis occidentalis)*, a closely related subspecies, was higher when minimum spring temperatures were higher (North et al. 2000, p. 805), a relationship that may be a function of increased prey availability. Across their range, spotted owls have previously shown an unexplained pattern of alternating years of high and low reproduction, with highest reproduction occurring during even-numbered years (e.g., Franklin et al. 1999, p. 1). Annual variation in breeding may be related to weather (i.e., temperature and precipitation) (Wagner et al. 1996, p. 74; Zabel et al. 1996, pp. 437-438) and fluctuation in prey abundance (Zabel et al. 1996, pp. 437-438).

A variety of factors may regulate spotted owl population levels. These factors may be density-dependent (e.g., habitat quality, habitat abundance) or density-independent (e.g., climate). Interactions may occur among factors. For example, as habitat quality decreases, density-independent factors may have more influence on survival and reproduction, which tends to increase variation in the rate of growth (Franklin et al. 2000, pp. 581-582). Specifically, weather could have increased negative effects on spotted owl fitness for those owls occurring in relatively lower quality habitat (Franklin et al. 2000, pp. 581-582). A consequence of this pattern is that at some point, lower habitat quality may cause the population to be unregulated (have negative growth) and decline to extinction (Franklin et al. 2000, p. 583).

Olson et al. (2005, pp. 930-931) used open population modeling of site occupancy that incorporated imperfect and variable detectability of spotted owls and allowed modeling of temporal variation in site occupancy, extinction, and colonization probabilities (at the site scale). The authors found that visit detection probabilities average less than 0.70 and were highly variable among study years and among their three study areas in Oregon. Pair site occupancy probabilities declined greatly on one study area and slightly on the other two areas. However, for all owls, including singles and pairs, site occupancy was mostly stable through time. Barred owl presence had a negative effect on these parameters (see barred owl discussion in the New Threats section below). However, there was enough temporal and spatial variability in detection rates to indicate that more visits would be needed in some years and in some areas, especially if establishing pair occupancy was the primary goal.

Threats

Reasons for Listing

The spotted owl was listed as threatened throughout its range "due to loss and adverse modification of suitable habitat as a result of timber harvesting and exacerbated by catastrophic events such as fire, volcanic eruption, and wind storms" (55 FR 26114-26194). More specifically, significant threats to the spotted owl included the following: 1) low populations, 2) declining populations, 3) limited habitat, 4) declining habitat, 5) distribution of habitat or populations, 6) isolation of provinces, 7) predation and competition, 8) lack of coordinated conservation measures; and (9) vulnerability to natural disturbance (57 FR 1796-1838). These threats were characterized for each province as severe, moderate, low, or unknown. Declining habitat was recognized as a severe or moderate threat to the spotted owl in all 12 provinces, isolation of provinces within 11 provinces, and declining populations in 10 provinces. Together, these three factors represented the greatest concern range-wide to the conservation of the spotted owl. Limited habitat was considered a severe or moderate threat in nine provinces, and low populations a severe or moderate concern in eight provinces, suggesting that these factors are a concern throughout the majority of the range. Vulnerability to natural disturbances was rated as low in five provinces.

The degree to which predation and competition might pose a threat to the spotted owl was unknown in more provinces than any of the other threats, indicating a need for additional information. Few empirical studies exist to confirm that habitat fragmentation contributes to increased levels of predation on spotted owls (Courtney et al. 2004, pp. 11-8 to 11-9). However, great horned owls (*Bubo virginianus*), an effective predator on spotted owls, are closely associated with fragmented forests, openings, and clearcuts (Johnson 1992, p. 84; Laidig and Dobkin 1995, p. 155). As mature forests are harvested, great horned owls may colonize fragmented forests, thereby increasing spotted owl vulnerability to predation.

New Threats

The Service conducted a 5-year review of the spotted owl in 1994 (USFWS 2004), for which the Service prepared a scientific evaluation of the status of the spotted owl (Courtney et al. 2004).

An analysis was conducted assessing how the threats described in 1990 might have changed by 2004. Some of the key threats identified in 2004 are:

- "Although we are certain that current harvest effects are reduced, and that past harvest is also probably having a reduced effect now as compared to 1990, we are still unable to fully evaluate the current levels of threat posed by harvest because of the potential for lag effects…In their questionnaire responses…6 of 8 panel member identified past habitat loss due to timber harvest as a current threat, but only 4 viewed current harvest as a present threat" (Courtney et al. 2004, p. 11-7)

- "Currently the primary source of habitat loss is catastrophic wildfire, although the total amount of habitat affected by wildfires has been small (a total of 2.3 percent of the range-wide habitat base over a 10-year period)" (Courtney et al. 2004, p. 11-8)

- "Although the panel had strong differences of opinion on the conclusiveness of some of the evidence suggesting [barred owl] displacement of [spotted owls], and the mechanisms by which this might be occurring, there was no disagreement that [barred owls] represented an operational threat. In the questionnaire, all 8 panel members identified [barred owls] as a current threat, and also expressed concern about future trends in [barred owl] populations." (Courtney et al. 2004, p. 11-8)

Barred Owls

With its recent expansion to as far south as Marin County, California (Gutierrez et al. 2004, pp. 7-12 to 7-13), the barred owl's range now completely overlaps that of the spotted owl. Barred owls may be competing with spotted owls for prey (Hamer et al. 2001, p. 226) or habitat (Dunbar et al. 1991, p. 467; Hamer et al. 1989, p. 55; Herter and Hicks 2000, p. 285; Pearson and Livezey 2003, p. 274). In addition, barred owls physically attack spotted owls (Pearson and Livezey 2003, p. 274), and circumstantial evidence strongly indicated that a barred owl killed a spotted owl (Leskiw and Gutiérrez 1998, p. 226). Evidence that barred owls are causing negative effects on spotted owls is largely indirect, based primarily on retrospective examination of long-term data collected on spotted owls (Kelly et al. 2003, p. 46; Olson et al. 2005, p. 921; Pearson and Livezey 2003, p. 267). It is widely believed, but not conclusively confirmed, that the two species of owls are competing for resources. However, given that the presence of barred owls has been identified as a negative effect while using methods designed to detect a different species (spotted owls), it seems safe to presume that the effects are stronger than estimated. Because there has been no research to quantitatively evaluate the strength of different types of competitive interactions, such as resource partitioning and competitive interference, the particular mechanism by which the two owl species may be competing is unknown.

Barred owls were initially thought to be more closely associated with early successional forests than spotted owls, based on studies conducted on the west slope of the Cascades in Washington (Hamer 1988, p. 34; Iverson 1993, p. 39). However, recent studies conducted in the Pacific Northwest show that barred owls frequently use mature and old-growth forests (Pearson and Livezey 2003, p. 270; Schmidt 2006, p. 13). In the fire prone forests of eastern Washington, a telemetry study conducted on barred owls showed that barred owl home ranges were located on

lower slopes or valley bottoms, in closed canopy, mature, Douglas-fir forest, while spotted owl sites were located on mid-elevation areas with southern or western exposure, characterized by closed canopy, mature, ponderosa pine or Douglas-fir forest (Singleton et al. 2005, p. 1).

The only study comparing spotted owl and barred owl food habits in the Pacific Northwest indicated that barred owl diets overlap strongly (76 percent) with spotted owl diets (Hamer et al. 2001, p. 226). However, barred owl diets are more diverse than spotted owl diets and include species associated with riparian and other moist habitats, along with more terrestrial and diurnal species (Hamer et al. 2001, pp. 225-226).

The presence of barred owls has been reported to reduce spotted owl detectability, site occupancy, reproduction, and survival. Olson et al. (2005, p. 924) found that the presence of barred owls had a significant negative effect on the detectability of spotted owls, and that the magnitude of this effect did not vary among years. The occupancy of historical territories by spotted owls in Washington and Oregon was significantly lower ($p < 0.001$) after barred owls were detected within 0.8 kilometer (0.5 miles) of the territory center but was "only marginally lower" ($p = 0.06$) if barred owls were located more than 0.8 kilometer (0.5 miles) from the spotted owl territory center (Kelly et al. 2003, p. 51). Pearson and Livezey (2003, p. 271) found that there were significantly more barred owl site-centers in unoccupied spotted owl circles than occupied spotted owl circles (centered on historical spotted owl site-centers) with radii of 0.8 kilometer (0.5 miles) ($p = 0.001$), 1.6 kilometer (1 mile) ($p = 0.049$), and 2.9 kilometer (1.8 miles) ($p = 0.005$) in Gifford Pinchot National Forest. In Olympic National Park, Gremel (2005, p. 11) found a significant decline ($p = 0.01$) in spotted owl pair occupancy at sites where barred owls had been detected, while pair occupancy remained stable at spotted owl sites without barred owls. Olson et al. (2005, p. 928) found that the annual probability that a spotted owl territory would be occupied by a pair of spotted owls after barred owls were detected at the site declined by 5 percent in the HJ Andrews study area, 12 percent in the Coast Range study area, and 15 percent in the Tyee study area.

Olson et al. (2004, p. 1048) found that the presence of barred owls had a significant negative effect on the reproduction of spotted owls in the central Coast Range of Oregon (in the Roseburg study area). The conclusion that barred owls had no significant effect on the reproduction of spotted owls in one study (Iverson 2004, p. 89) was unfounded because of small sample sizes (Livezey 2005, p. 102). It is likely that all of the above analyses underestimated the effects of barred owls on the reproduction of spotted owls because spotted owls often cannot be relocated after they are displaced by barred owls (USFWS 2008, p. 65). Anthony et al. (2006, p. 32) found significant evidence for negative effects of barred owls on apparent survival of spotted owls in two of 14 study areas (Olympic and Wenatchee). They attributed the equivocal results for most of their study areas to the coarse nature of their barred owl covariate.

In a recent analysis of more than 9,000 banded spotted owls throughout their range, only 47 hybrids were detected (Kelly and Forsman 2004, p. 807). Consequently, hybridization with the barred owl is considered to be "an interesting biological phenomenon that is probably inconsequential, compared with the real threat—direct competition between the two species for food and space" (Kelly and Forsman 2004, p. 808).

The preponderance of evidence suggests that barred owls are exacerbating the spotted owl population decline, particularly in Washington, portions of Oregon, and the northern coast of California (Gutierrez et al. 2004, pp. 7-39 to 7-40; Olson et al. 2005, pp. 930-931). There is no evidence that the increasing trend in barred owls has stabilized in any portion of the spotted owl's range in the western United States, and "there are no grounds for optimistic views suggesting that barred owl impacts on spotted owls have been already fully realized" (Gutierrez et al. 2004, p. 7-38).

Wildfire

Studies indicate that the effects of wildfire on spotted owls and their habitat are variable, depending on fire intensity, severity and size. Within the fire-adapted forests of the spotted owl's range, spotted owls likely have adapted to withstand fires of variable sizes and severities. Bond et al. (Bond et al. 2002, p. 1025) examined the demography of the three spotted owl subspecies after wildfires, in which wildfire burned through spotted owl nest and roost sites in varying degrees of severity. Post-fire demography parameters for the three subspecies were similar or better than long-term demographic parameters for each of the three subspecies in those same areas (Bond et al. 2002, p. 1026). In a preliminary study conducted by Anthony and Andrews (2004, p. 8) in the Oregon Klamath Province, their sample of spotted owls appeared to be using a variety of habitats within the area of the Timbered Rock fire, including areas where burning had been moderate.

In 1994, the Hatchery Complex fire burned 17,603 hectares in the Wenatchee National Forest in Washington's eastern Cascades, affecting six spotted owl activity centers (Gaines et al. 1997, p. 125). Spotted owl habitat within a 2.9-kilometer (1.8-mile) radius of the activity centers was reduced by 8 to 45 percent (mean = 31 percent) as a result of the direct effects of the fire and by 10 to 85 percent (mean = 55 percent) as a result of delayed mortality of fire-damaged trees and insects. Direct mortality of spotted owls was assumed to have occurred at one site, and spotted owls were present at only one of the six sites 1 year after the fire (Gaines et al. 1997, p. 126). In 1994, two wildfires burned in the Yakama Indian Reservation in Washington's eastern Cascades, affecting the home ranges of two radio-tagged spotted owls (King et al. 1998, pp. 2-3). Although the amount of home ranges burned was not quantified, spotted owls were observed using areas that burned at low and medium intensities. No direct mortality of spotted owls was observed, even though thick smoke covered several spotted owl site-centers for a week. It appears that, at least in the short term, spotted owls may be resilient to the effects of wildfire—a process with which they have evolved. More research is needed to further understand the relationship between fire and spotted owl habitat use.

At the time of listing there was recognition that large-scale wildfire posed a threat to the spotted owl and its habitat (55 FR 26114: 26183 [June 26, 1990]). New information suggests fire may be more of a threat than previously thought. In particular, the rate of habitat loss due to fire has been greater than expected with over 102,000 acres of late-successional forest lost on Federal lands from 1993-2004 (Moeur et al. 2005, p. 110). Currently, the overall total amount of habitat loss from wildfires has been relatively small, and is estimated at 1.2 percent on Federal lands (Lint 2005, p. v). It may be possible to influence through silvicultural management how fire prone forests will burn and the extent of the fire when it occurs. Silvicultural management of

forest fuels are currently being implemented throughout the spotted owl's range, in an attempt to reduce the levels of fuels that have accumulated during nearly 100 years of effective fire suppression. However, our ability to protect spotted owl habitat and viable populations of spotted owls from large fires through risk-reduction endeavors is uncertain (Courtney et al. 2004, p. 12-11). The Northwest Forest Plan (NWFP) recognized wildfire as an inherent part of managing spotted owl habitat in certain portions of the range. The distribution and size of reserve blocks as part of the NWFP design may help mitigate the risks associated with large-scale fire (Lint 2005, p. 77).

West Nile Virus

West Nile Virus (WNV) has killed millions of wild birds in North America since it arrived in 1999 (Caffrey 2003, p. 12; Marra et al. 2004, p. 393). Mosquitoes are the primary carriers (vectors) of the virus that causes encephalitis in humans, horses, and birds. Mammalian prey may also play a role in spreading WNV among predators, like spotted owls. Owls and other predators of mice can contract the disease by eating infected prey (Garmendia et al. 2000, p. 3111). One captive spotted owl in Ontario, Canada, is known to have contracted WNV and died (Gancz et al. 2004, p. 2137), but there are no documented cases of the virus in wild spotted owls.

Health officials expect that WNV will eventually spread throughout the range of the spotted owl (Courtney et al. 2004, p. 8-31) but it is unknown how WNV will ultimately affect owl populations. Susceptibility to infection and mortality rates of infected individuals vary among bird species, even within groups (Courtney et al. 2004, p. 8-33). Owls appear to be quite susceptible. For example, eastern screech owls (*Megascops asio*) in Ohio experienced 100 percent mortality (Courtney et al. 2004, p. 8-33). Barred owls, in contrast, showed lower susceptibility (Courtney et al. 2004, p. 8-34).

Courtney et al. (2004, p. 8-35) offer two possible scenarios for the likely outcome of spotted owl populations being infected by WNV. One scenario is that a range-wide reduction in spotted owl population viability is unlikely because the risk of contracting WNV varies between regions. An alternative scenario is that WNV will cause unsustainable mortality, due to the frequency and/or magnitude of infection, thereby resulting in long-term population declines and extirpation from parts of the spotted owl's current range. WNV remains a potential threat of uncertain magnitude and effect (Courtney et al. 2004, p. 8-34).

Sudden Oak Death

Sudden oak death was recently identified as a potential threat to the spotted owl (Courtney et al. 2004, p. 11-8). This disease is caused by the fungus-like pathogen, *Phytopthora ramorum*, that was recently introduced from Europe and is rapidly spreading. At the present time, sudden oak death is found in natural stands from Monterey to Humboldt Counties, California, and has reached epidemic proportions in oak (*Quercus* spp.) and tanoak (*Lithocarpus densiflorus*) forests along approximately 186 miles (300 km) of the central and northern California coast (Rizzo et al. 2002, p. 733). It has also been found near Brookings, Oregon, killing tanoak and causing dieback of closely associated wild rhododendron (*Rhododendron* spp.) and evergreen huckleberry (*Vaccinium ovatum*) (Goheen et al. 2002, p. 441). It has been found in several

different forest types and at elevations from sea level to over 2625 ft. (800 m). Sudden oak death poses a threat of uncertain proportion because of its potential impact on forest dynamics and alteration of key prey and spotted owl habitat components (e.g., hardwood trees - canopy closure and nest tree mortality); especially in the southern portion of the spotted owl's range (Courtney et al. 2004, p. 11-8).

Inbreeding Depression, Genetic Isolation, and Reduced Genetic Diversity

Inbreeding and other genetic problems due to small population sizes were not considered an imminent threat to the spotted owl at the time of listing. Recent studies show no indication of reduced genetic variation and past bottlenecks in Washington, Oregon, or California (Barrowclough et al. 1999, p. 922; Haig et al. 2004, p. 36). However, in Canada, the breeding population is estimated to be less than 33 pairs and annual population decline may be as high as 35 percent (Harestad et al. 2004, p. 13). Canadian populations may be more adversely affected by issues related to small population size including inbreeding depression, genetic isolation, and reduced genetic diversity (Courtney et al. 2004, p. 11-9). Low and persistently declining populations throughout the northern portion of the species range (see "Population Trends" below) may be at increased risk of losing genetic diversity.

Climate change

Climate change, a potential additional threat to spotted owl populations, is not explicitly addressed in the NWFP. Climate change could have direct and indirect impacts on spotted owls and their prey. However, the emphasis on maintenance of seral stage complexity and related biological diversity in Matrix Lands under the NWFP should contribute to the resiliency of the Federal forest landscape related to impacts of climate change (Courtney et al. 2004, p. 9-15).

Based upon a global meta-analysis of climate change data, Parmesan and Yohe (2003, pp. 37-42) discussed several potential implications of global climate change to biological systems, including terrestrial plants and animals. Results indicated that 62 percent of species exhibited trends indicative of advancement of spring conditions. In bird species, climate change trends were manifested in earlier nesting activities. Because the spotted owl exhibits a limited tolerance to heat relative to other bird species (Weathers et al. 2001, p. 685), subtle changes in climate have the potential to affect spotted owls. However, the specific impacts to the species are unknown.

Disturbance-Related Effects

The effects of noise on spotted owls are largely unknown, and whether noise is a concern has been a controversial issue. The effect of noise on birds is extremely difficult to determine due to the inability of most studies to quantify one or more of the following variables: 1) timing of the disturbance in relation to nesting chronology; 2) type, frequency, and proximity of human disturbance; 3) clutch size; 4) health of individual birds; 5) food supply; and 6) outcome of previous interactions between birds and humans (Knight and Skagen 1988, pp. 355-358). Additional factors that confound the issue of disturbance include the individual bird's tolerance level, ambient sound levels, physical parameters of sound and how it reacts with topographic characteristics and vegetation, and differences in how species perceive noise.

Although information specific to behavioral responses of spotted owls to disturbance is limited, research indicates that recreational activity can cause Mexican spotted owls (*S. o. lucida*) to vacate otherwise suitable habitat (Swarthout and Steidl 2001, p. 314) and helicopter overflights can reduce prey delivery rates to nests (Delaney et al. 1999, p. 70). Additional effects from disturbance, including altered foraging behavior and decreases in nest attendance and reproductive success, have been reported for other raptors (Andersen et al. 1989, p. 296; McGarigal et al. 1991, p. 5; White and Thurow 1985, p. 14).

Spotted owls may also respond physiologically to a disturbance without exhibiting a significant behavioral response. In response to environmental stressors, vertebrates secrete stress hormones called corticosteroids (Campbell 1990, p. 925). Although these hormones are essential for survival, extended periods with elevated stress hormone levels may have negative effects on reproductive function, disease resistance, or physical condition (Carsia and Harvey 2000, pp. 517-518; Sapolsky et al. 2000, p. 1). In avian species, the secretion of corticosterone is the primary non-specific stress response (Carsia and Harvey 2000, p. 517). The quantity of this hormone in feces can be used as a measure of physiological stress (Wasser et al. 1997, p. 1019). Recent studies of fecal corticosterone levels of spotted owls indicate that low intensity noise of short duration and minimal repetition does not elicit a physiological stress response (Tempel and Gutiérrez 2003, p.698; Tempel and Gutiérrez 2004, p. 538). However, prolonged activities, such as those associated with timber harvest, may increase fecal corticosterone levels depending on their proximity to spotted owl core areas (Tempel and Gutiérrez 2004, p. 544; Wasser et al. 1997, p. 1021).

Conservation Needs of the Spotted Owl

Based on the above assessment of threats, the spotted owl has the following habitat-specific and habitat-independent conservation (i.e., survival and recovery):

Habitat-specific Needs

1. Large blocks of suitable habitat to support clusters or local population centers of spotted owls (e.g., 15 to 20 breeding pairs) throughout the owl's range;

2. Suitable habitat conditions and spacing between local spotted owl populations throughout its range to facilitate survival and movement;

3. Suitable habitat distributed across a variety of ecological conditions within the spotted owl's range to reduce risk of local or widespread extirpation;

4. A coordinated, adaptive management effort to reduce the loss of habitat due to catastrophic wildfire throughout the spotted owl's range, and a monitoring program to clarify whether these risk reduction methods are effective and to determine how owls use habitat treated to reduce fuels; and

5. In areas of significant population decline, sustain the full range of survival and recovery options for this species in light of significant uncertainty.

Habitat-independent Needs

1. A coordinated, research and adaptive management effort to better understand and manage competitive interactions between spotted and barred owls; and

2. Monitoring to better understand the risk that West Nile Virus and sudden oak death pose to spotted owls and, for West Nile Virus, research into methods that may reduce the likelihood or severity of outbreaks in spotted owl populations.

Conservation Strategy

Since 1990, various efforts have addressed the conservation needs of the spotted owl and attempted to formulate conservation strategies based upon these needs. The various efforts began with the Interagency Scientific Committee's Conservation Strategy (Thomas et al. 1990). The efforts continued with the designation of critical habitat (57 FR 1796-1838, the Draft Recovery Plan (USFWS 1992); the Scientific Analysis Team report (Thomas et al. 1993); and the report of the Forest Ecosystem Management Assessment Team (FEMAT 1993). The efforts culminated with the NWFP (USDA and USDI 1994b). Each conservation strategy was based upon the reserve design principles first articulated in the Interagency Scientific Committee's report, which are summarized as follows:

- Species that are well distributed across their range are less prone to extinction than species confined to small portions of their range.

- Large blocks of habitat, containing multiple pairs of the species, are superior to small blocks of habitat with only one to a few pairs.

- Blocks of habitat that are close together are better than blocks far apart. Habitat that occurs in contiguous blocks is better than habitat that is more fragmented.

- Habitat between blocks is more effective as dispersal habitat if it resembles suitable habitat.

Conservation on Federal Lands

Since it was signed on April 13, 1994, the NWFP has guided the management of Federal forest lands within the range of the spotted owl (USDA and USDI 1994a; 1994b). The NWFP was designed to protect large blocks of old growth forest and provide habitat for species that depend on those forests including the spotted owl, as well as to produce a predictable and sustainable level of timber sales. The NWFP included land use allocations which would provide for population clusters of spotted owls (i.e., demographic support) and maintain connectivity between population clusters. Certain land use allocations in the plan contribute to supporting population clusters: Late-successional Reserves (LSRs), Managed Late-successional Areas, and Congressionally Reserved areas. Riparian Reserves, Adaptive Management Areas and Administratively Withdrawn areas can provide both demographic support and connectivity/dispersal between the larger blocks, but were not necessarily designed for that

purpose. Matrix areas were to support timber production while also retaining biological legacy components important to old-growth obligate species (in 100-acre owl cores, 15 percent late-successional provision, etc. (USDA and USDI 1994a; 1994b) which would persist into future managed timber stands.

The NWFP with its rangewide system of LSRs was based on work completed by three previous studies (Thomas et al. 2006, pp. 279-280): the 1990 Interagency Scientific Committee (ISC) Report (Thomas et al. 1990), the 1991 report for the Conservation of Late-successional Forests and Aquatic Ecosystems (Johnson et al. 1991), and the 1993 report of the Scientific Assessment Team (Thomas et al. 1993). In addition, the 1992 Draft Recovery Plan for the Northern Spotted Owl (USFWS 1992) was based on the ISC report.

The Forest Ecosystem Management Assessment Team predicted, based on expert opinion, the spotted owl population would decline in the Matrix land use allocation over time, while the population would stabilize and eventually increase within LSRs as habitat conditions improved over the next 50 to 100 years (Thomas et al. 1993, p. II-31; USDA and USDI 1994a, p. 3&4-229). Based on the results of the first decade of monitoring, Lint (2005, p. 18) could not determine whether implementation of the NWFP would reverse the spotted owl's declining population trend because not enough time had passed to provide the necessary measure of certainty. However, the results from the first decade of monitoring do not provide any reason to depart from the objective of habitat maintenance and restoration as described in the NWFP (Lint 2005, p. 18; Noon and Blakesley 2006, p. 288). (Courtney et al. 2004, p. 6-34) suggested that more fuels treatments are needed in east-side forests to preclude large-scale losses of habitat to stand-replacing wildfires. Other stressors that occur in suitable habitat, such as the range expansion of the barred owl (already in action) and infection with WNV (which may or may not occur) may complicate the conservation of the spotted owl. Recent reports about the status of the spotted owl offer few management recommendations to deal with these emerging threats. The arrangement, distribution, and resilience of the NWFP land use allocation system may prove to be the most appropriate strategy in responding to these unexpected challenges (Courtney et al. 2004, p. 6-34).

Under the NWFP, the agencies anticipated a decline of spotted owl populations during the first decade of implementation. Recent reports (Anthony et al. 2006, pp. 33-34) identified greater than expected spotted owl declines in Washington and northern portions of Oregon, and more stationary populations in southern Oregon and northern California. The reports did not find a direct correlation between habitat conditions and changes in vital rates of spotted owls at the meta-population scale. However, at the territory scale, there is evidence of negative effects to spotted owl fitness due to reduced habitat quantity and quality. Also, there is no evidence to suggest that dispersal habitat is currently limiting (Courtney et al. 2004, p. 9-12; Lint 2005, p. 87). Even with the population decline, Courtney et al (2004, p. 9-15) noted that there is little reason to doubt the effectiveness of the core principles underpinning the NWFP conservation strategy.

The current scientific information, including information showing spotted owl population declines, indicates that the spotted owl continues to meet the definition of a threatened species (USFWS 2004, p. 54). That is, populations are still relatively numerous over most of its historic

range, which suggests that the threat of extinction is not imminent, and that the subspecies is not endangered; even though, in the northern part of its range population trend estimates are showing a decline.

Northern Spotted Owl Recovery Plan

In May, 2008, the Service published the 2008 Final Recovery Plan for the Northern Spotted Owl (USFWS 2008). The recovery plan identifies that competition with barred owls, ongoing loss of suitable habitat as a result of timber harvest and catastrophic fire, and loss of amount and distribution of suitable habitat as a result of past activities and disturbances are the most important range-wide threats to the spotted owl (USFWS 2008, pp. 57-67). To address these threats, the present recovery strategy has the following three essential elements: barred owl control, dry-forest landscape management strategy, and managed owl conservation areas (MOCAs) (USFWS 2008, pp. 12-15). The recovery plan lists recovery actions that address research of the competition between spotted and barred owls, experimental control of barred owls to better understand the impact the species is having on spotted owls, and, if recommended by research, management of barred owls (USFWS 2008, p. 15).

The foundation of the plan for managing forest habitat in the western Provinces of Washington and Oregon is the MOCA network on Federal lands, which are intended to support stable and well-distributed populations of spotted owls over time and allow for movement of spotted owls across the network (USFWS 2008, p. 13). On the fire-dominated east side of the Cascade Mountains in Washington and Oregon, and the California Cascades, the dry-forest habitat management strategy is intended to maintain spotted owl habitat in an environment of frequent natural disturbances (USFWS 2008, p. 14). Additionally, the recovery plan identifies Conservation Support Areas (CSAs) in Washington, the west side of the Cascades in Oregon, and in California.

The CSAs are located on private, State, and Federal lands and are expected to support the MOCA network and the dry-forest landscape management approach (USFWS 2008, p. 14). In addition, the recovery plan recommends a research and monitoring program be implemented to track progress toward recovery, inform changes in recovery strategy by a process of adaptive management, and ultimately determine when delisting is appropriate (USFWS 2008, p. 15). The three primary elements of this program include 1) the monitoring of spotted owl population trends, 2) an inventory of spotted owl distribution, and 3) a comprehensive program of barred owl research and monitoring (USFWS 2008, p. 15). The recovery plan estimates that recovery of the spotted owl could be achieved in approximately 30 years (USFWS 2008, p. VIII).

Conservation Efforts on non-Federal Lands

In the report from the Interagency Scientific Committee (Thomas et al. 1990, p. 3), the draft recovery plan (USFWS 1992, p. 272), and the report from the Forest Ecosystem Management Assessment Team (Thomas et al. 1993, p. IV-189), it was noted that limited Federal ownership in some areas constrained the ability to form a network of old-forest reserves to meet the conservation needs of the spotted owl. In these areas in particular, non-Federal lands would be important to the range-wide goal of achieving conservation and recovery of the spotted owl. The

U.S. Fish and Wildlife Service's primary expectations for private lands are for their contributions to demographic support (pair or cluster protection) to Federal lands, or their connectivity with Federal lands. In addition, timber harvest within each state is governed by rules that provide protection of spotted owls or their habitat to varying degrees.

There are 17 current or completed Habitat Conservation Plans (HCPs) that have incidental take permits issued for spotted owls—eight in Washington, three in Oregon, and four in California (USFWS 2008, p. 55). The HCPs range in size from 40 acres to more than 1.6 million acres, although not all acres are included in the mitigation for spotted owls. In total, the HCPs cover approximately 2.9 million acres (9.1 percent) of the 32 million acres of non-Federal forest lands in the range of the spotted owl. The period of time that the HCPs will be in place ranges from 5 to 100 years; however, most of the HCPs are of fairly long duration. While each HCP is unique, there are several general approaches to mitigation of incidental take:

- Reserves of various sizes, some associated with adjacent Federal reserves.
- Forest harvest that maintains or develops suitable habitat.
- Forest management that maintains or develops dispersal habitat.
- Deferral of harvest near specific sites.

Washington. In 1996, the State Forest Practices Board adopted rules (WFPB 1996) that would contribute to conserving the spotted owl and its habitat on non-Federal lands. Adoption of the rules was based in part on recommendations from a Science Advisory Group that identified important non-Federal lands and recommended roles for those lands in spotted owl conservation (Buchanan et al. 1994, p. ii; Hanson et al. 1993, pp. 11-15). The 1996 rule package was developed by a stakeholder policy group and then reviewed and approved by the Forest Practices Board (Buchanan and Sweeden 2005, p. 9). Spotted owl-related HCPs in Washington generally were intended to provide demographic or connectivity support (USFWS 1992, p. 272).

Oregon. The Oregon Forest Practices Act provides for protection of 70-acre core areas around sites occupied by an adult pair of spotted owls capable of breeding (as determined by recent protocol surveys), but it does not provide for protection of spotted owl habitat beyond these areas (ODF 2007, p. 64) . In general, no large-scale spotted owl habitat protection strategy or mechanism currently exists for non-Federal lands in Oregon. The three spotted owl-related HCPs currently in effect cover more than 300,000 acres of non-Federal lands. These HCPs are intended to provide some nesting habitat and connectivity over the next few decades (USFWS 2008, p. 56).

California. The California State Forest Practice Rules, which govern timber harvest on private lands, require surveys for spotted owls in suitable habitat and to provide protection around activity centers (CDF 2007, pp. 85-87). Under the Forest Practice Rules, no timber harvest plan can be approved if it is likely to result in incidental take of federally listed species, unless the take is authorized by a Federal incidental take permit (CDF 2007, pp. 85-87) (California Department of Forestry and Fire Protection 2007, pp. 85-87). The California Department of Fish

and Game initially reviewed all timber harvest plans to ensure that take was not likely to occur; the U.S. Fish and Wildlife Service took over that review function in 2000. Several large industrial owners operate under spotted owl management plans that have been reviewed by the U.S. Fish and Wildlife Service and that specify basic measures for spotted owl protection. Four HCPs authorizing take of spotted owls have been approved; these HCPs cover more than 669,000 acres of non-Federal lands. Implementation of these plans is intended to provide for spotted owl demographic and connectivity support to NWFP lands (USFWS 2008, p. 56).

Current Condition of the Spotted Owl

The current condition of a species incorporates the effects of all past human and natural activities or events that have led to the present-day status of the species and its habitat (USFWS and NMFS 1998, pp. 4-19).

Range-wide Habitat Trends

Habitat Baseline

The 1992 Draft Spotted Owl Recovery Plan estimated approximately 8.3 million acres of spotted owl habitat remained range-wide (USFWS 1992, p. 37). However, reliable habitat baseline information for non-Federal lands is not available (Courtney et al. 2004, p. 6-5). The Service has used information provided by the U.S. Forest Service, Bureau of Land Management, and National Park Service to update the habitat baseline conditions on Federal lands for spotted owls on several occasions since the spotted owl was listed in 1990. The estimate of 7.4 million acres used for the NWFP in 1994 (USDA and USDI 1994b, p. G-34) was determined to be representative of the general amount of spotted owl habitat on these lands. This baseline was used to track relative changes over time in subsequent analyses.

In 2005, a new map depicting suitable spotted owl habitat throughout their range was produced as a result of the NWFP's effectiveness monitoring program (Lint 2005, pp. 21-82). However, the spatial resolution of this new habitat map currently makes it unsuitable for tracking habitat effects at the scale of individual projects. The Service is evaluating the map for future use in tracking habitat trends. Additionally, there are no reliable estimates of spotted owl habitat on other land ownerships; consequently, acres that have undergone ESA section 7 consultation can be tracked, but not evaluated in the context of change with respect to a reference condition on non-Federal lands. The production of the NWFP monitoring program habitat map does, however, provide an opportunity for future evaluations of trends in non-Federal habitat.

NWFP Lands Analysis 1994 – 2001

In 2001, the Service conducted an assessment of habitat baseline conditions, the first since implementation of the NWFP (USFWS 2001, p. 1). This range-wide evaluation of habitat, compared to the Final Supplemental Environmental Impact Statement, was necessary to determine if the rate of potential change to spotted owl habitat was consistent with the change anticipated in the NWFP. In particular, the Service considered habitat effects that were documented through the ESA section 7 consultation processes since 1994. In general, the

analytical framework of these consultations focused on the reserve and connectivity goals established by the NWFP land-use allocations (USDA and USDI 1994b), with effects expressed in terms of changes in suitable spotted owl habitat within those land-use allocations. The Service determined that actions and effects were consistent with the expectations for implementation of the NWFP from 1994 to June, 2001 (USFWS 2001, p. 32).

Range-wide Analysis 1994 – Present.

This section updates the information considered in U.S. Fish and Wildlife Service (2001), relying particularly on information in documents the Service produced pursuant to section 7 of the Act and information provided by NWFP agencies on habitat loss resulting from natural events (e.g., fires, windthrow, insect and disease). To track impacts to spotted owl habitat, the Service designed the Consultation Effects Tracking System database which records impacts to spotted owls and their habitat at a variety of spatial and temporal scales. Data are entered into the database under various categories including, land management agency, land-use allocation, physiographic province, and type of habitat affected.

In 1994, about 7.4 million acres of suitable spotted owl habitat were estimated to exist on Federal lands managed under the NWFP. As of April 4, 2011, the Service had consulted on the proposed removal of approximately 188,971 acres (Table 1) or 2.55 percent of 7.4 million acres of spotted owl suitable habitat on Federal lands. Of the total Federal acres consulted on for removal, approximately 160,556 acres or 2.17 percent of 7.4 million acres of spotted owl habitat were removed as a result of timber harvest. These changes in suitable spotted owl habitat are consistent with the expectations for implementation of the NWFP (USDA and USDI 1994b).

April 13, 2004 marked the start of the second decade of the NWFP. Decade specific baselines and summaries of effects by State, physiographic province and land use function from proposed management activities and natural events are not provided here, but can be calculated using the Service's Consultation Effects Tracking system.

Habitat loss from Federal lands due to management activities has varied among the individual provinces with most of the impacts concentrated within the Non-Reserve relative to the Reserve land-use allocations (Table 2). When habitat loss is evaluated as a proportion of the affected acres range-wide, the most pronounced losses have occurred within Oregon (79 percent), especially within its Klamath Mountains (40 percent) and Cascades (East and West) (38 percent) Provinces, followed by much smaller habitat losses in Washington (10.27 percent) and California (10.54 percent) (Table 2).

From 1994 through April 4, 2011, habitat lost due to natural events was estimated at approximately 207,262 acres range-wide (Table 2). About two-thirds of this loss was attributed to the Biscuit Fire that burned over 500,000 acres in southwest Oregon (Rogue River basin) and northern California in 2002. This fire resulted in a loss of approximately 113,451 acres of spotted owl habitat, including habitat within five LSRs. Approximately 18,630 acres of spotted owl habitat were lost due to the B&B Complex and Davis Fires in the East Cascades Province of Oregon. When habitat loss from natural events and timber harvest is evaluated as a proportion of provincial baselines, the Oregon Klamath Mountains (20.3 percent) and the Cascades East (12.99

percent) provinces have proportional losses greater than the range-wide mean (5.36 percent) (Table 2).

Because there is no comprehensive spotted owl habitat baseline for non-Federal lands, there is little available information regarding spotted owl habitat trends on non-Federal lands. Yet, we do know that internal Service consultations conducted since 1992 have documented the eventual loss of 472,772 acres (Table 1) of habitat on non-Federal lands. Most of these losses have yet to be realized because they are part of large-scale, long-term HCPs. Combining effects on Federal and non-Federal lands, the Service had consulted on the proposed removal of approximately 661,743 acres of spotted owl habitat range-wide, resulting from all management activities, as of April 4, 2011 (Table 1).

Table 1. Range-wide changes in spotted owl NRF[1] habitat (in acres) caused by Federal actions subject to section 7 consultations and natural disturbance events (wildfire, etc.) from May 1994 to present (April 4, 2011).

Land Ownership	Consulted On Habitat Changes[2]		Other Habitat Changes[3]	
	Removed/ Downgraded	Maintained/ Improved	Removed/ Downgraded	Maintained/ Improved
Northwest Forest Plan (USFS, BLM, NPS)	188,971	512,961	207,262	5,481
Bureau of Indian Affairs/ Tribes	108,210	28,372	2,398	0
Habitat Conservation Plans / Safe Harbor Agreements	295,889	14,430	N/A	N/A
Other Federal, State, County, or Private Lands	68,673	21,894	279	0
TOTAL Changes	661,743	577,657	209,939	5,481

Source: Table A from the Service's Northern Spotted Owl Consultation Effects Tracker (web application and database) April 4, 2011.

1 Nesting, roosting, foraging (NRF) habitat. In California, suitable habitat is divided into two components; nesting – roosting (NR) habitat, and foraging (F) habitat. The NR component most closely resembles NRF habitat in Oregon and Washington. Due to differences in reporting methods, effects to suitable habitat compiled in this, and all subsequent tables include effects for nesting, roosting, and foraging (NRF) for 1994-June 6, 2001. After June 26, 2001, suitable habitat includes NRF for Washington and Oregon but only nesting and roosting (NR) for California.

2 Includes both effects reported by U.S. Fish and Wildlife Service (2001) and subsequent effects compiled in the Northern Spotted Owl Consultation Effects Tracker (web application and database).

3 Includes effects to NRF habitat (as documented through technical assistance) resulting from wildfires (not from suppression efforts), insect and disease outbreaks, and other natural causes, private timber harvest, and land exchanges not associated with consultation.

[4] The 'Multi-agency' grouping is used to lump a variety of NWFP mixed agency or admin unit consultations that were reported together prior to June 26, 2001, and cannot be separated out.

[5] Includes lands that are owned or managed by other Federal agencies not included in the NWFP.

[6] Includes lands not covered by Habitat Conservation Plans that are owned or managed by states, counties, municipalities, and private entities. Effects that occurred on private lands from right-of-way permits across U.S. Forest Service and Bureau of Land Management lands are included.

Table 2. Aggregate results of all adjusted, suitable habitat (NRF[1]) acres affected by ESA section 7 consultation for the spotted owl; baseline and summary of effects by state, physiographic province, and land use function from 1994 to present for lands managed under the NWFP (April 4, 2011).

Physiographic Province[2]		Evaluation Baseline[3]	Habitat Removed/Downgraded[4]					% Provincial Baseline Affected	% Range-wide Effects
			NWFP Land Use Allocations			Habitat Loss to Natural Events[7]	Total (Consultation and Natural Event Effects)		
		Total	Reserves[5]	Non-Reserves[6]	Total Consultation Effects				
WA	Eastern Cascades	706,849	4,522	6,392	10,914	14,307	25,221	3.57	6.37
	Olympic Peninsula	560,217	869	1,711	2,580	299	2,879	0.51	0.73
	Western Cascades	1,112,480	1,681	10,870	12,551	3	12,554	1.13	3.17
OR	Cascades East	443,659	2,500	14,249	16,749	40,884	57,633	12.99	14.55
	Cascades West	2,046,472	3,697	63,941	67,638	24,583	92,221	4.51	23.27
	Coast Range	516,577	527	3,844	4,371	66	4,437	0.86	1.12
	Klamath Mountains	785,589	2,631	55,200	57,831	101,676	159,507	20.3	40.26
	Willamette Valley	5,658	0	0	0	0	0	0	0
CA	Cascades	88,237	0	4,820	4,820	4	4,824	5.47	1.22
	Coast	51,494	464	79	543	100	643	1.25	0.16
	Klamath	1,079,866	1,546	9,428	10,974	25,340	36,314	3.36	9.16
	Total	7,397,098	18,437	170,534	188,971	207,262	396,233	5.36	100

Source: Table B from the Service's Northern Spotted Owl Consultation Effects Tracker (web application and database) April 4, 2011.
Notes:

1 Nesting, roosting, foraging (NRF) habitat. In California, suitable habitat is divided into two components; nesting – roosting (NR) habitat, and foraging (F) habitat. The NR component most closely resembles NRF habitat in Oregon and Washington. Due to differences in reporting methods, effects to suitable habitat compiled in this, and all subsequent tables include effects for nesting, roosting, and foraging (NRF) for 1994-June 26, 2001. After June 26, 2001, suitable habitat includes NRF for Washington and Oregon but only nesting and roosting (NR) for California.

2 Defined by the NWFP as the twelve physiographic provinces, as presented in Figure 3 and 4-1 on page 3 and 4-16 of the Final Supplemental Environmental Impact Statement (FSEIS) (USDA and USDI 1994a).

3 1994 FSEIS baseline (USDA and USDI 1994a).

4 Includes both effects reported by USFWS (2001) and subsequent effects compiled in the Northern Spotted Owl Consultation Effects Tracking System (web application and database).

5 Land-use allocations intended to provide large blocks of habitat to support clusters of breeding pairs (LSR, MLSA, CRA).

6 Land-use allocations intended to provide habitat to support movement of spotted owls among reserves (Matrix, AMA, AWA).

7 Acres for all physiographic provinces, except the Oregon Klamath Mountains, are from the Scientific Evaluation of the Status of the Northern Spotted Owl (Courtney et al. 2004, p. 6-5) and subsequent effects entered into the Northern Spotted Owl Consultation Effects Tracking System. Acres for the Oregon Klamath Mountains province are from the biological assessment entitled: Fiscal year 2006-2008 programmatic consultation: re-initiation on activities that may affect listed species in the Rogue-River/South Coast Basin, Medford BLM, and Rogue-Siskiyou National Forest and from subsequent effects entered into the Northern Spotted Owl Consultation Effects Tracking System.

Other Habitat Trend Assessments

In 2005, the Washington Department of Wildlife released the report, "*An Assessment of Spotted Owl Habitat on Non-Federal Lands in Washington between 1996 and 2004*" (Pierce et al. 2005). This study estimates the amount of spotted owl habitat in 2004 on lands affected by state and private forest practices. The study area is a subset of the total Washington forest practice lands, and statistically-based estimates of existing habitat and habitat loss due to fire and timber harvest are provided. In the 3.2-million acre study area, Pierce et al. (2005, p. 88) estimated there was 816,000 acres of suitable spotted owl habitat in 2004, or about 25 percent of their study area. Based on their results, Pierce and others (2005, p. 98) estimated there were less than 2.8 million acres of spotted owl habitat in Washington on all ownerships in 2004. Most of the suitable owl habitat in 2004 (56 percent) occurred on Federal lands, and lesser amounts were present on state-local lands (21 percent), private lands (22 percent) and tribal lands (1 percent).

Most of the harvested spotted owl habitat was on private (77 percent) and state-local (15 percent) lands. A total of 172,000 acres of timber harvest occurred in the 3.2 million-acre study area, including harvest of 56,400 acres of suitable spotted owl habitat. This represented a loss of about 6 percent of the owl habitat in the study area distributed across all ownerships (Pierce et al. 2005, p. 91). Approximately 77 percent of the harvested habitat occurred on private lands and about 15 percent occurred on State lands. Pierce and others (2005, p. 80) also evaluated suitable habitat levels in 450 spotted owl management circles (based on the provincial annual median spotted owl home range). Across their study area, they found that owl circles averaged about 26 percent suitable habitat in the circle across all landscapes. Values in the study ranged from an average of 7 percent in southwest Washington to an average of 31 percent in the east Cascades, suggesting that many owl territories in Washington are significantly below the 40 percent suitable habitat threshold used by the State as a viability indicator for spotted owl territories (Pierce et al. 2005, p. 90).

Moeur et al. (2005, p. 110) estimated an increase of approximately 1.25 to 1.5 million acres of medium and large older forest (greater than 20 inches dbh, single and multi-storied canopies) on Federal lands in the NWFP area between 1994 and 2003. The increase occurred primarily in the lower end of the diameter range for older forest. The net area in the greater than 30 inch dbh size class increased by only an estimated 102,000 to 127,000 acres (Moeur et al. 2005, p. 100). The estimates were based on change-detection layers for losses due to harvest and fire and remeasured inventory plot data for increases due to ingrowth. Transition into and out of medium and large older forest over the 10-year period was extrapolated from inventory plot data on a subset of Forest Service land types and applied to all Federal lands. Because size class and general canopy layer descriptions do not necessarily account for the complex forest structure often associated with spotted owl habitat, the significance of these acres to spotted owl conservation remains unknown.

<u>Spotted Owl Numbers, Distribution, and Reproduction Trends</u>

There are no estimates of the historical population size and distribution of spotted owls, although they are believed to have inhabited most old-growth forests throughout the Pacific Northwest prior to modern settlement (mid-1800s), including northwestern California (USFWS 1989, pp. 2-

17). The final rule listing the spotted owl as threatened (55 FR 26114-26194 [June 26, 1990]), estimated that approximately 90 percent of the roughly 2,000 known spotted owl breeding pairs were located on federally managed lands, 1.4 percent on State lands, and 6.2 percent on private lands. The percent of spotted owls on private lands in northern California was slightly higher (Thomas et al. 1990, p. 64; USFWS 1989, pp. 4-11).

The current range of the spotted owl extends from southwest British Columbia through the Cascade Mountains, coastal ranges, and intervening forested lands in Washington, Oregon, and California, as far south as Marin County (55 FR 26114 [June 26, 1990]). The range of the spotted owl is partitioned into 12 physiographic provinces (Figure 1) based on recognized landscape subdivisions exhibiting different physical and environmental features (USFWS 1992, p. 31). The spotted owl has become rare in certain areas, such as British Columbia, southwestern Washington, and the northern coastal ranges of Oregon.

As of July 1, 1994, there were 5,431 known locations of, or site centers of spotted owl pairs or resident singles: 851 sites (16 percent) in Washington, 2,893 (53 percent) in Oregon, and 1,687 (31 percent) in California (60 FR 9484:9495 [Feb. 17, 1995]). By June 2004, the number of territorial spotted owl sites recognized by Washington Department of Fish and Wildlife was 1,044 (Buchanan and Sweeden 2005, p. 37). The actual number of currently occupied spotted owl locations across the range is unknown because many areas remain unsurveyed (USFWS 2008, p. 44). In addition, many historical sites are no longer occupied because spotted owls have been displaced by barred owls, timber harvest, or severe fires, and it is possible that some new sites have been established due to reduced timber harvest on Federal lands since 1994. The totals listed in 60 FR 9484:9495 [Feb. 17, 1995], represent the cumulative number of locations recorded in the three states, not population estimates.

Because existing survey coverage and effort are insufficient to produce reliable range-wide estimates of population size, researchers use other indices, such as demographic data, to evaluate trends in spotted owl populations. Analysis of demographic data can provide an estimate of the rate and direction of population growth [i.e., lambda (λ)]. A λ of 1.0 indicates a stationary population (i.e., neither increasing nor decreasing), a λ less than 1.0 indicates a declining population, and a λ greater than 1.0 indicates a growing population. Demographic data, derived from studies initiated as early as 1985, have been analyzed periodically (Anderson and Burnham 1992; Anthony et al. 2006; Burnham et al. 1994; Forsman et al. 1996; Forsman et al. In press [2010]) to estimate trends in the populations of the spotted owl.

In January 2009, two meta-analyses modeled rates of population change for up to 24 years using the re-parameterized Jolly-Seber method (λRJS). One meta-analysis modeled the 11 long-term study areas (Table 3), while the other modeled the eight study areas that are part of the effectiveness monitoring program of the NWFP (Forsman et al. In press [2010], cited in USFWS 2010, p. 89).

Table 3. Spotted owl demographic study areas (Forsman et al. In press [2010], cited in USFWS 2010, p. 89).

Study Area	Fecundity	Apparent Survival[1]	λ_{RJS}	Population change[2]
Cle Elum	Declining	Declining	0.937	Declining
Rainier	Increasing	Declining	0.929	Declining
Olympic	Stable	Declining	0.957	Declining
Coast Ranges	Increasing	Declining since 1998	0.966	Declining
HJ Andrews	Increasing	Declining since 1997	0.977	Declining
Tyee	Stable	Declining since 2000	0.996	Stationary
Klamath	Declining	Stable	0.990	Stationary
Southern Cascades	Declining	Declining since 2000	0.982	Stationary
NW California	Declining	Declining	0.983	Declining
Hoopa	Stable	Declining since 2004	0.989	Stationary
Green Diamond	Declining	Declining	0.972	Declining

[1]Apparent survival calculations are based on model average.
[2]Population trends are based on estimates of realized population change.

Point estimates of λRJS were all below 1.0 and ranged from 0.929 to 0.996 for the 11 long-term study areas. There was strong evidence that populations declined on 7 of the 11 areas (Forsman et al. In press [2010]), these areas included Rainier, Olympic, Cle Elum, Coast Range, HJ Andrews, Northwest California and Green Diamond. On other four areas (Tyee, Klamath, Southern Cascades, and Hoopa), populations were either stable, or the precision of the estimates was not sufficient to detect declines.

The weighted mean λRJS for all of the 11 study areas was 0.971 (standard error [SE] = 0.007, 95 percent confidence interval [CI] = 0.960 to 0.983), which indicated an average population decline of 2.9 percent per year from 1985 to 2006. This is a lower rate of decline than the 3.7 percent reported by Anthony et al. (2006), but the rates are not directly comparable because Anthony et al. (2006) examined a different series of years and because two of the study areas in their analysis were discontinued and not included in Forsman et al. (In press [2010]). Forsman et al. (In press [2010]) explains that the indication populations were declining was based on the fact that the 95 percent confidence intervals around the estimate of mean lambda did not overlap 1.0 (stable) or barely included 1.0.

The mean λRJS for the eight demographic monitoring areas (Cle Elum, Olympic, Coast Range, HJ Andrews, Tyee, Klamath, Southern Cascades and Northwest California) that are part of the effectiveness monitoring program of the NWFP was 0.972 (SE = 0.006, 95 percent CI = 0.958 to 0.985), which indicated an estimated decline of 2.8 percent per year on Federal lands with the range of the spotted owl. The weighted mean estimate λRJS for the other three study areas (Rainier, Hoopa and Green Diamond) was 0.969 (SE = 0.016, 95 percent CI = 0.938 to 1.000), yielding an estimated average decline of 3.1 percent per year. These data suggest that demographic rates for spotted owl populations on Federal lands were somewhat better than

elsewhere; however, this comparison is confounded by the interspersion of non-Federal land in study areas and the likelihood that spotted owls use habitat on multiple ownerships in some demography study areas.

The number of populations that declined and the rate at which they have declined are noteworthy, particularly the precipitous declines in the Olympic, Cle Elum, and Rainier study areas in Washington and the Coast Range study area in Oregon. Estimates of population declines in these areas ranged from 40 to 60 percent during the study period through 2006 (Forsman et al. In press [2010]). Spotted owl populations on the HJ Andrews, Northwest California, and Green Diamond study areas declined by 20-30 percent whereas the Tyee, Klamath, Southern Cascades, and Hoopa study areas showed declines of 5 to 15 percent.

Decreases in adult apparent survival rates were an important factor contributing to decreasing population trends. Forsman et al. (In press [2010]) found apparent survival rates were declining on 10 of the study area with the Klamath study area in Oregon being the exception. Estimated declines in adult survival were most precipitous in Washington where apparent survival rates were less than 80 percent in recent years, a rate that may not allow for sustainable populations (Forsman et al. In press [2010]). In addition, declines in adult survival for study areas in Oregon have occurred predominately within the last five years and were not observed in the previous analysis by Anthony et al. (2006). Forsman et al. (In press [2010]) express concerns by the collective declines in adult survival across the subspecies range because spotted owl populations are most sensitive to changes in adult survival.

There are few spotted owls remaining in British Columbia. Chutter et al. (2004, p. v) suggested immediate action was required to improve the likelihood of recovering the spotted owl population in British Columbia. So, in 2007, personnel in British Columbia captured and brought into captivity the remaining 16 known wild spotted owls (USFWS 2008, p. 48). Prior to initiating the captive-breeding program, the population of spotted owls in Canada was declining by as much as 10.4 percent per year (Chutter et al. 2004, p. v). The amount of previous interaction between spotted owls in Canada and the United States is unknown.

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APPENDIX C: – STATUS OF THE SPECIES – MARBLED MURRELET

APPENDIX C

STATUS OF THE SPECIES: Marbled Murrelet

Legal Status

The marbled murrelet (murrelet) was listed as a threatened species[1] on September 28, 1992, in Washington, Oregon, and northern California (57 FR 45328 [October 1, 1992]). Since the species' listing, the FWS has completed two 5-yr status reviews of the species: September 1, 2004 (USFWS 2004) and June 12, 2009 (USFWS 2009). The legal status of the murrelet remains unchanged from the original designation.

Threats to Murrelet Survival and Recovery

Murrelets are long-lived seabirds that spend most of their life in the marine environment, with breeding adult birds annually nesting in the forest canopy of mature and old-growth forests from April 1 through September 15. Murrelets have a naturally low reproductive rate. Breeding adults lay just one egg and renesting, in the event of nest failure, is thought to be an extremely rare event.

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

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

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

[1] The Act defines a threatened species as a species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

There have been changes in the levels of these threats since the 1992 listing (USFWS 2004, pp. 11-12; USFWS 2009, pp. 27-67). The regulatory mechanisms implemented since 1992 that affect land management in Washington, Oregon, and California (for example, the Northwest Forest Plan (NWFP)) and new gill-netting regulations in northern California and Washington have reduced the threats to murrelets (USFWS 2004, pp. 11-12). The threat levels for the other threats identified in 1992 listing (57 FR 45333-45336 [October 1, 1992]) including the loss of nesting habitat, predation rates, and mortality risks from oil spills and gill net fisheries (despite the regulatory changes) remained unchanged following the FWS's 2004, 5-year, range-wide status review for the murrelet (USFWS 2004, pp. 11-12).

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

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

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

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

Nesting Habitat Abundance

The destruction, modification, or curtailment of nesting habitat from logging, urbanization, and land use conversion has generally been regarded as the most influential environmental stressor that led to the 1992 Federal listing of the species under the Act. The FWS estimates that over 80 percent of the historic nesting habitat has been rendered unsuitable for nesting (57 FR 45328 [October 1, 1992]). Because of the important role nesting habitat plays in the survival and recovery of the species, significant attention has been given to describing the quality, quantity, and location of the remaining nesting habitat and planning for the restoration of nesting habitat in California, Oregon, and Washington.

Loss of Nesting Habitat Since 1992

The FWS has determined that the rate of habitat loss has declined since listing, particularly on Federal lands due to implementation of the NWFP (USFWS 2004, pp. 11 and 13). Between 1992 and 2003, the estimated loss of suitable murrelet habitat totaled 22,398 acres in Washington, Oregon, and California combined, of which 5,364 acres resulted from timber harvest and 17,034 acres resulted from natural events (McShane et al. 2004, pp. 4-64). Those data primarily represented losses on Federal lands, and did not include data for most private or State lands within the murrelets' range.

More recently, (Raphael et al. 2006 in Huff et al. 2006) used habitat models to estimate losses of potential murrelet habitat for the period from 1994-1996 to 2002-2003 on both Federal and non-Federal lands within the five Conservation Zones in the NWFP area. Results indicate that losses of potential nesting habitat may be greater than previously estimated, with losses ranging from 61,000 to 279,000 acres (depending on the model, see discussion below) in the 5-Conservation Zone area, with 10 to 28 percent of habitat loss occurring on Federal lands and 72 to 90 percent on non-Federal lands.

Current Amount of Nesting Habitat

McShane et al. (2004, p. 4-2), reviewed and summarized habitat estimates from 16 sources and estimated the amount of murrelet nesting habitat at 2,223,048 acres distributed throughout Washington, Oregon, and California (McShane et al. 2004, p. 4-5). Washington State contains almost half of all remaining nesting habitat with an estimated 1,022,695 acres or 48 percent of the total. Approximately 93 percent (2,000,000 acres) are reported to occur on Federal lands (McShane et al. 2004, p. 4-10).

In another effort, (Raphael et al 2006 in Huff et al. 2006) produced two spatial models for the NWFP Effectiveness Monitoring (EM) program to predict the amount, location, and distribution of murrelet nesting habitat. Combining vegetation-based maps derived from satellite imagery and prior estimates of habitat on State and private lands from 1994 to 2003, (Raphael et al. 2006, p. 109 in Huff et al. 2006) used a panel of experts to reclassify 22 old-growth forest classes into four classes of murrelet habitat based upon nesting suitability. Referred to as the Expert Judgment Model, the model classifies existing forest structure, based upon percent conifer cover, canopy structure, quadratic mean diameter, and forest patch size, into four classes of suitability

for nesting murrelets. (Raphael et al. 2006, p. 116-123 in Huff et al. 2006) found that across the murrelet range, most habitat-capable land (52 percent) is unsuitable nesting habitat (Class 1) and 18 percent is classified as Class 4 habitat (highest suitability), with an estimated 41 percent of the Class 4 habitat (1,620,800 acres) occurring on non-Federal lands.

The second habitat model developed by (Raphael et al. 2006 in Huff et al. 2006) used the Biomapper Ecological Niche-Factor Analysis methodology developed by Hirzel et al. (2002). The resulting murrelet habitat suitability maps are based on both the physical and vegetative attributes adjacent to known murrelet occupied polygons or nest locations for each NWFP province. The maps provide a range of habitat suitability values, each with acreage estimates. In Washington, 2.1 million acres of habitat were rated with a habitat suitability (HS) greater than 60 and captured 82 percent of the stands documented as occupied, while 440,700 acres of habitat were rated as HS >80 habitat and captured 36 percent of the known occupied stands.

The FWS believes the Expert Judgment and Ecological Niche Factor Analysis models, which relate known (occupied) murrelet nest stands to habitat abundance, distribution, and quality, represent the best available information on the subject. While not necessarily the best means to describe suitable habitat at the site scale, the FWS expects these models have higher reliability for provincial-scale analysis compared to previous efforts.

Population Status

The initial at-sea surveys for murrelets that began during the 1990s in the marine waters of Washington, Oregon, and California were generally independent and sporadic efforts to assess murrelet population status (abundance, trends, distribution, and fecundity). Through a more coordinated effort, researchers developed the EM Program for the NWFP (Bentivoglio et al. 2002) in 2000 that unified the various at-sea monitoring efforts within terrestrial portions of the five Conservation Zones contained within the planning area of the NWFP. At-sea surveys in Conservation Zone 6, though independent of the EM Program, are modeled after the EM Program survey methods. The at-sea survey data collected prior to the EM Program are generally not suitable for statistical comparisons or trend analyses due to differences in survey methods, (McShane et al. 2004).

<u>Abundance and Distribution</u>

Murrelet abundance during the early 1990s in Washington, Oregon, and California was estimated at 18,550 to 32,000 birds (Ralph et al. 1995). Through the efforts of the EM program, the 2008 murrelet abundance in the listed range of the species (Table 1) is estimated at 17,965 birds (14,722 – 21,208, 95 percent confidence interval (CI); (USFWS 2009, p. 16). Conservation Zones 3 and 4 support approximately 61 percent (11,036/17,965) of the murrelet population within the U.S., have the highest reported densities and the lowest within-zone statistical variation in population size (Falxa et al. 2009, p. 9). Murrelets occur in the lowest abundance in Conservation Zones 5 and 6 where just 1.6 percent of all murrelets were recorded during the 2008 surveys.

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

Table 1. Estimates of murrelet density and population size (95 percent confidence interval (CI)) in Conservation Zones 1 through 6 during the 2008 breeding season (USFWS 2009, p. 16).

Conservation Zone	**Density** (birds/km^2)	**Coefficient of Variation** (% Density)	**Population Size Estimates with 95% CI**			**Survey Area** (km^2)
			Number of Birds	Lower	Upper	
1	1.34	17.0	4,699	3,132	6,201	3,497
2	1.18	21.1	1,944	1,187	2,843	1,650
3	3.87	15.4	6,176	4,175	7,903	1,595
4	4.18	19.4	4,850	3,688	7,325	1,159
5	0.14	50.5	121	-	242	883
6	-	-	174	91	256	-
Zones 1-6	-	-	17,965	14,722	21,208	-

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

Trend

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

Marine Surveys

Researchers from the EM Program detected a statistically significant decline ($p \leq 0.05$) in the abundance of the surveyed populations in Conservation Zones 1 through 5 for the 2000-2008 sample period (Falxa et al. 2009, p. 14). The decline, estimated at 490 birds per year (Standard Error (se) = 241, $p = 0.0412$), or about 3,900 birds over the 9-year period (95% CI = ±4,553 birds), represents a 2.4 percent annual rate of decline (21.6 percent decline during the 2000 - 2008 survey period).

Because of a concern about possible departures from the survey protocol in 2000, Falxa et al. (2009) also report results from the 2001-2008 period without the 2000 data. In the absence of

2000 data, the estimated decline increases to 870 birds per year (standard error (se) = 129), or about 6,900 birds over the 8-year period (95% CI = ±2,533 birds), representing an annual decline of 4.3 percent (34.4 percent decline during the 2001-2008 survey period).

The 2008 population estimate for Conservation Zone 6 represents a decline of about 55 percent from the 2007 estimate and a 75 percent decline from the 2003 estimate (Peery et al. 2008), or an average decline of about 15 percent per year between 2003 and 2008. The 2007 and 2008 population estimates in Conservation Zone 6 are the lowest since the surveys began in 1999. The authors conclude that the murrelet population in central California has exhibited a significant and rapid decline from 2003 to 2008 (Peery et al. 2008).

Trend analyses detected no statistically significant trends in murrelet abundance at the scale of the Conservation Zone for 2000-2008.[2] However, using 9 years of survey data, the statistical power to detect decline rates of 2 to 4 percent per year was generally not high (Miller et al. 2006, pg. 57 in Huff et al. 2006).[3] With a *p value* estimate of 0.07, it appears the change in murrelet abundance during the 2000-2008 sample period is approaching significance in Conservation Zone 3.

Population Models

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

In a report developed for the 5-year Status Review of the Marbled Murrelet in Washington, Oregon, and California (McShane et al. 2004, p. 3-27 to 3-60), computer models were used to forecast 40-year murrelet population trends. A series of female-only, multi-aged, discrete-time stochastic Leslie Matrix population models were developed for each conservation zone to forecast decadal population trends over a 40-year period with extinction probabilities beyond 40 years (to 2100). The authors incorporated available demographic parameters (Table 2) for each conservation zone to describe population trends and evaluate extinction probabilities (McShane et al. 2004, p. 3-49).

McShane et al. (2004) used mark-recapture studies conducted in British Columbia by Cam et al. (2003) and Bradley et al. (2004) to estimate annual adult survival and telemetry studies or at-sea survey data to estimate fecundity. Model outputs predicted -3.1 to -4.6 percent mean annual rates of population change (decline) per decade the first 20 years of model simulations in murrelet Conservation Zones 1 through 5 (McShane et al. 2004, p. 3-52). Simulations for all zone populations predicted declines during the 20 to 40-year forecast, with mean annual rates of

[2] If the 2000 data are excluded, trend analyses detected a highly significant decline in Conservation Zone 1 (p = 0.0099) with an estimated annual rate of decline of 7.9 percent (s.e. = 183) or 577 birds per year.
[3] The FWS does not consider the absence of a statistically detectable trend to be conclusive evidence of population stability.

-2.1 to -6.2 percent per decade (McShane et al. 2004, p. 3-52). These reported rates of decline are similar to the estimates of -4 to -7 percent per year reported in the Recovery Plan (USFWS 1997b, p. 5).

Table 2. Rangewide murrelet demographic parameter values based on four studies all using Leslie Matrix models.

Demographic Parameter	Beissinger 1995	Beissinger and Nur 1997*	Beissinger and Peery (2007)	McShane et al. 2004
Juvenile Ratio (Ŕ)	0.10367	0.124 or 0.131	0.089	0.02 - 0.09
Annual Fecundity	0.11848	0.124 or 0.131	0.06-0.12	-
Nest Success	-	-	0.16-0.43	0.38 - 0.54
Maturation	3	3	3	2 - 5
Estimated Adult Survivorship	85 % – 90%	85 % – 88 %	82 % - 90 %	83 % – 92 %

*In U.S. Fish and Wildlife FWS (1997b).

McShane et al. (2004, pp. 3-54 to 3-60) modeled population extinction probabilities beyond 40 years under different scenarios for immigration and mortality risk from oil spills and gill nets. Modeled results forecast different times and probabilities for local extirpations, with an extinction risk[4] of 16 percent and mean population size of 45 individuals in 100 years in the listed range of the species (McShane et al. 2004, pp. 3-58).

Reproduction

Generally, estimates of murrelet fecundity are directed at measures of breeding success, either from direct assessments of nest success in the terrestrial environment, marine counts of hatch-year birds, or computer models. Telemetry estimates are typically preferred over marine counts for estimating breeding success due to fewer biases (McShane et al. 2004, p. 3-2). However, because of the challenges of conducting telemetry studies, estimating murrelet reproductive rates with an index of reproduction, referred to as the juvenile ratio (Ŕ),[5] continues to be important, despite the debate over use of this index (see discussion in Beissinger and Peery 2007, p. 296).

Although difficult to obtain, nest success rates[6] are available from telemetry studies conducted in California (Hebert and Golightly 2006; Peery et al. 2004) and Washington (Bloxton and Raphael 2006). In northwest Washington, Bloxton and Raphael (2005, p. 5) documented a nest success rate of 0.20 (2 chicks fledging from 10 nest starts). In central California, murrelet nest success is 0.16 (Peery et al. 2004, p. 1098) and in northern California it is 0.31 to 0.56 (Hebert and Golightly 2006, p. 95). No studies or published reports from Oregon are available.

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

[5] The juvenile ratio (**Ŕ**) for murrelets is derived from the relative abundance of hatch-year (HY; 0-1 yr-old) to after-hatch-year (AHY; 1+ yr-old) birds (Beissinger and Peery 2007, p. 297) and is calculated from marine survey data.

[6] Nest success here is defined by the annual number of known hatchlings departing from the nest (fledging) divided by the number of nest starts.

Unadjusted and adjusted values for estimates of murrelet juvenile ratios suggest extremely low breeding success in northern California (0.003 to 0.008 - Long et al. 2008, pp. 18-19), central California (0.035 and 0.032 - Beissinger and Peery 2007, pp. 299, 302), and in Oregon (0.0254 - 0.0598 - Crescent Coastal Research 2008, p. 13). Estimates for **Ŕ** (adjusted) in the San Juan Islands in Washington have been below 0.15 every year since surveys began in 1995, with three of those years below 0.05 (Raphael et al. 2007, p. 16).

These current estimates of **Ŕ** are assumed to be below the level necessary to maintain or increase the murrelet population. Demographic modeling suggests murrelet population stability requires a minimum reproductive rate of 0.18 to 0.28 (95 % CI) chicks per pair per year (Beissinger and Peery 2007, p. 302; USFWS 1997b). Even the lower level of the 95 percent confidence interval from USFWS (1997b) Beissinger and Peery (2007, p. 302) is greater than the current range of estimates for Ŕ (0.02 to 0.13 chicks per pair) for any of the Conservation Zones (Table 2).

The current estimates for **Ŕ** also appear to be well below what may have occurred prior to the murrelet population decline. Beissinger and Peery (2007, p. 298) performed a comparative analysis using historic data from 29 bird species to predict the historic **Ŕ** for murrelets in central California, resulting in an estimate of 0.27 (95% CI: 0.15 - 0.65). Therefore, the best available scientific information of murrelet fecundity from model predictions and trend analyses of survey-derived population data appear to align well. Both indicate that the murrelet reproductive rate is generally insufficient to maintain stable population numbers throughout all or portions of the species' listed range.

<u>Summary: Murrelet Abundance, Distribution, Trend, and Reproduction</u>

The 2007 and 2008 estimated abundance for murrelets within the species listed range were the lowest recorded levels since inception of the EM program (Falxa et al. 2009, p. 9), with the current population size within the listed range of the species estimated at 17,965 birds (95% CI: 14,722 – 21,208) (USFWS 2009, p. 16). Although murrelets are distributed throughout their historical range, the area of occupancy within their historic range appears to be reduced from historic levels. The distribution of the species also exhibits five areas of discontinuity: a segment of the border region between British Columbia, Canada and Washington; southern Puget Sound, WA; Destruction Island, WA to Tillamook Head, OR; Humboldt County, CA to Half Moon Bay, CA; and the entire southern end of the breeding range in the vicinity of Santa Cruz and Monterey Counties, CA (McShane et al. 2004, p. 3-70).

A statistically significant decline was detected in Conservation Zone 1 for the 2001-2008 period and the decline in Conservation Zone 3 is approaching significance (***p*** = 0.0731) for the 2000-2008 period (Falxa et al. 2009, p. 14). The overall population trend from the combined 2000-2008 population estimates (Conservation Zones 1 - 5) indicate a statistically significant, rangewide annual rate of decline in the range of 2.4 to 4.3 percent (Falxa et al. 2009, p. 14), or about 490 birds per year (S.E. = 241, ***p*** = 0.0412). This equates to an overall estimated 21.6 percent decline during the 2000-2008 survey period.

The current range of estimates for **Ŕ**, the juvenile to adult ratio, is assumed to be below the level necessary to maintain or increase the murrelet population. Whether derived from marine surveys

or from population modeling (**Ŕ** = 0.02 to 0.13, Table 2), the available information is in general agreement that the current ratio of hatch year birds to after-hatch year birds is insufficient to maintain stable numbers of murrelets throughout the listed range. The current estimates for **Ŕ** also appear to be well below what may have occurred prior to the murrelet population decline (Beissinger and Peery 2007, p. 298) and model predictions forecast an extinction risk of 16 percent, with a 3-state mean population size of 45 individuals in 100 years in the listed portion of the species' range (McShane et al. 2004, p. 3-58).

Thus, considering the best available data on abundance, distribution, population trend, and the low reproductive success of the species, the FWS concludes the murrelet population within the portion of its listed range currently has little or no capability to self-regulate, as indicated by the significant, annual decline in abundance the species is currently undergoing throughout the listed range. The FWS expects the species to continue to exhibit further reductions in the distribution and abundance into the foreseeable future, due largely to the expectation that the variety of environmental stressors present in the marine and terrestrial environments (discussed in the *Threats to Murrelet Survival and Recovery* section) will continue into the foreseeable future.

Recovery Plan

The Marbled Murrelet Recovery Plan outlines the conservation strategy with both short- and long-term objectives. The Plan places special emphasis on the terrestrial environment for habitat-based recovery actions due to nesting occurring in inland forests.

In the short-term, specific actions identified as necessary to stabilize the population include protecting occupied habitat and minimizing the loss of unoccupied but suitable habitat (USFWS 1997b, p. 119). Specific actions include maintaining large blocks of suitable habitat, maintaining and enhancing buffer habitat, decreasing risks of nesting habitat loss due to fire and windthrow, reducing predation, and minimizing disturbance. The designation of critical habitat also contributes towards the initial objective of stabilizing the population size through the maintenance and protection of occupied habitat and minimizing the loss of unoccupied but suitable habitat.

Long-term conservation needs identified in the Plan include:

- increasing productivity (abundance, the ratio of juveniles to adults, and nest success) and population size;
- increasing the amount (stand size and number of stands), quality, and distribution of suitable nesting habitat;
- protecting and improving the quality of the marine environment; and
- reducing or eliminating threats to survivorship by reducing predation in the terrestrial environment and anthropogenic sources of mortality at sea.

Recovery Zones

The Plan identified six Conservation Zones (Figure 1) throughout the listed range of the species: Puget Sound (Conservation Zone 1), Western Washington Coast Range (Conservation Zone 2), Oregon Coast Range (Conservation Zone 3), Siskiyou Coast Range (Conservation Zone 4), Mendocino (Conservation Zone 5), and Santa Cruz Mountains (Conservation Zone 6). Recovery zones are the functional equivalent of recovery units as defined by FWS policy (USFWS 1997b, p. 115).

Recovery Zones in Washington

Conservation Zones 1 and 2 extend inland 50 miles from marine waters. Conservation Zone 1 includes all the waters of Puget Sound and most waters of the Strait of Juan de Fuca south of the U.S.-Canadian border and the Puget Sound, including the north Cascade Mountains and the northern and eastern sections of the Olympic Peninsula. Conservation Zone 2 includes marine waters within 1.2 miles (2 km) off the Pacific Ocean shoreline, with the northern terminus immediately south of the U.S.-Canadian border near Cape Flattery along the midpoint of the Olympic Peninsula and extending to the southern border of Washington (the Columbia River) (USFWS 1997b, pg. 126).

Lands considered essential for the recovery of the murrelet within Conservation Zones 1 and 2 are 1) any suitable habitat in a Late Successional Reserve (LSR), 2) all suitable habitat located in the Olympic Adaptive Management Area, 3) large areas of suitable nesting habitat outside of LSRs on Federal lands, such as habitat located in the Olympic National Park, 4) suitable habitat on State lands within 40 miles off the coast, and 5) habitat within occupied murrelet sites on private lands (USFWS 1997b).

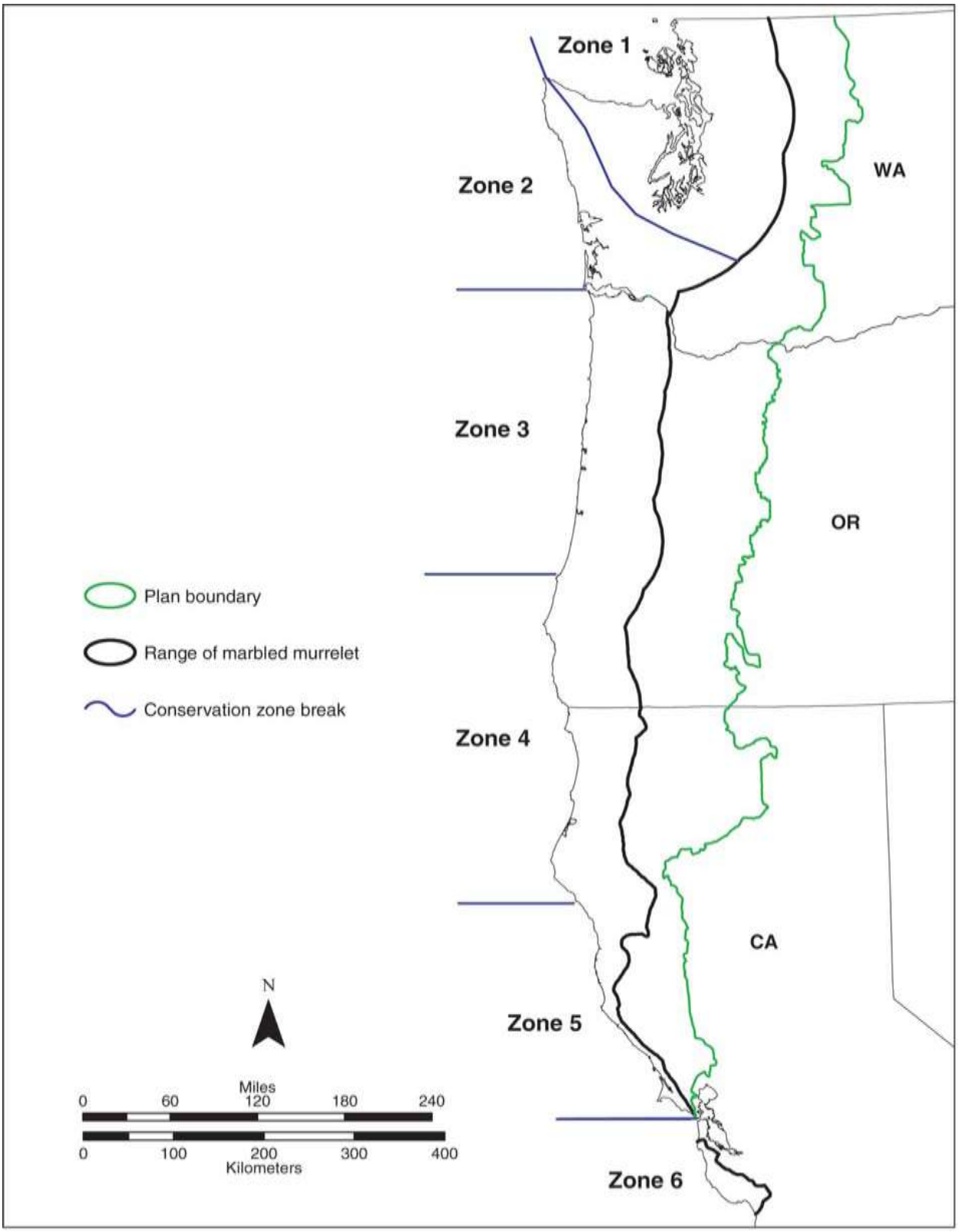

Figure 1. The six geographic areas identified as Conservation Zones in the recovery plan for the marbled murrelet (USFWS 1997b). Note: "Plan boundary" refers to the Northwest Forest Plan. Figure adapted from Huff et al. (2006, p. 6).

Conservation Needs of the Species

Reestablishing an abundant supply of high quality murrelet nesting habitat is a vital conservation need given the extensive removal during the 20th century. However, there are other conservation imperatives. Foremost among the conservation needs are those in the marine and terrestrial environments to increase murrelet fecundity by increasing the number of breeding adults, improving murrelet nest success (due to low nestling survival and low fledging rates), and reducing anthropogenic stressors that reduce individual fitness[7] or lead to mortality.

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

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

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

Thus, increasing murrelet reproductive success and reducing the frequency, magnitude, or duration of any anthropogenic stressor that directly or indirectly affects murrelet fitness or survival in the marine and terrestrial environments are the priority conservation needs of the species. The FWS estimates recovery of the murrelet will require at least 50 years (USFWS 1997b).

Summary

The level of risk posed by some threats to the murrelet population may have been reduced as a result of the species' listing under the Act, such as the passage of the Oil Pollution Act and implementation of the NWFP. However, the FWS is not aware that any threats have been removed since listing and in some portions of the listed range, new threats (identified above) have been identified which affect the species at the local population or listed-entity scales. Currently, the FWS expects these threats to continue into the foreseeable future and those that cause direct mortality or reduce individual fitness are likely to contribute to murrelet population declines.

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

Considering the life history characteristics of the murrelet, the species' capability to recover from the mortality or reduced-fitness stressors is extremely low. The low observed reproductive rate causes the murrelet population to be highly sensitive to mortality and fitness-reducing stressors, particularly when they occur at a frequency which exceeds the species' loss-replacement rate. Despite the relatively long life span of murrelets and a reasonably high adult survival rate, the annual replacement rates needed for long-term population maintenance and stability is currently well below the annual rate of individuals being removed from each Conservation Zone.

Therefore, given the interactive effect of an extremely low fecundity and the current threats facing the species, it is reasonable to predict that the murrelet populations (in each Conservation Zone) throughout the listed range are likely to continue to decline. The decline is expected to continue until murrelet fecundity is significantly improved and the anthropogenic stressors affecting fitness, survivorship, and nest success are eliminated or sufficiently reduced.

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STATUS OF DESIGNATED CRITICAL HABITAT: MURRELET

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

Critical habitat is defined in section 3(5)(A) of the Act as "the specific area within the geographic area occupied by the species on which are found those physical or biological features essential to the conservation of the species, and that may require special management considerations or protection, and specific areas outside the geographical area occupied by a species at the time it is listed, upon determination that such areas are essential for the conservation of the species." The Act defines conservation as the procedures necessary to bring about the eventual recovery and delisting of a listed species.

Legal Status

The final rule designating critical habitat for the murrelet (61 FR 26256 [May 24, 1996]) became effective on June 24, 1996. Critical habitat was designation for the murrelet to addresses the objective of stabilizing population size. The principle factors affecting the murrelet and the main cause of its population decline has been the loss of older forests and associated nest sites and habitat fragmentation (57 FR 45328:45330 [October 1, 1992]). The selection criteria considered in choosing areas for inclusion in murrelet critical habitat included 1) suitable nesting habitat, 2) survey data, 3) proximity to marine foraging habitat, 4) large, contiguous blocks of nesting habitat, 5) opportunities to maintain current distribution, and 6) adequacy of existing protection and management.

Primary Constituent Elements

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. In the 1996 final rule designating critical habitat for the murrelet (61 FR 26255:26246 [May 24, 1996]), the Service identified two PCEs essential to provide and support suitable nesting habitat for successful reproduction. These are 1) individual trees with potential nesting platforms (PCE 1), and 2) all forested areas, regardless of contiguity, within 0.5 mi of individual trees with potential nesting platforms and a canopy height of at least one-half the site-potential tree height (PCE 2). Areas with just PCE 1, or both PCE 1 and 2 are, by definition, considered to be critical habitat. These PCEs were deemed essential for providing suitable nesting habitat for successful reproduction of the murrelet, and thus its conservation. PCEs require special management considerations.

Conservation Role of Critical Habitat

In some areas, large blocks of Federal land can provide the necessary contribution for recovery of the species. However, in other areas, Federal ownership is limited and Federal lands alone cannot meet the recovery needs of murrelets to reverse the current population decline and maintain a well-distributed population. Critical habitat helps focus conservation activities by identifying area that contain essential habitat features (PCEs) thus alerting Federal agencies and the public to the importance of an area in the species' conservation. Critical habitat also identifies area that may require special management or protection (61 FR 26255:26263 [May 24, 1996]).

Activities that May Affect PCEs

The final rule (61 FR 26255:26271[May 24, 1996]) states that "A variety of ongoing or proposed activities that disturb or remove primary constituent elements may adversely affect, though not necessarily 'adversely modify' murrelet critical habitat as that term is used in section 7 consultations. Examples of such activities include 1) forest management activities which greatly reduce stand canopy closure, appreciably alter the stand structure, or reduce the availability of nesting sites, 2) land disturbance activities such as mining, sand and gravel extraction, construction of hydroelectric facilities and road building, and 3) harvest of certain types of commercial forest products (e.g., moss [Bryophyta] and salal [*Gaultheria shallon*])." Ultimately, actions may alter PCEs if they remove or degrade forest habitat, or prevent or delay future attainment of suitable habitat.

Distribution of Critical Habitat

The designated CHUs are distributed more or less evenly across the range of the species in Washington and Oregon, and less so in California. At the time of listing, designated critical habitat lands included 695 of the over 807 known-occupied sites on Federal lands, and 218 of the 354 known-occupied sites on non-Federal lands. Sites in Redwood National Park in California had not been entered into the database at the time or listing. Further, the Service did not include the marine environment in critical habitat, but instead relied on other existing regulations for protection of this area.

Thirty-two critical habitat units (CHUs) totaling 3,887,800 acres were designated on Federal, state, county, city, and private lands in Washington, Oregon, and California (61 FR 26255:26269[May 24, 1996]) (Table 1). These individual units are coded by the state in which they occur and are individually numbered by unit and sub-unit (e.g., WA-01-a, OR-01-a, CA-01-a). The majority of these CHUs (78 percent) occur on Federal lands. In the selection of CHUs, there was a reliance on lands designated as Late Successional Reserves (LSRs) on Forest Service land. Most LSRs within the range of the murrelet in Washington, Oregon, and California were designated as critical habitat. LSRs, as described in the Northwest Forest Plan, are most likely to develop into large blocks of suitable murrelet nesting habitat given sufficient time.

Table 1. Designated critical habitat by state, ownership, and land allocation

State	Ownership	Land Allocation	Designated Critical Habitat (hectares)	Designated Critical Habitat (acres)
Washington	Federal Lands	Congressionally Withdrawn Lands	740	1,800
		Late Successional Reserves	485,680	1,200,200
		Federal Total	*486,240*	*1,202,000*
	Non-Federal Lands	State Lands	172,720	426,800
		Private Lands	1,020	2,500
		Non-Federal Total	*173,740*	*429,300*
		Washington's Overall Total	*659,980*	*1,631,300*
Oregon	Federal Lands	Late Successional Reserves	541,530	1,338,200
	Non-Federal Lands	State Lands	70,880	175,100
		County Lands	440	1,100
		Private Lands	350	900
California (Northern)	Federal Lands	Late Successional Reserves	193,150	477,300
	Non-Federal Lands	State Lands	71,040	175,500
		Private Lands	16,360	40,400
California (Central)	Non-Federal Lands	State Lands	14,080	34,800
		County Lands	3,200	8,000
		City Lands	400	1,000
		Private Lands	1,720	4,200
		Overall Total	*1,573,392*	*3,887,800*

Although most of the areas designated as murrelet critical habitat occur on Federal lands, the Service designated selected non-Federal lands that met the selection criteria. These lands occurred in areas where Federal lands were insufficient to provide suitable nesting habitat for the recovery of the species. On non-Federal lands, 21 percent of critical habitat acres occur on state lands, 1.2 percent on private lands, 0.2 percent on county lands, and 0.003 percent on city lands. CHUs do not include non-Federal lands covered by a legally operative incidental take permit for murrelets issued under section 10(a) of the Act (61 FR 26255:26278[May 24, 1996]). Therefore, critical habitat designations were excluded on state lands upon completion of the Habitat Conservation Plans that addresses conservation of the murrelet. State lands in Washington, Oregon and California currently operate under approved Habitat Conservation Plans (HCPs).

Critical Habitat in Washington State

Washington contains 11 CHUs that total approximately 1,206,000 acres (Appendix 1) (excluding 426,800 acres of State land managed under the WDNR HCP). The acreage of land protected by critical habitat and the WDNR (1997) HCP represents 42 percent of critical habitat within the listed range. Each CHU is made up of between two and seven subunits that range from 191 acres to over 100,000 acres in size. Also, CHUs range between 9 and 53 percent potential nesting habitat.

In Washington State, there is a clear reliance on Federal lands to fulfill the functions for which critical habitat was designated. Eight CHUs contain exclusively Federal lands while one contains both Federal and private lands. These nine CHUs contain 78 percent of the total acreage of CHUs in Washington State. Critical habitat functions are also met by Federal lands not designated as critical habitat in National Parks, Wilderness Areas, and portions of Forest Service lands designated as Adaptive Management Areas and Matrix lands that were found to be occupied by murrelets.

Current Condition of Critical Habitat in Washington

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

We estimate that an insignificant amount of critical habitat has been removed or downgraded as a result of section 7 consultations. In Washington, there has been almost no loss of critical habitat due to timber harvest or major fires. The majority of critical habitat loss has been through landslides and blow-down. In Washington, section 7 consultations are based on the amounts of critical habitat addressed in the final rule. The Service is currently in the process of assessing the current condition of murrelet critical habitat in Oregon and California.

Summary

Murrelet critical habitat was designated in 1996 due to the high rate of nesting habitat loss and fragmentation. The objective of the designation was to stabilize the murrelet population size. Washington contains 11 CHUs and totals 1,204,000 acres, the majority of which is on Federal land. The Service identified two primary constituent elements for the CHU, specifically 1) individual trees with potential nesting platforms, and 2) forested areas within 0.5 mi of individual trees with potential nesting platforms and a canopy height of at least one-half the site-potential tree height. Most of the areas designated as murrelet critical habitat occur on Federal land. The highest quality critical habitat occurs on National Parks and Wilderness areas where harvest historically has not occurred. Designating critical habitat in these areas was deemed unnecessary.

Appendix 1. Murrelet Critical Habitat Units (CHU) and Sub-Units in Washington (excludes land managed under the WDNR HCP)

CHU Name	Total Acres in CHU	Total Acres of Potential MAMU Nesting Habitat (2003)	Percent of CHU with Potential MAMU Habitat	Ownership
WA-01-a	60,454	20,286	34%	LSR
WA-01-b	8,200	3,687	45%	LSR
WA-02-a	15,941	8,373	53%	LSR
WA-02-b	1,982	803	40%	LSR
WA-02-c	46,342	21,821	47%	LSR
WA-02-d	412	125	30%	LSR
WA-03-a	97,834	35,045	36%	LSR
WA-03-b	64,993	18,734	29%	LSR
WA-05-b	401	111	28%	PRIVATE
WA-05-c	297	27	9%	PRIVATE
WA-05-d	327	42	13%	PRIVATE
WA-05-f	191	28	15%	PRIVATE
WA-05-g	218	50	23%	PRIVATE
WA-06-a	71,536	22,002	31%	LSR
WA-06-b	44,195	17,137	39%	LSR
WA-07-a	78,133	19,052	24%	LSR
WA-07-b	1,075	286	27%	PRIVATE
WA-07-c	88,699	35,592	40%	LSR
WA-07-d	24,112	9,290	39%	LSR
WA-08-a	85,202	28,082	33%	LSR
WA-08-b	20,399	7,757	38%	LSR
WA-09-a	1,826	761	42%	CWD (Navy)
WA-09-b	108,074	47,882	44%	LSR
WA-09-c	6,918	3,018	44%	LSR
WA-09-d	13,051	4,039	31%	LSR
WA-09-e	48,827	16,488	34%	LSR
WA-10-a	76,586	23,874	31%	LSR
WA-10-b	41,953	14,391	34%	LSR
WA-10-c	25,706	11,033	43%	LSR
WA-11-a	72,196	13,665	19%	LSR
WA-11-b	11,139	1,375	12%	LSR
WA-11-c	37,572	7,029	19%	LSR
WA-11-d	51,360	9,320	18%	LSR
Totals	**1,206,153**	**401,204**	**Average: 33%**	

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APPENDIX D – STATUS OF THE SPECIES – BULL TROUT AND DESIGNATED BULL TROUT CRITICAL HABITAT

Appendix D – Status of the Species – Bull Trout and Designated Bull Trout Critical Habitat

Listing Status

The coterminous United States population of the bull trout (*Salvelinus confluentus*) was listed as threatened on November 1, 1999 (64 FR 58910). The threatened bull trout generally occurs in the Klamath River Basin of south-central Oregon; the Jarbidge River in Nevada; the Willamette River Basin in Oregon; Pacific Coast drainages of Washington, including Puget Sound; major rivers in Idaho, Oregon, Washington, and Montana, within the Columbia River Basin; and the St. Mary-Belly River, east of the Continental Divide in northwestern Montana (Bond 1992, p. 2; Brewin and Brewin 1997, p. 215; Cavender 1978, pp. 165-166; Leary and Allendorf 1997, pp. 716-719).

Throughout its range, the bull trout are threatened by the combined effects of habitat degradation, fragmentation, and alterations associated with dewatering, road construction and maintenance, mining, grazing, the blockage of migratory corridors by dams or other diversion structures, poor water quality, entrainment (a process by which aquatic organisms are pulled through a diversion or other device) into diversion channels, and introduced non-native species (64 FR 58910). Although all salmonids are likely to be affected by climate change, bull trout are especially vulnerable given that spawning and rearing are constrained by their location in upper watersheds and the requirement for cold water temperatures (Battin et al. 2007, pp. 6672-6673; Rieman et al. 2007, p. 1552). Poaching and incidental mortality of bull trout during other targeted fisheries are additional threats.

The bull trout was initially listed as three separate Distinct Population Segments (DPSs) (63 FR 31647; 64 FR 17110). The preamble to the final listing rule for the United States coterminous population of the bull trout discusses the consolidation of these DPSs with the Columbia and Klamath population segments into one listed taxon and the application of the jeopardy standard under section 7 of the Act relative to this species (64 FR 58910):

> Although this rule consolidates the five bull trout DPSs into one listed taxon, based on conformance with the DPS policy for purposes of consultation under section 7 of the Act, we intend to retain recognition of each DPS in light of available scientific information relating to their uniqueness and significance. Under this approach, these DPSs will be treated as interim recovery units with respect to application of the jeopardy standard until an approved recovery plan is developed. Formal establishment of bull trout recovery units will occur during the recovery planning process.

Current Status and Conservation Needs

In recognition of available scientific information relating to their uniqueness and significance, five segments of the coterminous United States population of the bull trout are considered essential to the survival and recovery of this species and are identified as interim recovery units: 1) Jarbidge River, 2) Klamath River, 3) Columbia River, 4) Coastal-Puget Sound, and 5) St. Mary-Belly River (USFWS 2002a, pp. iv, 2, 7, 98; 2004a, Vol. 1 & 2, p. 1; 2004b, p. 1). Each of these interim recovery units is necessary to maintain the bull trout's distribution, as well as its genetic and phenotypic diversity, all of which are important to ensure the species' resilience to changing environmental conditions.

A summary of the current status and conservation needs of the bull trout within these interim recovery units is provided below and a comprehensive discussion is found in the Service's draft recovery plans for the bull trout (USFWS 2002a, pp. vi-viii; 2004a, Vol. 2 p. iii-x; 2004b, pp. iii-xii).

The conservation needs of bull trout are often generally expressed as the four "Cs": cold, clean, complex, and connected habitat. Cold stream temperatures, clean water quality that is relatively free of sediment and contaminants, complex channel characteristics (including abundant large wood and undercut banks), and large patches of such habitat that are well connected by unobstructed migratory pathways are all needed to promote conservation of bull trout at multiple scales ranging from the coterminous to local populations (a local population is a group of bull trout that spawn within a particular stream or portion of a stream system). The recovery planning process for bull trout (USFWS 2002a, pp. 49-50; 2004a, Vol 1 & 2 pp. 12-18; 2004b, pp. 60-86) has also identified the following conservation needs: 1) maintenance and restoration of multiple, interconnected populations in diverse habitats across the range of each interim recovery unit, 2) preservation of the diversity of life-history strategies, 3) maintenance of genetic and phenotypic diversity across the range of each interim recovery unit, and 4) establishment of a positive population trend. Recently, it has also been recognized that bull trout populations need to be protected from catastrophic fires across the range of each interim recovery unit (Rieman et al. 2003).

Central to the survival and recovery of bull trout is the maintenance of viable core areas (USFWS 2002a, pp. 53-54; 2004a, Vol. 1 pp. 210-218, Vol 2. pp. 61-62; 2004b, pp. 15-30, 64-67). A core area is defined as a geographic area occupied by one or more local bull trout populations that overlap in their use of rearing, foraging, migratory, and overwintering habitat. Each of the interim recovery units listed above consists of one or more core areas. There are 121 core areas recognized across the coterminous range of the bull trout (USFWS 2002a, pp. 6, 48, 98; 2004a, Vol. 1 p. vi, Vol. 2 pp. 14, 134; 2004b, pp. iv, 2; 2005, p. ii).

Jarbidge River Interim Recovery Unit

This interim recovery unit currently contains a single core area with six local populations. Less than 500 resident and migratory adult bull trout, representing about 50 to 125 spawning adults, are estimated to occur in the core area. The current condition of the bull trout in this interim recovery unit is attributed to the effects of livestock grazing, roads, incidental mortalities of released bull trout from recreational angling, historic angler harvest, timber harvest, and the introduction of non-native fishes (USFWS 2004b). The draft bull trout recovery plan (USFWS 2004b) identifies the following conservation needs for this interim recovery unit: 1) maintain the current distribution of the bull trout within the core area, 2) maintain stable or increasing trends in abundance of both resident and migratory bull trout in the core area, 3) restore and maintain suitable habitat conditions for all life history stages and forms, and 4) conserve genetic diversity and increase natural opportunities for genetic exchange between resident and migratory forms of the bull trout. An estimated 270 to 1,000 spawning bull trout per year are needed to provide for the persistence and viability of the core area and to support both resident and migratory adult bull trout (USFWS 2004b).

Klamath River Interim Recovery Unit

This interim recovery unit currently contains three core areas and seven local populations. The current abundance, distribution, and range of the bull trout in the Klamath River Basin are greatly reduced from historical levels due to habitat loss and degradation caused by reduced water quality, timber harvest, livestock grazing, water diversions, roads, and the introduction of non-native fishes (USFWS 2002a). Bull trout populations in this interim recovery unit face a high risk of extirpation (USFWS 2002a). The draft Klamath River bull trout recovery plan (USFWS 2002a) identifies the following conservation needs for this interim recovery unit: 1) maintain the current distribution of bull trout and restore distribution in previously occupied areas, 2) maintain stable or increasing trends in bull trout abundance, 3) restore and maintain suitable habitat conditions for all life history stages and strategies, 4) conserve genetic diversity and provide the opportunity for genetic exchange among appropriate core area populations. Eight to 15 new local populations and an increase in population size from about 2,400 adults currently to 8,250 adults are needed to provide for the persistence and viability of the three core areas (USFWS 2002a).

Columbia River Interim Recovery Unit

The Columbia River interim recovery unit includes bull trout residing in portions of Oregon, Washington, Idaho, and Montana. Bull trout are estimated to have occupied about 60 percent of the Columbia River Basin, and presently occur in 45 percent of the estimated historical range (Quigley and Arbelbide 1997, p. 1177). This interim recovery unit currently contains 97 core areas and 527 local populations. About 65 percent of these core areas and local populations occur in central Idaho and northwestern Montana. The Columbia River interim recovery unit has declined in overall range and numbers of fish (63 FR 31647). Although some strongholds still exist with migratory fish present, bull trout generally occur as isolated local populations in headwater lakes or tributaries where the migratory life history form has been lost. Though still widespread, there have been numerous local extirpations reported throughout the Columbia

River basin. In Idaho, for example, bull trout have been extirpated from 119 reaches in 28 streams (IDFG, in litt. 1995). The draft Columbia River bull trout recovery plan (USFWS 2002c) identifies the following conservation needs for this interim recovery unit: 1) maintain or expand the current distribution of the bull trout within core areas, 2) maintain stable or increasing trends in bull trout abundance, 3) restore and maintain suitable habitat conditions for all bull trout life history stages and strategies, and 4) conserve genetic diversity and provide opportunities for genetic exchange.

This interim recovery unit currently contains 97 core areas and 527 local populations. About 65 percent of these core areas and local populations occur in Idaho and northwestern Montana. The condition of the bull trout within these core areas varies from poor to good. All core areas have been subject to the combined effects of habitat degradation and fragmentation caused by the following activities: dewatering; road construction and maintenance; mining; grazing; the blockage of migratory corridors by dams or other diversion structures; poor water quality; incidental angler harvest; entrainment into diversion channels; and introduced non-native species. The Service completed a core area conservation assessment for the 5-year status review and determined that, of the 97 core areas in this interim recovery unit, 38 are at high risk of extirpation, 35 are at risk, 20 are at potential risk, 2 are at low risk, and 2 are at unknown risk (USFWS 2005, pp. 2, Map A, pp. 73-83).

Coastal-Puget Sound Interim Recovery Unit

Bull trout in the Coastal-Puget Sound interim recovery unit exhibit anadromous, adfluvial, fluvial, and resident life history patterns. The anadromous life history form is unique to this interim recovery unit. This interim recovery unit currently contains 14 core areas and 67 local populations (USFWS 2004a). Bull trout are distributed throughout most of the large rivers and associated tributary systems within this interim recovery unit. Bull trout continue to be present in nearly all major watersheds where they likely occurred historically, although local extirpations have occurred throughout this interim recovery unit. Many remaining populations are isolated or fragmented and abundance has declined, especially in the southeastern portion of the interim recovery unit. The current condition of the bull trout in this interim recovery unit is attributed to the adverse effects of dams, forest management practices (e.g., timber harvest and associated road building activities), agricultural practices (e.g., diking, water control structures, draining of wetlands, channelization, and the removal of riparian vegetation), livestock grazing, roads, mining, urbanization, poaching, incidental mortality from other targeted fisheries, and the introduction of non-native species. The draft Coastal-Puget Sound bull trout recovery plan (USFWS 2004a) identifies the following conservation needs for this interim recovery unit: 1) maintain or expand the current distribution of bull trout within existing core areas, 2) increase bull trout abundance to about 16,500 adults across all core areas, and 3) maintain or increase connectivity between local populations within each core area.

St. Mary-Belly River Interim Recovery Unit

This interim recovery unit currently contains six core areas and nine local populations (USFWS 2002b). Currently, bull trout are widely distributed in the St. Mary-Belly River drainage and occur in nearly all of the waters that it inhabited historically. Bull trout are found only in a 1.2-

mile reach of the North Fork Belly River within the United States. Redd count surveys of the North Fork Belly River documented an increase from 27 redds in 1995 to 119 redds in 1999. This increase was attributed primarily to protection from angler harvest (USFWS 2002b). The current condition of the bull trout in this interim recovery unit is primarily attributed to the effects of dams, water diversions, roads, mining, and the introduction of non-native fishes (USFWS 2002b). The draft St. Mary-Belly River bull trout recovery plan (USFWS 2002b) identifies the following conservation needs for this interim recovery unit: 1) maintain the current distribution of the bull trout and restore distribution in previously occupied areas, 2) maintain stable or increasing trends in bull trout abundance, 3) restore and maintain suitable habitat conditions for all life history stages and forms, 4) conserve genetic diversity and provide the opportunity for genetic exchange, and 5) establish good working relations with Canadian interests because local bull trout populations in this interim recovery unit are comprised mostly of migratory fish, whose habitat is mostly in Canada.

Life History

Bull trout exhibit both resident and migratory life history strategies. Both resident and migratory forms may be found together, and either form may produce offspring exhibiting either resident or migratory behavior (Rieman and McIntyre 1993, pp. 1-18) . Resident bull trout complete their entire life cycle in the tributary (or nearby) streams in which they spawn and rear. The resident form tends to be smaller than the migratory form at maturity and also produces fewer eggs (Fraley and Shepard 1989, p. 1; Goetz 1989, pp. 15-16). Migratory bull trout spawn in tributary streams where juvenile fish rear 1 to 4 years before migrating to either a lake (adfluvial form), river (fluvial form) (Fraley and Shepard 1989, pp. 135-137; Goetz 1989, pp. 22-25), or saltwater (anadromous form) to rear as subadults and to live as adults (Cavender 1978, pp. 139, 165-68; McPhail and Baxter 1996, p. 14; WDFW et al. 1997, pp. 17-18, 22-26). Bull trout normally reach sexual maturity in 4 to 7 years and may live longer than 12 years. They are iteroparous (they spawn more than once in a lifetime). Repeat- and alternate-year spawning has been reported, although repeat-spawning frequency and post-spawning mortality are not well documented (Fraley and Shepard 1989, pp. 135-137; Leathe and Graham 1982, p. 95; Pratt 1992, p. 6; Rieman and McIntyre 1996, p. 133).

The iteroparous reproductive strategy of bull trout has important repercussions for the management of this species. Bull trout require passage both upstream and downstream, not only for repeat spawning but also for foraging. Most fish ladders, however, were designed specifically for anadromous semelparous salmonids (fishes that spawn once and then die, and require only one-way passage upstream). Therefore, even dams or other barriers with fish passage facilities may be a factor in isolating bull trout populations if they do not provide a downstream passage route. Additionally, in some core areas, bull trout that migrate to marine waters must pass both upstream and downstream through areas with net fisheries at river mouths. This can increase the likelihood of mortality to bull trout during these spawning and foraging migrations.

Growth varies depending upon life-history strategy. Resident adults range from 6 to 12 inches total length, and migratory adults commonly reach 24 inches or more (Goetz 1989, pp. 29-32;

Pratt 1984, p. 13) The largest verified bull trout is a 32-pound specimen caught in Lake Pend Oreille, Idaho, in 1949 (Simpson and Wallace 1982).

Habitat Characteristics

Bull trout have more specific habitat requirements than most other salmonids (Rieman and McIntyre 1993, p. 7). Habitat components that influence bull trout distribution and abundance include water temperature, cover, channel form and stability, valley form, spawning and rearing substrate, and migratory corridors (Fraley and Shepard 1989, pp. 137, 141; Goetz 1989, pp. 19-26; Bond in Hoelscher and Bjornn 1989, p. 57; Howell and Buchanan 1992, p. 1; Pratt 1992, p. 6; Rich 1996, pp. 35-38; Rieman and McIntyre 1993, pp. 4-7; Rieman and McIntyre 1995, pp. 293-294; Sedell and Everest 1991, p. 1; Watson and Hillman 1997, pp. 246-250). Watson and Hillman (1997, pp. 247-249) concluded that watersheds must have specific physical characteristics to provide the habitat requirements necessary for bull trout to successfully spawn and rear and that these specific characteristics are not necessarily present throughout these watersheds. Because bull trout exhibit a patchy distribution, even in pristine habitats (Rieman and McIntyre 1993, p. 7), bull trout should not be expected to simultaneously occupy all available habitats (Rieman et al. 1997, p. 1560).

Migratory corridors link seasonal habitats for all bull trout life histories. The ability to migrate is important to the persistence of bull trout (Gilpin, in litt. 1997, pp. 4-5; Rieman and McIntyre 1993, p. 7; Rieman et al. 1997, p. 1114). Migrations facilitate gene flow among local populations when individuals from different local populations interbreed or stray to nonnatal streams. Local populations that are extirpated by catastrophic events may also become reestablished by bull trout migrants. However, it is important to note that the genetic structuring of bull trout indicates there is limited gene flow among bull trout populations, which may encourage local adaptation within individual populations, and that reestablishment of extirpated populations may take a long time (Rieman and McIntyre 1993, p. 7; Spruell et al. 1999, pp. 118-120). Migration also allows bull trout to access more abundant or larger prey, which facilitates growth and reproduction. Additional benefits of migration and its relationship to foraging are discussed below under “Diet.”

Cold water temperatures play an important role in determining bull trout habitat quality, as these fish are primarily found in colder streams (below 15 °C or 59 °F), and spawning habitats are generally characterized by temperatures that drop below 9 °C (48 °F) in the fall (Fraley and Shepard 1989, p. 133; Pratt 1992, p. 6; Rieman and McIntyre 1993, p. 7).

Thermal requirements for bull trout appear to differ at different life stages. Spawning areas are often associated with cold-water springs, groundwater infiltration, and the coldest streams in a given watershed (Baxter et al. 1997, pp. 426-427; Pratt 1992, p. 6; Rieman and McIntyre 1993, p. 7; Rieman et al. 1997, p. 1117). Optimum incubation temperatures for bull trout eggs range from 2 °C to 6 °C (35 °F to 39 °F) whereas optimum water temperatures for rearing range from about 6 °C to 10 °C (46 °F to 50 °F) (Buchanan and Gregory 1997, pp. 121-122; Goetz 1989, pp. 22-24; McPhail and Murray 1979, pp. 41, 50, 53, 55). In Granite Creek, Idaho, Bonneau and Scarnecchia (1996) observed that juvenile bull trout selected the coldest water available in a plunge pool, 8 °C to 9 °C (46 °F to 48 °F), within a temperature gradient of 8 °C to 15 °C (4 °F

to 60 °F). In a landscape study relating bull trout distribution to maximum water temperatures, Dunham et al. (2003) found that the probability of juvenile bull trout occurrence does not become high (i.e., greater than 0.75) until maximum temperatures decline to 11 °C to 12 °C (52 °F to 54 °F).

Although bull trout are found primarily in cold streams, occasionally these fish are found in larger, warmer river systems throughout the Columbia River basin (Buchanan and Gregory 1997, pp. 121-122; Fraley and Shepard 1989, pp. 135-137; Rieman and McIntyre 1993, p. 2; Rieman and McIntyre 1995, p. 288; Rieman et al. 1997, p. 1114). Availability and proximity of cold water patches and food productivity can influence bull trout ability to survive in warmer rivers (Myrick et al. 2002). For example, in a study in the Little Lost River of Idaho where bull trout were found at temperatures ranging from 8 °C to 20 °C (46 °F to 68 °F), most sites that had high densities of bull trout were in areas where primary productivity in streams had increased following a fire (Gamett, pers. comm. 2002).

All life history stages of bull trout are associated with complex forms of cover, including large woody debris, undercut banks, boulders, and pools (Fraley and Shepard 1989, pp. 135-137; Goetz 1989, pp. 22-25; Hoelscher and Bjornn 1989, p. 54; Pratt 1992, p. 6; Rich 1996, pp. 35-38; Sedell and Everest 1991, p. 1; Sexauer and James 1997, pp. 367-369; Thomas 1992, pp. 4-5; Watson and Hillman 1997, pp. 247-249). Maintaining bull trout habitat requires stability of stream channels and maintenance of natural flow patterns (Rieman and McIntyre 1993, p. 7). Juvenile and adult bull trout frequently inhabit side channels, stream margins, and pools with suitable cover (Sexauer and James 1997, pp. 367-369). These areas are sensitive to activities that directly or indirectly affect stream channel stability and alter natural flow patterns. For example, altered stream flow in the fall may disrupt bull trout during the spawning period, and channel instability may decrease survival of eggs and young juveniles in the gravel from winter through spring (Fraley and Shepard 1989, pp. 135-137; Pratt 1992, p. 6; Pratt and Huston 1993, pp. 70-72). Pratt (1992, p. 6) indicated that increases in fine sediment reduce egg survival and emergence.

Bull trout typically spawn from August through November during periods of increasing flows and decreasing water temperatures. Preferred spawning habitat consists of low-gradient stream reaches with loose, clean gravel (Fraley and Shepard 1989, p. 135). Redds are often constructed in stream reaches fed by springs or near other sources of cold groundwater (Goetz 1989, p. 15; Pratt 1992, p. 8; Rieman and McIntyre 1996, p. 133). Depending on water temperature, incubation is normally 100 to 145 days (Pratt 1992, p. 8). After hatching, fry remain in the substrate, and time from egg deposition to emergence may surpass 200 days. Fry normally emerge from early April through May, depending on water temperatures and increasing stream flows (Ratliff and Howell 1992 in Howell and Buchanan 1992, pp. 10, 15; Pratt 1992, pp. 5-6).

Early life stages of fish, specifically the developing embryo, require the highest inter-gravel dissolved oxygen (IGDO) levels, and are the most sensitive life stage to reduced oxygen levels. The oxygen demand of embryos depends on temperature and on stage of development, with the greatest IGDO required just prior to hatching.

A literature review conducted by the Washington Department of Ecology (WDOE 2002) indicates that adverse effects of lower oxygen concentrations on embryo survival are magnified as temperatures increase above optimal (for incubation). In a laboratory study conducted in Canada, researchers found that low oxygen levels retarded embryonic development in bull trout (Giles and Van der Zweep 1996, pp. 54-55). Normal oxygen levels seen in rivers used by bull trout during spawning ranged from 8 to 12 mg/L (in the gravel), with corresponding instream levels of 10 to 11.5 mg/L (Stewart et al. 2007). In addition, IGDO concentrations, water velocities in the water column, and especially the intergravel flow rate, are interrelated variables that affect the survival of incubating embryos (ODEQ 1995). Due to a long incubation period of 220+ days, bull trout are particularly sensitive to adequate IGDO levels. An IGDO level below 8 mg/L is likely to result in mortality of eggs, embryos, and fry.

Migratory forms of bull trout may develop when habitat conditions allow movement between spawning and rearing streams and larger rivers, lakes or nearshore marine habitat where foraging opportunities may be enhanced (Brenkman and Corbett 2005, pp. 1073, 1079-1080; Frissell 1993, p. 350; Goetz et al. 2004, pp. 45, 55, 60, 68, 77, 113-114, 123, 125-126). For example, multiple life history forms (e.g., resident and fluvial) and multiple migration patterns have been noted in the Grande Ronde River (Baxter 2002). Parts of this river system have retained habitat conditions that allow free movement between spawning and rearing areas and the mainstem Snake River. Such multiple life history strategies help to maintain the stability and persistence of bull trout populations to environmental changes. Benefits to migratory bull trout include greater growth in the more productive waters of larger streams, lakes, and marine waters; greater fecundity resulting in increased reproductive potential; and dispersing the population across space and time so that spawning streams may be recolonized should local populations suffer a catastrophic loss (Frissell 1999, pp. 15-16; MBTSG 1998, pp. iv, 48-50; Rieman and McIntyre 1993, pp. 18-19; USFWS 2004a, Vol. 2, p. 63). In the absence of the migratory bull trout life form, isolated populations cannot be replenished when disturbances make local habitats temporarily unsuitable. Therefore, the range of the species is diminished, and the potential for a greater reproductive contribution from larger fish with higher fecundity is lost (Rieman and McIntyre 1993, pp. 1-18).

Diet

Bull trout are opportunistic feeders, with food habits primarily a function of size and life-history strategy. A single optimal foraging strategy is not necessarily a consistent feature in the life of a fish, because this strategy can change as the fish progresses from one life stage to another (i.e., juvenile to subadult). Fish growth depends on the quantity and quality of food that is eaten (Gerking 1994), and as fish grow, their foraging strategy changes as their food changes, in quantity, size, or other characteristics. Resident and juvenile migratory bull trout prey on terrestrial and aquatic insects, macrozooplankton, and small fish (Boag 1987, p. 58; Donald and Alger 1993, pp. 239-243; Goetz 1989, pp. 33-34). Subadult and adult migratory bull trout feed on various fish species (Brown 1994, p. 21; Donald and Alger 1993, p. 242; Fraley and Shepard 1989, p. 135; Leathe and Graham 1982, p. 95). Bull trout of all sizes other than fry have been found to eat fish up to half their length (Beauchamp and VanTassell 2001). In nearshore marine areas of western Washington, bull trout feed on Pacific herring (*Clupea pallasi*), Pacific sand

lance (*Ammodytes hexapterus*), and surf smelt (*Hypomesus pretiosus*) (Goetz et al. 2004, p. 114; WDFW et al. 1997, p. 23).

Bull trout migration and life history strategies are closely related to their feeding and foraging strategies. Migration allows bull trout to access optimal foraging areas and exploit a wider variety of prey resources. Optimal foraging theory can be used to describe strategies fish use to choose between alternative sources of food by weighing the benefits and costs of capturing one source of food over another. For example, prey often occur in concentrated patches of abundance ("patch model") (Gerking 1994). As the predator feeds in one patch, the prey population is reduced, and it becomes more profitable for the predator to seek a new patch rather than continue feeding on the original one. This can be explained in terms of balancing energy acquired versus energy expended. For example, in the Skagit River system, anadromous bull trout make migrations as long as 121 miles between marine foraging areas in Puget Sound and headwater spawning grounds, foraging on salmon eggs and juvenile salmon along their migration route (WDFW et al. 1997). Anadromous bull trout also use marine waters as migration corridors to reach seasonal habitats in non-natal watersheds to forage and possibly overwinter (Brenkman and Corbett 2005, p. 1079; Goetz et al. 2004, pp. 36, 60).

Changes in Status of the Coastal-Puget Sound Interim Recovery Unit

Although the status of bull trout in Coastal-Puget Sound interim recovery unit has been improved by certain actions, it continues to be degraded by other actions, and it is likely that the overall status of the bull trout in this population segment has not improved since its listing on November 1, 1999. Improvement has occurred largely through changes in fishing regulations and habitat-restoration projects. Fishing regulations enacted in 1994 either eliminated harvest of bull trout or restricted the amount of harvest allowed, and this likely has had a positive influence on the abundance of bull trout. Improvement in habitat has occurred following restoration projects intended to benefit either bull trout or salmon, although monitoring the effectiveness of these projects seldom occurs. On the other hand, the status of this population segment has been adversely affected by a number of Federal and non-Federal actions, some of which were addressed under section 7 of the Act. Most of these actions degraded the environmental baseline; all of those addressed through formal consultation under section 7 of the Act permitted the incidental take of bull trout.

Section 10(a)(1)(B) permits have been issued for Habitat Conservation Plans (HCP) completed in the Coastal-Puget Sound population segment. These include: 1) the City of Seattle's Cedar River Watershed HCP, 2) Simpson Timber HCP (now Green Diamond Resources), 3) Tacoma Public Utilities Green River HCP, 4) Plum Creek Cascades HCP, 5) Washington State Department of Natural Resources (WSDNR) State Trust Lands HCP, 6) West Fork Timber HCP, and 7) WSDNR Forest Practices HCP. These HCPs provide landscape-scale conservation for fish, including bull trout. Many of the covered activities associated with these HCPs will contribute to conserving bull trout over the long-term; however, some covered activities will result in short-term degradation of the baseline. All HCPs permit the incidental take of bull trout.

Changes in Status of the Columbia River Interim Recovery Unit

The overall status of the Columbia River interim recovery unit has not changed appreciably since its listing on June 10, 1998. Populations of bull trout and their habitat in this area have been affected by a number of actions addressed under section 7 of the Act. Most of these actions resulted in degradation of the environmental baseline of bull trout habitat, and all permitted or analyzed the potential for incidental take of bull trout. The Plum Creek Cascades HCP, Plum Creek Native Fish HCP, Storedahl Daybreak Mine HCP, and WSDNR Forest Practices HCP addressed portions of the Columbia River population segment of bull trout.

Changes in Status of the Klamath River Interim Recovery Unit

Improvements in the Threemile, Sun, and Long Creek local populations have occurred through efforts to remove or reduce competition and hybridization with non-native salmonids, changes in fishing regulations, and habitat-restoration projects. Population status in the remaining local populations (Boulder-Dixon, Deming, Brownsworth, and Leonard Creeks) remains relatively unchanged. Grazing within bull trout watersheds throughout the recovery unit has been curtailed. Efforts at removal of non-native species of salmonids appear to have stabilized the Threemile and positively influenced the Sun Creek local populations. The results of similar efforts in Long Creek are inconclusive. Mark and recapture studies of bull trout in Long Creek indicate a larger migratory component than previously expected.

Although the status of specific local populations has been slightly improved by recovery actions, the overall status of Klamath River bull trout continues to be depressed. Factors considered threats to bull trout in the Klamath Basin at the time of listing – habitat loss and degradation caused by reduced water quality, past and present land use management practices, water diversions, roads, and non-native fishes – continue to be threats today.

Changes in Status of the Saint Mary-Belly River Interim Recovery Unit

The overall status of bull trout in the Saint Mary-Belly River interim recovery unit has not changed appreciably since its listing on November 1, 1999. Extensive research efforts have been conducted since listing, to better quantify populations of bull trout and their movement patterns. Limited efforts in the way of active recovery actions have occurred. Habitat occurs mostly on Federal and Tribal lands (Glacier National Park and the Blackfeet Nation). Known problems due to instream flow depletion, entrainment, and fish passage barriers resulting from operations of the U.S. Bureau of Reclamation's Milk River Irrigation Project (which transfers Saint Mary-Belly River water to the Missouri River Basin) and similar projects downstream in Canada constitute the primary threats to bull trout and to date they have not been adequately addressed under section 7 of the Act. Plans to upgrade the aging irrigation delivery system are being pursued, which has potential to mitigate some of these concerns but also the potential to intensify dewatering. A major fire in August 2006 severely burned the forested habitat in Red Eagle and Divide Creeks, potentially affecting three of nine local populations and degrading the baseline.

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STATUS OF BULL TROUT CRITICAL HABITAT (Rangewide)

Legal Status

Current Designation

The Service published a final critical habitat designation for the coterminous United States population of the bull trout on October 18, 2010 (70 FR 63898); the rule becomes effective on November 17, 2010. A justification document was also developed to support the rule and is available on our website (http://www.fws.gov/pacific/bulltrout). The scope of the designation involved the species' coterminous range, which includes the Jarbidge River, Klamath River, Columbia River, Coastal-Puget Sound, and Saint Mary-Belly River population segments (also considered as interim recovery units)[8]. Rangewide, the Service designated reservoirs/lakes and stream/shoreline miles as bull trout critical habitat (Table 1). Designated bull trout critical habitat is of two primary use types: 1) spawning and rearing, and 2) foraging, migration, and overwintering (FMO).

Table 1. Stream/shoreline distance and reservoir/lake area designated as bull trout critical habitat by state.

State	Stream/Shoreline Miles	Stream/Shoreline Kilometers	Reservoir /Lake Acres	Reservoir/ Lake Hectares
Idaho	8,771.6	14,116.5	170,217.5	68,884.9
Montana	3,056.5	4,918.9	221,470.7	89,626.4
Nevada	71.8	115.6	-	-
Oregon	2,835.9	4,563.9	30,255.5	12,244.0
Oregon/Idaho	107.7	173.3	-	-
Washington	3,793.3	6,104.8	66,308.1	26,834.0
Washington (marine)	753.8	1,213.2	-	-
Washington/Idaho	37.2	59.9	-	-
Washington/Oregon	301.3	484.8	-	-
Total	19,729.0	31,750.8	488,251.7	197,589.2

The 2010 revision increases the amount of designated bull trout critical habitat by approximately 76 percent for miles of stream/shoreline and by approximately 71 percent for acres of lakes and reservoirs compared to the 2005 designation.

This rule also identifies and designates as critical habitat approximately 1,323.7 km (822.5 miles) of streams/shorelines and 6,758.8 ha (16,701.3 acres) of lakes/reservoirs of unoccupied habitat to address bull trout conservation needs in specific geographic areas in several areas not occupied at the time of listing. No unoccupied habitat was included in the 2005 designation. These unoccupied areas were determined by the Service to be essential for restoring functioning

[8] The Service's 5 year review (USFWS 2008, pg. 9) identifies six draft recovery units. Until the bull trout draft recovery plan is finalized, the current five interim recovery units are in affect for purposes of section 7 jeopardy analysis and recovery. The adverse modification analysis does not rely on recovery units.

migratory bull trout populations based on currently available scientific information. These unoccupied areas often include lower main stem river environments that can provide seasonally important migration habitat for bull trout. This type of habitat is essential in areas where bull trout habitat and population loss over time necessitates reestablishing bull trout in currently unoccupied habitat areas to achieve recovery.

The final rule continues to exclude some critical habitat segments based on a careful balancing of the benefits of inclusion versus the benefits of exclusion. Critical habitat does not include: 1) waters adjacent to non-Federal lands covered by legally operative incidental take permits for habitat conservation plans (HCPs) issued under section 10(a)(1)(B) of the Endangered Species Act of 1973, as amended (Act), in which bull trout is a covered species on or before the publication of this final rule; 2) waters within or adjacent to Tribal lands subject to certain commitments to conserve bull trout or a conservation program that provides aquatic resource protection and restoration through collaborative efforts, and where the Tribes indicated that inclusion would impair their relationship with the Service; or 3) waters where impacts to national security have been identified (75 FR 63898). Excluded areas are approximately 10 percent of the stream/shoreline miles and 4 percent of the lakes and reservoir acreage of designated critical habitat. Each excluded area is identified in the relevant Critical Habitat Unit (CHU) text, as identified in paragraphs (e)(8) through (e)(41) of the final rule. See Tables Y and Z for the list of excluded areas. It is important to note that the exclusion of waterbodies from designated critical habitat does not negate or diminish their importance for bull trout conservation. Because exclusions reflect the often complex pattern of land ownership, designated critical habitat is often fragmented and interspersed with excluded stream segments.

Table 2.—Stream/shoreline distance excluded from bull trout critical habitat based on tribal ownership or other plan.

Ownership and/or Plan	Kilometers	Miles
Lewis River Hydro Conservation Easements	7.0	4.3
DOD – Dabob Bay Naval	23.9	14.8
HCP – Cedar River (City of Seattle)	25.8	16.0
HCP – Washington Forest Practices Lands	1,608.30	999.4
HCP – Green Diamond (Simpson)	104.2	64.7
HCP – Plum Creek Central Cascades (WA)	15.8	9.8
HCP – Plum Creek Native Fish (MT)	181.6	112.8
HCP–Stimson	7.7	4.8
HCP – WDNR Lands	230.9	149.5
Tribal – Blackfeet	82.1	51.0
Tribal – Hoh	4.0	2.5
Tribal – Jamestown S'Klallam	2.0	1.2
Tribal – Lower Elwha	4.6	2.8
Tribal – Lummi	56.7	35.3
Tribal – Muckleshoot	9.3	5.8
Tribal – Nooksack	8.3	5.1
Tribal – Puyallup	33.0	20.5
Tribal – Quileute	4.0	2.5
Tribal – Quinault	153.7	95.5
Tribal – Skokomish	26.2	16.3
Tribal – Stillaguamish	1.8	1.1
Tribal – Swinomish	45.2	28.1
Tribal – Tulalip	27.8	17.3
Tribal – Umatilla	62.6	38.9
Tribal – Warm Springs	260.5	161.9
Tribal – Yakama	107.9	67.1
Total	3,094.9	1,923.1

Table 3. Lake/Reservoir area excluded from bull trout critical habitat based on tribal ownership or other plan.

Ownership and/or Plan	Hectares	Acres
HCP – Cedar River (City of Seattle)	796.5	1,968.2
HCP – Washington Forest Practices Lands	5,689.1	14,058.1
HCP – Plum Creek Native Fish	32.2	79.7
Tribal – Blackfeet	886.1	2,189.5
Tribal – Warm Springs	445.3	1,100.4
Total	7,849.3	19,395.8

Conservation Role and Description of Critical Habitat

The conservation role of bull trout critical habitat is to support viable core area populations (75 FR 63898:63943 [October 18, 2010]). The core areas reflect the metapopulation structure of

bull trout and are the closest approximation of a biologically functioning unit for the purposes of recovery planning and risk analyses. CHUs generally encompass one or more core areas and may include FMO areas, outside of core areas, that are important to the survival and recovery of bull trout.

Thirty-two CHUs within the geographical area occupied by the species at the time of listing are designated under the revised rule. Twenty-nine of the CHUs contain all of the physical or biological features identified in this final rule and support multiple life-history requirements. Three of the mainstem river units in the Columbia and Snake River basins contain most of the physical or biological features necessary to support the bull trout's particular use of that habitat, other than those physical biological features associated with Primary Constituent Elements (PCEs) 5 and 6, which relate to breeding habitat.

The primary function of individual CHUs is to maintain and support core areas, which 1) contain bull trout populations with the demographic characteristics needed to ensure their persistence and contain the habitat needed to sustain those characteristics (Rieman and McIntyre 1993, p. 19); 2) provide for persistence of strong local populations, in part, by providing habitat conditions that encourage movement of migratory fish (MBTSG 1998, pp. 48-49; Rieman and McIntyre 1993, pp. 22-23); 3) are large enough to incorporate genetic and phenotypic diversity, but small enough to ensure connectivity between populations (Hard 1995, pp. 314-315; Healey and Prince 1995, p. 182; MBTSG 1998, pp. 48-49; Rieman and McIntyre 1993, pp. 22-23); and 4) are distributed throughout the historic range of the species to preserve both genetic and phenotypic adaptations (Hard 1995, pp. 321-322; MBTSG 1998, pp. 13-16; Rieman and Allendorf 2001, p. 763; Rieman and McIntyre 1993, p. 23).

The Olympic Peninsula and Puget Sound CHUs are essential to the conservation of amphidromous bull trout, which are unique to the Coastal-Puget Sound population segment. These CHUs contain marine nearshore and freshwater habitats, outside of core areas, that are used by bull trout from one or more core areas. These habitats, outside of core areas, contain PCEs that are critical to adult and subadult foraging, overwintering, and migration.

Primary Constituent Elements for Bull Trout

Within the designated critical habitat areas, the PCEs for bull trout are those habitat components that are essential for the primary biological needs of foraging, reproducing, rearing of young, dispersal, genetic exchange, or sheltering. Based on our current knowledge of the life history, biology, and ecology of this species and the characteristics of the habitat necessary to sustain its essential life-history functions, we have determined that the following PCEs are essential for the conservation of bull trout.

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

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

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

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

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

6. In spawning and rearing areas, substrate of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount of fine sediment, generally ranging in size from silt to coarse sand, embedded in larger substrates, is characteristic of these conditions. The size and amounts of fine sediment suitable to bull trout will likely vary from system to system.

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

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

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

The revised PCE's are similar to those previously in effect under the 2005 designation. The most significant modification is the addition of a ninth PCE to address the presence of nonnative predatory or competitive fish species. Although this PCE applies to both the freshwater and

marine environments, currently no non-native fish species are of concern in the marine environment, though this could change in the future.

Note that only PCEs 2, 3, 4, 5, and 8 apply to marine nearshore waters identified as critical habitat. Also, lakes and reservoirs within the CHUs also contain most of the physical or biological features necessary to support bull trout, with the exception of those associated with PCEs 1 and 6. Additionally, all except PCE 6 apply to FMO habitat designated as critical habitat.

Critical habitat includes the stream channels within the designated stream reaches and has a lateral extent as defined by the bankfull elevation on one bank to the bankfull elevation on the opposite bank. Bankfull elevation is the level at which water begins to leave the channel and move into the floodplain and is reached at a discharge that generally has a recurrence interval of 1 to 2 years on the annual flood series. If bankfull elevation is not evident on either bank, the ordinary high-water line must be used to determine the lateral extent of critical habitat. The lateral extent of designated lakes is defined by the perimeter of the waterbody as mapped on standard 1:24,000 scale topographic maps. The Service assumes in many cases this is the full-pool level of the waterbody. In areas where only one side of the waterbody is designated (where only one side is excluded), the mid-line of the waterbody represents the lateral extent of critical habitat.

In marine nearshore areas, the inshore extent of critical habitat is the mean higher high-water (MHHW) line, including the uppermost reach of the saltwater wedge within tidally influenced freshwater heads of estuaries. The MHHW line refers to the average of all the higher high-water heights of the two daily tidal levels. Marine critical habitat extends offshore to the depth of 10 meters (m) (33 ft) relative to the mean low low-water (MLLW) line (zero tidal level or average of all the lower low-water heights of the two daily tidal levels). This area between the MHHW line and minus 10 m MLLW line (the average extent of the photic zone) is considered the habitat most consistently used by bull trout in marine waters based on known use, forage fish availability, and ongoing migration studies and captures geological and ecological processes important to maintaining these habitats. This area contains essential foraging habitat and migration corridors such as estuaries, bays, inlets, shallow subtidal areas, and intertidal flats.

Adjacent shoreline riparian areas, bluffs, and uplands are not designated as critical habitat. However, it should be recognized that the quality of marine and freshwater habitat along streams, lakes, and shorelines is intrinsically related to the character of these adjacent features, and that human activities that occur outside of the designated critical habitat can have major effects on physical and biological features of the aquatic environment.

Activities that cause adverse effects to critical habitat are evaluated to determine if they are likely to “destroy or adversely modify” critical habitat by no longer serving the intended conservation role for the species or retaining those PCEs that relate to the ability of the area to at least periodically support the species. Activities that may destroy or adversely modify critical habitat are those that alter the PCEs to such an extent that the conservation value of critical habitat is appreciably reduced (75 FR 63898:63943; USFWS 2004, Vol. 1. pp. 140-193, Vol. 2. pp. 69-114). The Service’s evaluation must be conducted at the scale of the entire critical habitat

area designated, unless otherwise stated in the final critical habitat rule (USFWS and NMFS 1998, pp. 4-39). Thus, adverse modification of bull trout critical habitat is evaluated at the scale of the final designation, which includes the critical habitat designated for the Klamath River, Jarbidge River, Columbia River, Coastal-Puget Sound, and Saint Mary-Belly River population segments. However, we consider all 32 CHUs to contain features or areas essential to the conservation of the bull trout (75 FR 63898:63901, 63944). Therefore, if a proposed action would alter the physical or biological features of critical habitat to an extent that appreciably reduces the conservation function of one or more critical habitat units for bull trout, a finding of adverse modification of the entire designated critical habitat area may be warranted (75 FR 63898:63943).

Current Critical Habitat Condition Rangewide

The condition of bull trout critical habitat varies across its range from poor to good. Although still relatively widely distributed across its historic range, the bull trout occurs in low numbers in many areas, and populations are considered depressed or declining across much of its range (67 FR 71240). This condition reflects the condition of bull trout habitat. The decline of bull trout is primarily due to habitat degradation and fragmentation, blockage of migratory corridors, poor water quality, past fisheries management practices, impoundments, dams, water diversions, and the introduction of nonnative species (63 FR 31647, June 10 1998; 64 FR 17112, April 8, 1999).

There is widespread agreement in the scientific literature that many factors related to human activities have impacted bull trout and their habitat, and continue to do so. Among the many factors that contribute to degraded PCEs, those which appear to be particularly significant and have resulted in a legacy of degraded habitat conditions are as follows: 1) fragmentation and isolation of local populations due to the proliferation of dams and water diversions that have eliminated habitat, altered water flow and temperature regimes, and impeded migratory movements (Dunham and Rieman 1999, p. 652; Rieman and McIntyre 1993, p. 7); 2) degradation of spawning and rearing habitat and upper watershed areas, particularly alterations in sedimentation rates and water temperature, resulting from forest and rangeland practices and intensive development of roads (Fraley and Shepard 1989, p. 141; MBTSG 1998, pp. ii - v, 20-45); 3) the introduction and spread of nonnative fish species, particularly brook trout and lake trout, as a result of fish stocking and degraded habitat conditions, which compete with bull trout for limited resources and, in the case of brook trout, hybridize with bull trout (Leary et al. 1993, p. 857; Rieman et al. 2006, pp. 73-76); 4) in the Coastal-Puget Sound region where amphidromous bull trout occur, degradation of mainstem river FMO habitat, and the degradation and loss of marine nearshore foraging and migration habitat due to urban and residential development; and 5) degradation of FMO habitat resulting from reduced prey base, roads, agriculture, development, and dams.

Effects of Climate Change on Bull Trout Critical Habitat

One objective of the final rule was to identify and protect those habitats that provide resiliency for bull trout use in the face of climate change. Over a period of decades, climate change may directly threaten the integrity of the essential physical or biological features described in PCEs 1, 2, 3, 5, 7, 8, and 9. Protecting bull trout strongholds and cold water refugia from disturbance

and ensuring connectivity among populations were important considerations in addressing this potential impact. Additionally, climate change may exacerbate habitat degradation impacts both physically (e.g., decreased base flows, increased water temperatures) and biologically (e.g., increased competition with non-native fishes).

Consulted on Effects for Critical Habitat

The Service has formally consulted on the effects to bull trout critical habitat throughout its range. Section 7 consultations include actions that continue to degrade the environmental baseline in many cases. However, long-term restoration efforts have also been implemented that provide some improvement in the existing functions within some of the critical habitat units.

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