

**A Biological Assessment of Impacts to Aquatic Threatened Species
from Lost Man Creek Erosion Control and Disturbed Land Restoration Plan in
Redwood National and State Parks (RNSP)**

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I. INTRODUCTION

The purpose of this biological assessment (BA) is to determine the effects of the proposed Redwood National and State Parks (RNSP or “park”) actions in Lost Man Creek to control erosion and restore disturb lands on threatened salmonids and their habitats. RNSP intends this biological assessment, prepared in accordance with legal requirements set forth under Section 7 of the Endangered Species Act (19 U.S.C. 1536 (c)), to satisfy the Essential Fish Habitat consultation under the Magnuson-Stevens Act (16 U.S.C. 1801) with the National Marine Fisheries Service (NMFS).

Redwood National and State Parks (RNSP) are located in Humboldt and Del Norte Counties in northwestern California (see Map 1). The parks encompass 105,516 acres, of which approximately 50,000 acres were densely roaded and intensively harvested prior to acquisition by the parks. Since the 1978 expansion, RNSP has been actively performing watershed restoration work with the primary goal of reducing sediment transport from hillslope roads into streams on parklands in the downstream third of the Redwood Creek basin. Park staff also provides recommendations to landowners upstream of the park to identify and reduce erosion threats on privately owned land primarily managed for timber production.

In recent years, the physical presence of roads in the landscape has been documented to have a wide range of undesirable impacts on ecosystems. Roads have been clearly identified as the primary cause of accelerated erosion in the park, impacting numerous downslope and downstream riparian resources, including both aquatic and terrestrial habitats. This strategy will both reduce future erosion of soils into streams and restore natural watershed and ecosystem processes to parklands.

Hundreds of miles of haul and skid roads still remain untreated in the parks at this time. Winter storms and tectonic activities continue to accelerate erosion from these untreated roads above natural background levels. A major event could cause widespread damage to riparian and aquatic resources, old-growth forests, recovering second growth forests, and wetlands. As roads age and decay, progressively smaller storms have the potential to produce considerable resource damage. The proposed work will reduce future soil erosion in a watershed with high potential for large mass movements and road caused sedimentation to occur (see Appendix 3).

II. CONSULTATION TO DATE

Redwood National and State Parks obtained a list from the Arcata Fish and Wildlife Service Office identifying the endangered, threatened, and candidate species that may be present or may be affected by park activities, dated January 23, 2006 (Document Number 517497160-163835). This list included 27 species currently listed as threatened or endangered and four species that are candidates for listing in Humboldt and Del Norte Counties.

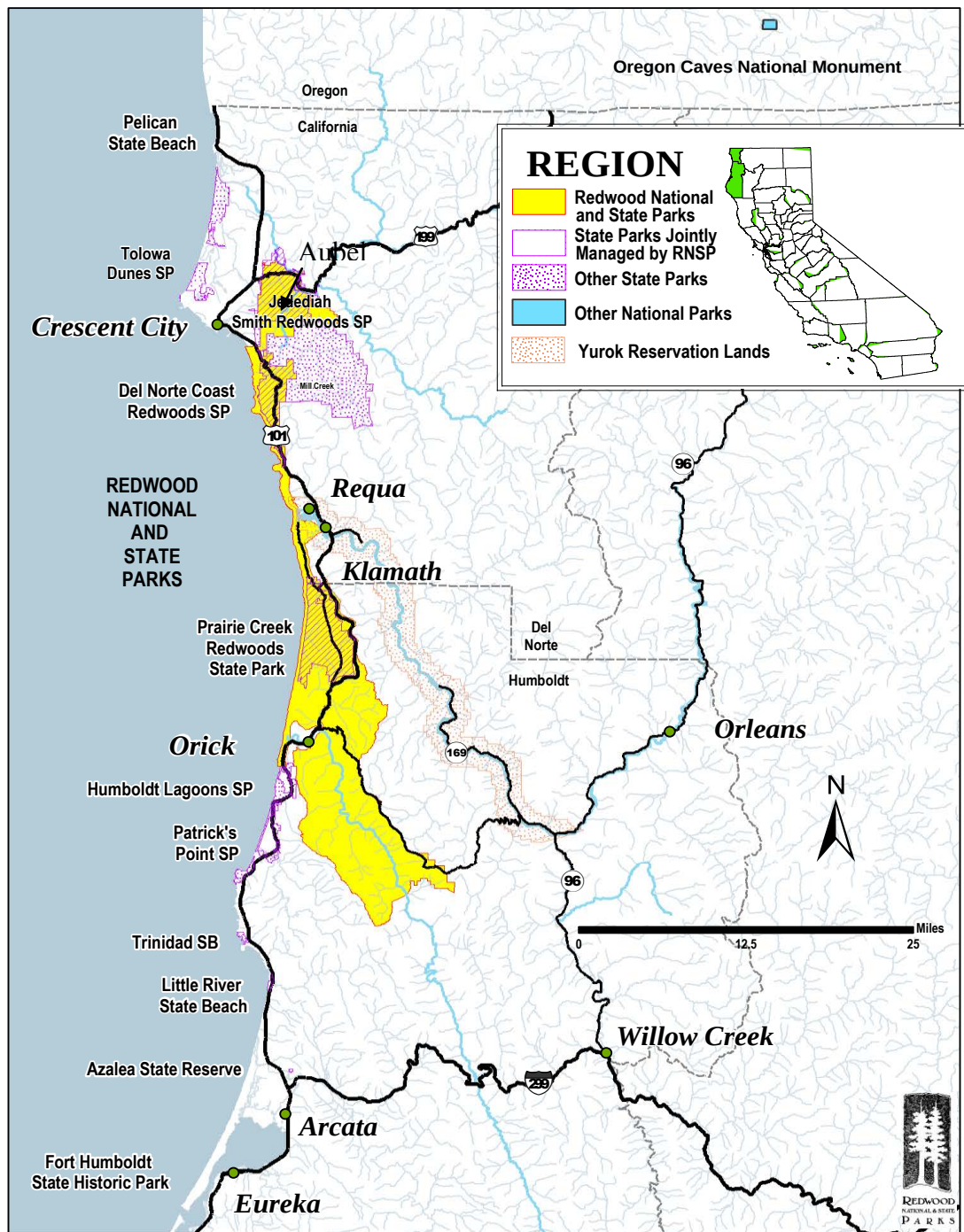
Of the 27 species listed for the two counties, three federally listed as threatened anadromous fish occur in RNSP. The three anadromous fish are the Southern Oregon/Northern California Coasts (SONCC) coho salmon (Oncorhynchus kisutch), the California Coastal (CC) chinook salmon (Oncorhynchus tshawytscha) [formerly part of the Southern Oregon/Northern California Coasts ESU for chinook salmon] (*Note:* Newly designated critical habitat for CC chinook (F.R. Vol. 70, No. 170 52488-52627 Sept. 2, 2005) and Northern California (NC) steelhead trout (Oncorhynchus mykiss) (F.R. Vol. 71, No. 3834-862 Jan. 5, 2006) went into effect January 2, 2006)]. The proposed action is located on federal lands within RNSP. The project identified in this assessment is located in designated critical habitat for the coho salmon, chinook salmon, and steelhead trout.

Informal consultation on this project began during an Interagency Consultation Team (ICT) field trip to South Fork Lost Man Creek on July 14, 2004. The intent of this trip was to view the A130 road, its stream crossings, and the various problems associated with erosion at this site. There were three ICT meetings on February 8 and 16, 2005 and March 9, 2005. During these meetings the geologists presented information regarding variables such as erosion potential, sediment yield volumes, and delivery potential along various roads and locations within the South Fork. Discussions took place regarding potential impacts to aquatic and terrestrial systems with and without road removal and with different levels of removal.

The presentations summarized preliminary field assessment data, various ways of using the data in order to develop and present potential alternatives for the EA, and finally several possible alternatives that meet the purpose and need of the proposed action. Discussions focused on data analysis methodology and treatment criteria for developing and analyzing alternatives.

Maps showed locations of all erosion sites, then sites color-coded with their associated erosion potential (EP) rating (high, medium or low). Next were pie charts showing volume of sediment from each road that would be delivered to the stream system (or “total yield”), first for all sites (335,446 cy), and then just for sites with medium or high EP (328,387 cy). The low EP sites represent only 2% of the total yield, indicating that the majority of the erosion is moderately or highly likely to happen in a large storm.

A second field trip to the A130 with personnel from AFWO took place on March 30, 2005. The purpose of this trip was to view the treatment site in terms of impacts on residual habitat and to assess the condition of the habitat at the very end of the road where mapping showed residual trees occurring close to the area that could potentially be affected by treatment. A skid road proposed as an alternate access route to the northern end of the A130 to avoid heavy equipment crossing South Fork Lost Man Creek also was observed. Part of this road is through the contiguous old growth block. Other access issues associated with this site were discussed and as well as the need to clearly define where/how access would occur.



Map 1. Redwood National & State Parks, Humboldt County and Del Norte County, California.

III. CURRENT MANAGEMENT DIRECTION

Redwood National and State Parks are located in Humboldt and Del Norte Counties in northwestern California and encompass 105,516 acres of land. Numerous federal and state laws, regulations, and policies guide management.

The National Park Service (NPS) Organic Act of 1916 states that national parks will be managed “to conserve the scenery and the natural and historic objects, and the wildlife therein, and to provide for the enjoyment of the same in such a manner and by such means as will leave them unimpaired for the enjoyment of future generations.”

The NPS Management Policies describe actions that shall be undertaken to restore disturbed lands:

“The Service will re-establish natural functions and processes in human-disturbed components of natural systems in parks unless otherwise directed by Congress. Landscapes disturbed by natural phenomena, such as landslides, earthquakes, floods, hurricanes, tornadoes, and fires, will be allowed to recover naturally unless manipulation is necessary to protect park developments or visitor safety. Impacts to natural systems resulting from human disturbances include the introduction of exotic species; the contamination of air, water, and soil; changes to hydrologic patterns and sediment transport; the acceleration of erosion and sedimentation; and the disruption of natural processes. The Service will seek to return human-disturbed areas to the natural conditions and processes characteristic of the ecological zone in which the damaged resources are situated. The Service will use the best available technology, within available resources, to restore the biological and physical components of these systems, accelerating both their recovery and the recovery of landscape and biological-community structure and function.”

The management of Redwood National Park is guided by the 1968 enabling legislation (PL 90-545) in which Congress established the Park to preserve significant examples of primeval coast redwood forest, and the streams and seashores with which they are associated, for purposes of public inspiration, enjoyment, and scientific study. The 1978 park expansion legislation (PL 95-250) added lands to create a more meaningful park for the use and enjoyment of the visitors, and directed the NPS to implement a watershed rehabilitation program to reduce erosion caused primarily by roads built in association with timber harvest.

Watershed Restoration

Public Law 95-250 was signed on March 27, 1978 adding 48,000 acres to Redwood National Park. This legislation authorized initiation of “...a program for rehabilitation of areas within...the park contributing significant sedimentation because of past logging disturbances and road conditions and, to the extent feasible, to reduce risk of damage to stream side areas adjacent to Redwood Creek...” In 1978 a watershed rehabilitation program was initiated that concentrates

on preventing human-induced erosion and encourages the return of natural vegetation patterns in the watersheds.

A Watershed Restoration Plan was developed in 1981 which guided restoration activity in the park until 1995 when a series of meetings, collectively referred to as a “Road Summit”, were held that resulted in an evaluation of the park’s road network. During the Road Summit, which ended in 1997, a long-term road access network and road classification were developed based on analyses of resources-at-risk (e.g. salmonids, old-growth redwoods), levels of use, and sediment risk from roads. Road treatment prioritization was developed at the sub-watershed level as this was viewed as the most appropriate scale to evaluate aquatic and riparian resource degradation. The prioritization was based on an approach that would protect the best existing aquatic and riparian habitats that are under the greatest threat of impacts from failing roads.

In 2003 in response to changing conditions and resource management needs, new road and resource information, and advances in technology since 1996, RNSP initiated a process of updating the road classification network and sub-watershed treatment prioritization. This was done by reanalyzing information from the original Road Summit using quantifiable, reproducible methods. The prioritization identified Lost Man Creek as the highest priority sub-watershed for restoration treatments within park lands in Redwood Creek.

The General Management Plan/General Plan and Environmental Impact Statement/Report for Redwood National and State Parks (USDI and CDPR 1999) provides comprehensive guidance for managing the national and state parks as one complex with similar resources. The General Management Plan/ General Plan (GMP) provides overall vision and direction for the parks and identifies future planning needs. Under the GMP, the agencies will emphasize the protection of resources and will also provide a variety of opportunities for visitors to enjoy the parks. New visitor services and facilities will be provided to enhance the visitor experience if these services and facilities do not impact sensitive resources. The park agencies will cooperate with adjacent communities and landowners, local American Indian tribes, and other government agencies to accomplish long-range resource management planning to reduce threats to park resources. Hiking, mountain biking, and camping are currently important components of the activities available to people that visit RNSP.

The GMP identifies individual action plans needed to address specific park actions such as estuary, second growth, trail, fire and fuels, vegetation, backcountry visitor use, and transportation management. Relative to management of listed threatened and endangered species the GMP directs park staff to “...avoid, minimize, rectify, reduce, compensate, or otherwise mitigate any potential adverse impacts on state or federally listed or proposed or candidate threatened or endangered species....” in association with construction, visitor use, or restoration activities (GMP p. 37). These actions will be achieved primarily by restricting work temporally and spatially so as not to disturb T&E species and by designating almost one-third of the parks as “primitive” zones where disturbance to all species from human activities would be limited to

those “...necessary to restore and maintain ecosystem function” (GMP p. 38).

The National Park Service signed the Interagency Memorandum of Understanding implementing the *Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl* (USDA and USDI 1994; Northwest Forest Plan ROD). National Park lands within the range of the northern spotted owl are designated as congressionally reserved. Redwood National and State Parks are managed using an ecosystem management strategy, similar to the strategy presented in the Northwest Forest Plan ROD. Implementation of RNSP operations consistent with federal and state enabling legislation (i.e., to preserve, and restore where needed, the old-growth forest ecosystem) will augment the lands designated as Riparian and Late Successional Reserves on other nearby federal lands. Redwood National and State Parks policies and guidelines relative to watershed restoration are similar to those outlined by the Aquatic Conservation Strategy in the Northwest Forest Plan ROD.

Section 7(a) 1 of the Endangered Species Act (ESA) of 1973, as amended, requires that federal agencies utilize their authorities in furtherance of the purposes of the ESA by carrying out programs for the conservation of endangered and threatened species. Section 7(a) 2 of the ESA requires that a federal agency, in consultation with and with the assistance of the Secretary of the Interior, ensures that any action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of any listed species or results in the destruction or adverse modification of critical habitat. Specific management direction for each of the listed threatened, endangered, or proposed species considered in this document is reviewed in Section V, “Status and Distribution of Listed Species”.

IV. DESCRIPTION OF THE PROPOSED ACTION

A. Overview

This project will remove failing, abandoned logging roads in ecologically sensitive Lost Man Creek watershed, a tributary to Prairie Creek. Work will include excavating road fill that is currently or has the potential for delivering sediment into sensitive stream channels that support valuable aquatic resources, and re-establishing topography and the stream channel network that existed prior to road construction.

The affected area of this project includes approximately 28 mi of abandoned and failing roads targeted for removal that are dispersed throughout 5,804 ac (2,349 ha) in the South Fork (including Manning Creek), Middle Fork, North Fork (including Larry Damm Creek), and Little Lost Man sub-basins of Lost Man Creek. Sediment production from these roads is estimated at over **300,000** cubic yards during the next hundred years. The total area of ground disturbance estimated to result from restoration activities would be 215.8 ac (87.3 ha), or 3.7% of the project area (see Map 2).

This project is proposed for implementation under the Line Item Construction Program, with funding beginning in 2006 and continuing through 2009.

B. NARRATIVE OF THE PROPOSED ACTION BY IMPLEMENTATION YEAR

2006

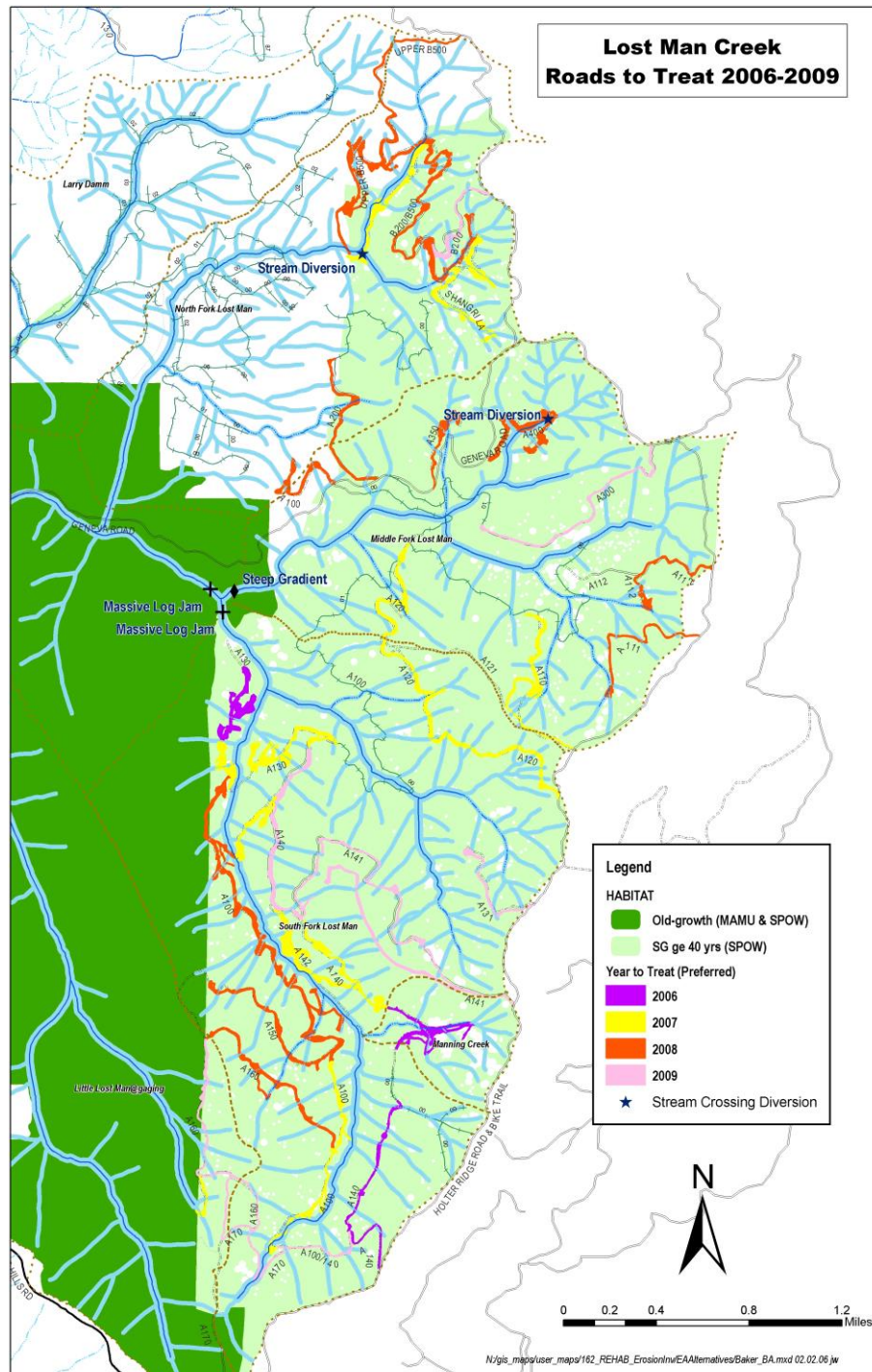
Watershed restoration efforts will remove 2.58 miles of road from portions of the A130 and A140 roads in the South Fork Lost Man and Manning Creek sub-watersheds in 2006. This will include 6 stream crossings in the South Fork Lost Man basin and 10 stream crossings in the Manning Creek sub-basin. Associated with stream crossing removal, there will 0.55 miles of road fully recontoured to mimic pre-road topography, and 17,738 c.y. of fill material will be excavated in order to prevent 16,401 c.y. of erosion with a potential to deliver 11,501 c.y. of sediment to the stream network. Between these stream crossings 1.76 miles of road will be fully recontoured to mimic pre-road topography, while 0.37 miles of road will be partially recontoured to provide hydrologic transparency to the road corridor. Road fill excavation not associated with stream crossings will be 34,068 c.y. in order to prevent 72,269 c.y. of sediment from potentially entering aquatic habitat, and 3056 c.y. of sediment from potentially damaging terrestrial resources. Disturbance area associated with the proposed 2006 watershed restoration projects will be 18.58 acres, with 3.96 acres of that area being within 100 ft of a stream. The closest worksite to the South Fork Lost Man fish barrier is on the A130 road at a distance of 56.16m.

A130

The A130 Road is located along the west side of the main stem of the South Fork of Lost Man Creek. The A130 is recognized as having the largest erosion potential in the Lost Man Creek drainage. The A130 is associated with a landscape heavily impacted by a large concentration of skid roads. The A130 and the associated skid roads are in an advanced stage of active erosion and are contributing a considerable amount of sediment to the South Fork of Lost Man Creek.

The A130 is located above the inner gorge of the South Fork and all proposed restoration along the A130 and associated skid roads will occur outside of the inner gorge. Restoration is not expected to impact any riparian vegetation along the main stem of the South Fork of Lost Man Creek. However, restoration of all stream crossings along the A130 will result in the removal of vegetation.

The A130 is underlain by the Franciscan formation. This material is prone towards more massive earth flow and block slides and much of the landscape associated with the A130 is located within active slides. Portions of the A130 are already obliterated by past failures. The northern most portion of the A130 will not be treated due to the loss of access from several past failures. While these mass wasting features are not to be treated, the interrupted drainage problems associated with the road network will be remedied to minimize future aggravation of these features.



Map 2. Proposed Project Area

The following four tables contains statistical information for the Lost Man Creek Watershed Restoration by proposed project year.

Additional Information for Lost Man Creek Watershed Restoration FY 2006	Streams					
	North	Middle	Mannin g	South	Little	Larry
Miles of Road Treated:	0.00	0.00	1.07	1.51	0.00	0.00
STREAM CROSSINGS:						
Number of Stream Crossings Removed:	0	0	10	6	0	0
Length of Road Fully removed and Recontoured:	0.00	0.00	0.32	0.13	0.00	0.00
Volume of Road Fill Excavated:	0	0	13971	3767	0	0
Volume of Sediment Prevented from Eroding:	0	0	13551	2850	0	0
Volume of Sediment Prevented from Delivering:	0	0	9551	1950	0	0
ROADS BETWEEN STREAM CROSSINGS:						
Length of Road Fully Removed and Recontoured:	0.00	0.00	0.67	1.09	0.00	0.00
Length of Road Partially Recontoured:	0.00	0.00	0.08	0.29	0.00	0.00
Volume of Road fill Excavated:	0	0	12536	21532	0	0
Volume of Sediment Prevented from Eroding that would Damage Aquatic Habitat:	0	0	14703	57566	0	0
Volume of Sediment Prevented from Eroding that would Damage Terrestrial Habitat:	0	0	270	2786	0	0
DISTURBANCE AREA:						
Total area of Restoration Disturbance (acres):			6.31	12.27		
Area of Restoration Disturbance in Riparian Buffers (100ft each side of stream):			2.77	1.19		
STREAM DISTANCE BETWEEN DISTURBANCE AND FISH BARRIERS (closet worksite)						
Main Stem Barrier (meters):		n/a				
South Fork Barrier (meters):				56.16		
Distance from South Fork to Main Stem Barrier: 574.80m				(A13 0)		

The A130 is located adjacent to intact old growth forest and all restoration is restricted to the period of September 15th to October 15th. Based upon preliminary field reconnaissance, it is estimated that it will take 3 seasons to complete all the restoration work along the A130 and surrounding hillslopes.

A140 in Manning Creek

Manning Creek is the last major tributary on the south fork. It is a low flow perennial stream with a steep gradient. The portion of Manning Creek above the A140 was heavily impacted by a large landing / stream crossing, an intersection of two skid roads that meet in the channel, and another skid intersection approximately 800 feet upstream of the lower intersection. There are also three minor skid road crossings on a tributary to Manning Creek that converges at the site of the landing on the A140.

Most of the excavation work planned for the Lost Man project is concentrated in this area. Not coincidentally, it is also one of the most concentrated areas of disturbance. There is active erosion in all portions of the channel fills and along road prisms constructed along the upper banks of the channel. Even with the highest levels of post-excavation sediment input (based on Larry Damm monitoring), annual sediment production from this area will be reduced in the first season (2006/2007) following road removal.

2007

Watershed restoration efforts will remove 8.24 miles of road from portions of the A100 (south), A130, A140 and Shangri La roads and the entire length of the A110, A120, A121, A142, A160-1 and North Branch North Fork roads. The work will be distributed amongst the North Fork, Middle Fork, South Fork, Little Lost Man and Larry Damm sub-watersheds in 2007. This will include 14 stream crossings in the North Fork Lost Man basin; 3 stream crossings in the Middle Fork Lost Man basin; 34 stream crossings in the South Fork Lost Man basin; 1 stream crossing in the Little Lost Man basin. Associated with stream crossing removal, there will 1.59 miles of road fully recontoured to mimic pre-road topography, and 62,192 c.y. of fill material will be excavated in order to prevent 57,361 c.y. of erosion with a potential to deliver 57,060 c.y. of sediment to the stream network. Between these stream crossings 3.74 miles of road will be fully recontoured to mimic pre-road topography, while 2.86 miles of road will be partially recontoured to provide hydrologic transparency to the road corridor. Road fill excavation not associated with stream crossings will be 120,028 c.y. in order to prevent 98,731 c.y. of sediment from potentially entering aquatic habitat, and 1,622 c.y. of sediment from potentially damaging terrestrial resources. Disturbance area associated with the proposed 2007 watershed restoration projects will be 76.55 acres, with 21.58 acres of that area being within 100 ft of a stream. The closest worksite to the South Fork Lost Man fish barrier is on the A130 road at a distance of 877.73m. The closest worksite to the Main Stem Lost Man fish barrier is on the A120 road at a distance of 1946.14m.

A142

The A142 is presently a series of remnant segments of a haul road constructed below the A140 on the upper portion of the south fork. A landing was constructed approximately 100 feet above the channel just before the point where the A142 ran onto the flood plain of the South Fork Lost Man Creek. It is anticipated that road removal work will begin at this landing, minimizing the amount of excavation work adjacent to the south fork.

Shangri La Road

The Shangri La Road is located in the north fork drainage of Lost Man Creek. It is predominately underlain by the Prairie Creek Formation which is the most erodible formation in the Lost Man Creek drainage. The Shangri La Road is located in the upper portion of the drainage and is situated within the inner gorge of two tributaries to the North Fork.

The Shangri La Road has three large landings that were constructed in intermittent stream courses. One is located at the confluence of three flow courses and will result in a considerable amount of vegetation removal. The other two are located in single tributaries that will result in disturbance to both riparian and surrounding hillslope vegetation.

Removal of the Shangri La Road is expected to take 2 seasons. The majority of the stream crossing removals will occur in the first season, scheduled for 2007. The remaining portion, which includes several smaller stream crossings, is scheduled for 2008.

North Branch North Fork Road

The North branch north fork road is a haul road, constructed along a 0.64 mile segment of the southwest bank of the creek. The road bench is typically 50 feet above the channel, road prism fill often extending to the flood plain elevation. Two major landings and a large stream crossing were constructed burying the original channel with approximately 10 to 20 feet of fill. The lower landing, at the terminus of the north branch north fork road, is considerably the larger of the two, built at the confluence of the north branch and the south branch of the north fork.

Of all the road removal work identified in the Lost Man Creek project area, this road represents one of the largest potential short term impacts to fisheries following the road removal treatment. An estimated 16,600 cubic yards of landing and stream crossing fill are prescribed to be removed from three locations in the north branch channel in 2007. Based on past monitoring data from the Larry Damm Creek project, an estimated 232 cubic yards of material may be activated into live stream flow during the first portion of winter storms in 2007 / 2008. All road features in the north branch channel are currently eroding, with the potential to deliver comparable quantities of sediment in any given storm event.

Additional Information for Lost Man Creek Watershed Restoration FY 2007	Streams					
	North	Middle	Mannin g	South	Little	Larry
Miles of Road Treated:	1.70	0.91	0.00	5.44	0.19	0.00
STREAM CROSSINGS:						
Number of Stream Crossings Removed:	14	3	0	34	1	0
Length of Road Fully removed and Recontoured:	0.61	0.04	0.00	0.87	0.11	0.00
Volume of Road Fill Excavated:	25883	293	0	35519	497	0
Volume of Sediment Prevented from Eroding:	22603	174	0	34208	376	0
Volume of Sediment Prevented from Delivering:	22511	145	0	34028	376	0
ROADS BETWEEN STREAM CROSSINGS:						
Length of Road Fully Removed and Recontoured:	1.09	0.21	0.00	2.37	0.07	0.00
Length of Road Partially Recontoured:	0.00	0.66	0.00	2.20	0.00	0.00
Volume of Road fill Excavated:	26449	10676	0	82116	787	0
Volume of Sediment Prevented from Eroding that would Damage Aquatic Habitat:	17793	4011	0	75847	1080	0
Volume of Sediment Prevented from Eroding that would Damage Terrestrial Habitat:	0	208	0	1414	0	0
DISTURBANCE AREA:						
Total area of Restoration Disturbance (acres):	14.78	11.49	0.06	49.21	1.01	0
Area of Restoration Disturbance in Riparian Buffers (100ft each side of stream):	8.09	1.98	0	11.18	0.33	0
STREAM DISTANCE BETWEEN DISTURBANCE AND FISH BARRIERS (closet worksite)						
Main Stem Barrier (meters):		1946.14 m				
South Fork Barrier (meters):				877.73 m		
Distance from South Fork to Main Stem Barrier: 574.80m		(A120)		(A130)		

2008

Watershed restoration efforts will remove 10.36 miles of road from portions of the A100 (south), A130, A160 and Shangri La roads and the entire length of the A100 (North), A111, A112, A150, A200, A350, A400, B200/B500 connector, and Upper B500 roads. The work will be distributed amongst the North Fork, Middle Fork, South Fork Lost Man, and Larry Damm sub-watersheds in 2008. This will include 18 stream crossings in the North Fork Lost Man basin; 19 stream crossings in the Middle Fork Lost Man basin; 40 stream crossings in the South Fork Lost Man basin. Associated with stream crossing removal, there will 1.8 miles of road fully recontoured to mimic pre-road topography, and 54,505 c.y. of fill material will be excavated in order to prevent 58,308 c.y. of erosion with a potential to deliver 55,763 c.y. of sediment to the stream network. Between these stream crossings 3.93 miles of road will be fully recontoured to mimic pre-road topography, while 4.64 miles of road will be partially recontoured to provide hydrologic transparency to the road corridor. Road fill excavation not associated with stream crossings will be 114,630 c.y. in order to prevent 62,404 c.y. of sediment from potentially entering aquatic habitat, and 2,926 c.y. of sediment from potentially damaging terrestrial resources. Disturbance area associated with the proposed 2008 watershed restoration projects will be 85.73 acres, with 22.97 acres of that area being within 100 ft of a stream. The closest worksite to the South Fork Lost Man fish barrier is on the A100 road at a distance of 1385.08m. The closest worksite to the Main Stem Lost Man fish barrier is on the A350 road at a distance of 1760.22m.

A100 (South) Road

The A100 (South) Road is located above the inner gorge of the main stem of South Fork Lost Man Creek. It bridges the main stem of South Fork Lost Man Creek via a collapsing log stringer bridge. Restoration will entail removing the old stringers and pulling back the perched fill along the creek's banks. The road bench of the A100 was cleared in 2000. Removing the bridge will not impact any riparian vegetation, but will leave side banks vulnerable to post-excavation adjustment. These will be adequately mulched according to the mulching guidelines for the restoration program. This crossing is located within the old growth buffer and will not be treated until after September 15th. The main stem of the South Fork will be diverted during the excavation and removal of the crossing. This crossing is expected to be removed in 2008.

A400 road

The A400 road is a short haul road built off the south side of the Geneva road in the middle fork of Lost Man Creek. The road is predominantly constructed adjacent to, but above the channel. One location along the A400 has the possibility for relatively minor post excavation impacts.

At a point where the A400 crosses the middle branch of the middle fork, three stream crossings will be excavated within close proximity to each other. This area will likely have an acre or more of restored landscape with surrounding both ephemeral and a low flow perennial channel. The terrain in this area is relatively gentle and should be on the lower end on surface erosion production. The project is scheduled for implementation in 2008.

Additional Information for Lost Man Creek Watershed Restoration FY 2008	Streams					
	North	Middle	Mannin g	South	Little	Larry
Miles of Road Treated:	3.96	3.36	0.00	3.04	0.00	0.00
STREAM CROSSINGS:						
Number of Stream Crossings Removed:	18	19	0	40	0	0
Length of Road Fully removed and Recontoured:	0.33	0.32	0.00	1.15	0.00	0.00
Volume of Road Fill Excavated:	19285	25216	0	10004	0	0
Volume of Sediment Prevented from Eroding:	17808	25193	0	15307	0	0
Volume of Sediment Prevented from Delivering:	17742	23040	0	14981	0	0
ROADS BETWEEN STREAM CROSSINGS:						
Length of Road Fully Removed and Recontoured:	1.90	1.52	0.00	0.51	0.00	0.00
Length of Road Partially Recontoured:	1.73	1.52	0.00	1.39	0.00	0.00
Volume of Road fill Excavated:	48679	41043	0	24908	0	0
Volume of Sediment Prevented from Eroding that would Damage Aquatic Habitat:	26918	26688	0	8798	0	0
Volume of Sediment Prevented from Eroding that would Damage Terrestrial Habitat:	2739	20	0	167	0	0
DISTURBANCE AREA:						
Total area of Restoration Disturbance (acres):	31.25	21.58	0	31.74	0.09	1.07
Area of Restoration Disturbance in Riparian Buffers (100ft each side of stream):	8.52	6.77	0	7.64	0	0.04
STREAM DISTANCE BETWEEN DISTURBANCE AND FISH BARRIERS (closet worksite)						
Main Stem Barrier (meters):		1760.22 m				
South Fork Barrier (meters):				1385.08 m		
Distance from South Fork to Main Stem Barrier: 574.80m		(A350)		(A100)		

2009

Watershed restoration efforts will remove 9.74 miles of road from portions of the A100 (south), A140 and A160 roads and the entire length of the A100/A140 Connector, A131, A141, A170/A160 Connector, A300 and B200 roads. The work will be distributed amongst the North Fork, Middle Fork, South Fork, and Little Lost Man sub-watersheds in 2009. This will include 2 stream crossings in the North Fork Lost Man basin; 3 stream crossings in the Middle Fork Lost Man basin; 12 stream crossings in the South Fork Lost Man basin; 1 stream crossing in the Little Lost Man basin. Associated with stream crossing removal, there will 0.34 miles of road fully recontoured to mimic pre-road topography, and 12,465 c.y. of fill material will be excavated in order to prevent 8,245 c.y. of erosion with a potential to deliver 7,319 c.y. of sediment to the stream network. Between these stream crossings 3.12 miles of road will be fully recontoured to mimic pre-road topography, while 6.27 miles of road will be partially recontoured to provide hydrologic transparency to the road corridor. Road fill excavation not associated with stream crossings will be 129,458 c.y. in order to prevent 54,223 c.y. of sediment from potentially entering aquatic habitat, and 7,513 c.y. of sediment from potentially damaging terrestrial resources. Disturbance area associated with the proposed 2009 watershed restoration projects will be 38.97 acres, with 5.5 acres of that area being within 100 ft of a stream. The closest worksite to the South Fork Lost Man fish barrier is on the A140 road at a distance of 1442.09 m. The closest worksite to the Main Stem Lost Man fish barrier is on the A300 road at a distance of 2779.13 m.

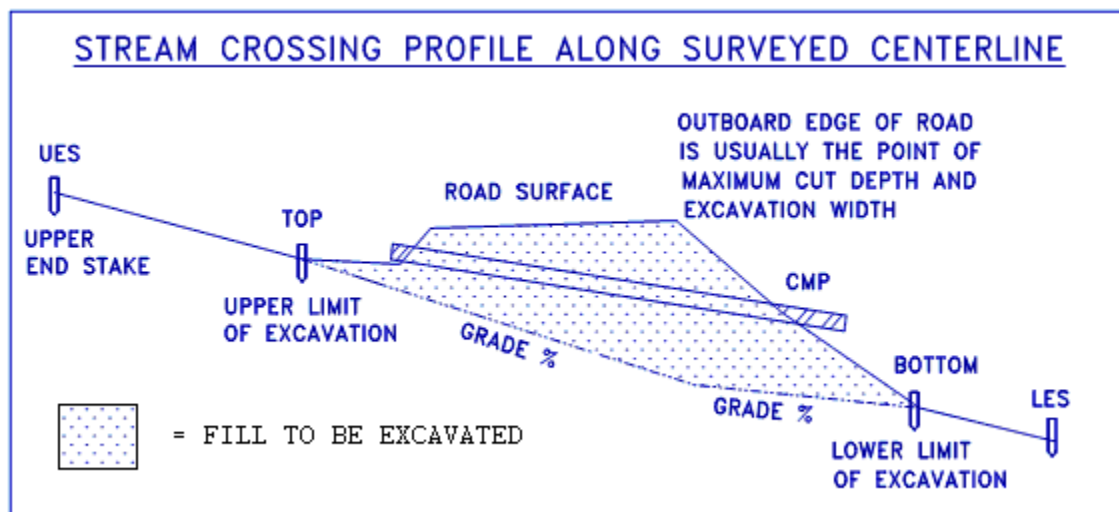
C. Watershed Restoration Methods

Redwood National and State Parks has been developing watershed restoration techniques over a 27-year period, and has become known for the skilled use of heavy equipment, primarily excavators and bulldozers, for disturbed lands restoration. Restoration will focus primarily on removing fill from stream channels and headwater swales, stabilizing sidecast fill material, and restoring natural hillslope topography and drainage patterns. Removal of roads and skid roads will include retrieving material sidecast during road construction, excavating stream crossing fill material, placing the excavated material in stable locations and shaping it to blend with the surrounding topography. In areas needing treatment, the goal is to re-create landforms that existed prior to road construction as much as is reasonably feasible. Stream crossings will be excavated to near original width, depth and slope to expose natural channel armor. Side slopes will generally match original contours above and below the road. Material excavated from the channels will be placed in stable locations away from streams. Road reaches will be recontoured, with excavated material placed against the cutbank locally (outsloping) or, where slopes are potentially unstable, moved to stable locations (exported outsloping). All excavated material is shaped to mimic and blend with the surrounding topography, recreating natural landforms and drainage patterns.

Additional Information for Lost Man Creek Watershed Restoration FY 2009	Streams					
	North	Middle	Manning	South	Little	Larry
Miles of Road Treated:	0.93	1.16	0.00	7.31	0.34	0.00
STREAM CROSSINGS:						
Number of Stream Crossings Removed:	2	3	0	12	1	0
Length of Road Fully removed and Recontoured:	0.03	0.04	0.00	0.25	0.02	0.00
Volume of Road Fill Excavated:	615	1531	0	9784	535	0
Volume of Sediment Prevented from Eroding:	520	1531	0	5855	339	0
Volume of Sediment Prevented from Delivering:	520	870	0	5590	339	0
ROADS BETWEEN STREAM CROSSINGS:						
Length of Road Fully Removed and Recontoured:	0.17	0.91	0.00	1.77	0.27	0.00
Length of Road Partially Recontoured:	0.73	0.21	0.00	5.29	0.04	0.00
Volume of Road fill Excavated:	9374	14833	0	101585	3666	0
Volume of Sediment Prevented from Eroding that would Damage Aquatic Habitat:	518	8694	0	42299	2712	0
Volume of Sediment Prevented from Eroding that would Damage Terrestrial Habitat:	700	601	0	6212	0	0
DISTURBANCE AREA:						
Total area of Restoration Disturbance (acres):	3.59	4.68	0.69	25.66	4.35	0
Area of Restoration Disturbance in Riparian Buffers (100ft each side of stream):	0.54	0.18	0	4.19	0.59	0
STREAM DISTANCE BETWEEN DISTURBANCE AND FISH BARRIERS (closet worksite)						
Main Stem Barrier (meters):		2779.13 m				
South Fork Barrier (meters):				1442.09 m		
Distance from South Fork to Main Stem Barrier: 574.80m		(A300)		(A140)		

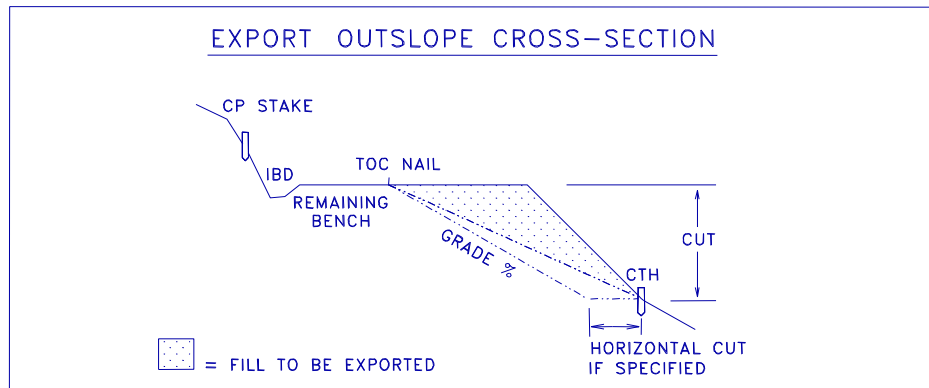
Stream Crossings

Stream crossing excavations (see figure below) involve the removal and disposal of road (crossing) fill, culverts, and organic debris from a stream channel, and shaping the completed excavation to blend with the surrounding land. The finished product mimics the original (pre-road construction) stream channel and side bank configuration. Generally, the original buried topsoil and channel armor beneath the fill are exposed during this process. Large woody debris that is uncovered during excavation is placed in the restored channel providing both sediment control and habitat complexity. Bare soils adjacent to live channels will be treated for surface erosion as prescribed in the Watershed Restoration Erosion Control and Monitoring Plan (Klein et al., 2002).



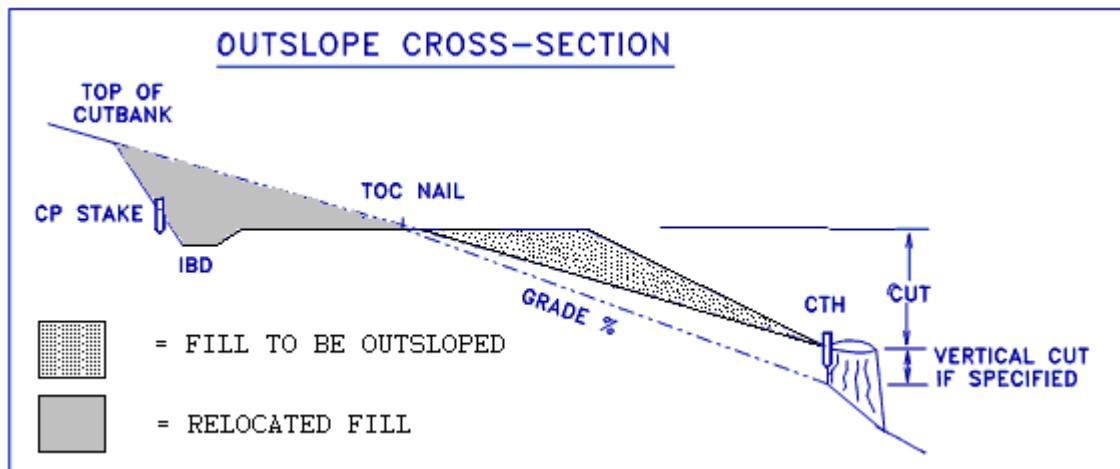
Exported Outsloping

An export outslope treatment can either remove the entire road bench width or only the outboard portion of the bench, leaving an inboard bench (see figure below). Generally, the original buried topsoil beneath the fill is exposed during this process. In both cases some or the entire excavated fill cannot remain local and must be exported (moved by whatever means) some distance to a stable fillsite. Any fill that will remain locally on the bench is placed in a stable location, shaped to re-create or mimic the pre-road construction landforms (ridges, swales, etc.) and creates a free draining surface.



Outsloping

An outslope treatment removes fill material from the outer edge of a road or landing and stores this fill **locally** on the remaining road or landing bench (see figure below). Generally, the original buried topsoil beneath the fill is exposed during this process. The fill is placed in a stable location, and is shaped to re-create the pre-road construction landforms.



D. Equipment Operations

Experienced heavy equipment contractors will be employed through a well-established contracting framework. Redwood National and State Parks may also utilize a cooperative agreement with the local Yurok Tribe to employ specially trained tribal members to implement the work. A RNSP watershed restoration geologist will be present on-site during excavation work 90% of the time during critical excavations and to make any needed adjustments to excavation design, and to ensure resource protection and quality control.

Wherever feasible the organic and nutrient rich component of excavated fill will be returned to

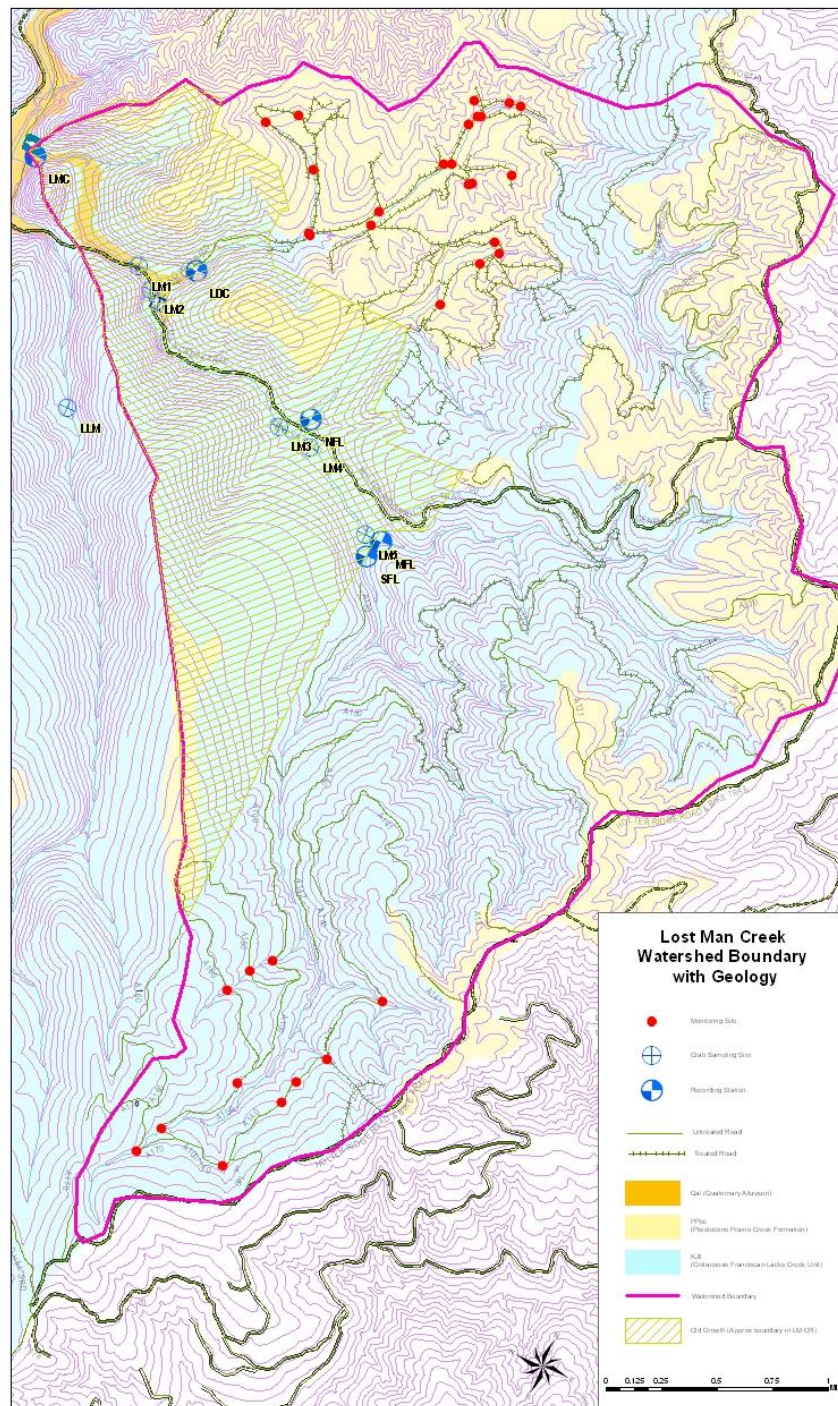
the surface to speed recovery of native vegetation. Complete road removal exposes original topsoil long buried under road fill material. Trees, shrubs, and other organic material encountered during excavation are stockpiled and spread over the finished surface. This reduces surface erosion and provides habitat for seedlings, fungi, microorganisms, insects, birds, newts, salamanders and small mammals. This habitat enhances the recovery of the forest ecosystem across the former road corridor.

E. Refining of Treatments

RNSP has been conducting erosion and turbidity monitoring in the Lost Man Creek watershed from 2002 to present to evaluate the possible effects of road removal on listed salmonids. The objectives of the monitoring program are: 1) to assess the effects of the road removal program on downstream turbidity and suspended sediment concentrations; and 2) to provide adaptive management feedback for refining erosion control methods and application criteria aimed at minimizing downstream effects and maximizing cost-effectiveness. The study has provided valuable information regarding the effectiveness of road removal techniques and approaches that we are now incorporating into the next wave of watershed restoration plans, compliance documents and contracts. A summary of the findings and adaptive management implications are described below.

Finding: Post excavation observations revealed that the comparatively higher level of adjustments to restoration sites came the first winter after excavation, with a lesser amount of erosion the second, and an imperceptible amount of erosion the third winter after excavation. Moreover, by three years after the restoration, the volunteer reestablishment of vegetation had eliminated surface erosion and in some cases started to encroach on the line-of-site for the photographic documentation. Similarly, the turbidity data indicate that erosion at new stream crossing excavations was generally most severe in the earliest large storms of the first season and diminished as the winter runoff season progressed. The highest turbidity concentrations peaked around 1900 NTU at the downstream-most monitoring station near the basin outlet (at the former fish hatchery site). This turbidity level was very brief, lasting less than an hour at the peak of a large stormflow event which occurred in WY2003 shortly after extensive restoration work in Larry Damm Creek. Since then, peak storm turbidities declined in a manner consistent with onsite erosion observations.

The monitoring site at the former fish hatchery is located about 1.5 stream miles downstream of the nearest restoration site (in Larry Damm Creek). Because the monitoring site at the former fish hatchery is our downstream-most site, we cannot quantify how far downstream turbidity from restoration work might have been detected. However, we acknowledge that turbidity from restoration work in Lost Man Creek would have affected turbidities in Prairie Creek below the confluence of the two creeks for some distance. (see Map 3)



Map 3 Sed/Turb Monitoring Sites

With implementation of adaptive management measures (described below), we expect that future restoration work will have a lower level of erosional response and downstream turbidities will be lower than those previously measures, all other factors being equal (e.g., storm magnitudes).

Adaptive Management: In order to minimize the localized short-term adjustment impact during the first winter after excavation, we will disperse (rather than concentrate) the restoration work as much as possible into three different locations of the watershed and spread the work out over a four year timeframe. The exact locations and proposed timing of treatments are displayed on Map 2. We also anticipate that post-excavation adjustment volumes in the South and Middle Forks will naturally be lower than in Larry Damm Creek and North Fork Creek due to geologic conditions and comparatively smaller areas of disturbance. We will implement all the BMPs described in the BA and monitor the proposed restoration work after completion.

Finding: Based on the onsite observations, stream crossing excavation sideslope failures relate primarily to attributes of fill placement, including:

- Inadequate compaction i.e., compaction performed by an excavator rather than a bulldozer);
- Placement of fill too close to channel;
- Placement of fill on too steep a slope;
- Placement of fill on top of unmapped springs and seeps;
- Attempting compaction with too high a water content in fill material

Adaptive Management: Prior to excavation, geologists will identify and map all springs, seeps, steep slopes and other unstable areas in relation to potential fill sites. The COTR will ensure that the contractor is fully aware of the potential unstable areas under wet conditions. The COTR will also ensure that final fill, if placed by the excavator, will be limited to safe locations with no chance of “light compaction” contributing to delivery to live streams.

Finding: The mulching guidelines were generally effective in reducing surface erosion, allowing native vegetation to reestablish, and providing near-stream woody debris to bind any liquefied fill that may have mobilized post-excavation.

Adaptive Management: Continue to apply natural mulch consisting of huckleberry, alder, fir, redwood and supplemented with shredded redwood bark or weed free strawbales, in accordance with established mulching guidelines (see Appendix 2). Mulching prescriptions will be modified to provide a clear area (approximately 4 foot wide corridor) along the upper edge of finished slopes to reduce life and safety hazards of accessing work sites for follow up monitoring.

Finding: In certain instances, the locations where sediment delivery occurred were related to the state of mind that the ground crews were in when the excavations were in progress. Situations where the work was behind schedule or facing impending inclement weather, impacting either budget or Threatened & Endangered Species would generally cause the ground crews

(contractors, equipment operators, and COTRs alike) to go into a ‘hurry up and get it done’ mode. A majority of the fill failures that occurred in the 2000-2002 seasons can be associated with a similar mind set.

Adaptive Management: It was agreed that accomplishing more sites should not become a driving focus at the expense of limiting the time available to devote to any given site. In addition, we are dispersing the remaining work in Lost Man Creek across time (4 years) and space (3 different project areas) in order to reduce the presence of a “hurry up” environment.

Finding: Erosion volumes from excavated stream crossings were estimated by measuring the voided area and establishing what portion of that eroded material entered the stream flow and was carried away as sediment. Based on these volumes, a general factor of 0.014% of the excavated volume from the crossing was generated as sediment following road removal.

Adaptive Management: Using the sediment factor from post excavation adjustment in Larry Damm Creek, the anticipated sediment production from removal of **all** of the stream crossings identified in the remaining Lost Man Creek project area would be less than 400 cubic yards of material in the first year. The annual sediment delivery from the same road system is over 2000 cubic yards, based on observed erosion over the past forty years. The short term impact of road removal would be a 1600 cubic yard reduction in sediment, if all the crossing were pulled in one year. The long term impact would be annual reduction of over 2000 cubic yards of sediment for the next 80 years.

F. Documentation

Road removal work will continue to be thoroughly documented. Original documents including geomorphic mapping, field notes and survey data will be archived at RNSP. Each road segment to be removed will be surveyed and monumented for planning and contracting purposes, resulting in estimates of volume of material to be excavated and of fill storage areas. Excavations will be surveyed again following restoration work to determine actual volumes of material moved during the project. Information gathered by the project geologists during the excavations will include equipment hours and specifics such as ground conditions and excavation methods employed by operators. Final excavation costs and volumes for each treatment will be compiled. The project geologists will establish and monument photo points to document conditions before, during and after excavation. Photo documentation will serve as a baseline for future vegetation growth studies, soil movement or any other changes that may take place after restoration work has been completed.

G. Road Removal Techniques

The goal of the watershed restoration program in Redwood National and State Parks is to minimize human-induced erosion and encourage the return of a natural pattern of vegetation. Ultimately the efforts should result in the restoration of natural ecosystems to a condition similar to what would have existed prior to disturbance by humans. A key component of this restoration work is road removal.

Approximately 28 miles of roads will be removed in the affected area of this project between 2006 and 2009 to minimize future erosion and restore natural watershed and ecosystem function (refer to map 2). Along these roads, there are approximately 165 stream crossings, none of which are on fish-bearing streams with listed salmonids present.

Road removal work involves completely excavating stream crossings, restoring natural contours and landforms along road corridors by retrieving sidecast fill, uncovering buried topsoil, spreading woody debris on finished surfaces and replanting with native species (if needed). In areas needing treatment, the goal is to re-create landforms that existed prior to road construction to the maximum extent reasonably and safely feasible, while protecting key aspects of habitat used by federally listed species.

The natural contours of the streambed and forest floor developed and existed in balance with the pre-disturbance natural hydrologic conditions, and represent the most stable configuration for the landscape. The re-exposed topsoil provides a nutrient-rich base for re-establishment of native species. The woody debris scattered adjacent to the finished stream channels provides immediate surface erosion control, habitat for small terrestrial species, and, as it decays, adds additional organic matter to the soil.

All locations along haul roads and most locations along skid roads that have the potential to erode and deliver sediment to the stream system would be fully excavated and restored to their pre-disturbance form and function. Some sections of haul roads and skid roads that have potential to erode, but where the sediment would be unlikely to reach (or be delivered to) the stream system would not be fully excavated. There are a few sites that have the potential to erode and deliver sediment to the stream system that cannot be safely accessed due to erosion that has already occurred and/or excessively steep slopes; these sites would not be treated.

At stream crossing excavations, the pre-disturbance channel bed and banks would be uncovered, and the excavated area would blend smoothly with the channel up- and downstream to the maximum extent feasible. Excavated material would be moved varying distances along the road to stable cut benches and placed against the cutbank to reconstruct the natural topography. Buried topsoil would be uncovered wherever it exists beneath fully excavated areas and would speed re-establishment of native vegetation.

The decision regarding whether to fully or partially excavate and restore a particular road or road segment would be based on weighing the risks and benefits of full restoration on terrestrial and aquatic habitats of concern. For example, those sites where erosion and sediment are likely to damage old growth trees downslope would be fully excavated. Conversely, those sites that have low potential to erode and deliver sediment to the stream system, and where full excavation would result in damage to terrestrial habitat by removing advanced second growth would receive a reduced level of treatment. In those cases failures of remaining unexcavated fill may occur in the future but would not be expected to cause substantial damage to the habitat.

This work requires the use of heavy equipment (various combinations of bulldozers, excavators, loaders, dump trucks and scrapers) in order to be effective. The normal period of operations will be the dry months, between June 1st and October 15th. Site specific start dates will be determined, based on potential affects to threatened or endangered species, in consultation with USFWS. If windows of dry weather are predicted beyond October 15th, and there are small additional work items that can be completed within the predicted window, then National Marine Fisheries Service will be consulted, and if agreement is reached work may continue.

Details of Stream Crossing Excavations

Stream crossings may have a functioning culvert or a culvert that is no longer functioning to convey water (by either being plugged, crushed, through leaking, or buried), or no culvert at all. Many of the crossings in the Lost Man Creek watershed have acted as dams, trapping a large wedge of sediment upstream of the crossing. Sooner or later, all stream crossings will fail. When they fail, either a significant proportion of the road fill placed in the stream valley and the accumulated sediment will erode, or the stream will divert and run down the road or local hillslopes, eroding gullies or initiating landslides. The majority of sediment eroded as a result of stream crossing failure ends up in the stream system.

A bulldozer begins a stream crossing excavation by dishing down the road fill, scooping out as much fill as possible, and pushing it along the road to a stable storage location. The excavation work does not disturb the bottom of the stream channel nor is it near flowing water during this time. Once the bulldozer has removed as much fill as possible without assistance, an excavator is moved onto the downstream portion of the remaining fill, and begins excavating the remaining fill from the channel, beginning at the downstream extent of the fill and moving in the upstream direction. The goal of the stream channel excavation is to uncover, yet not disturb, the buried natural channel armor, usually a combination of rock and woody debris. The large woody debris that is encountered during the excavation is placed in the channel, augmenting the natural channel armor.

Streams with significant surface flow capable of sediment transport off-site are diverted around excavation areas. Streams with only subsurface seepage through the buried streambed gravels are not diverted because the flow is not disturbed during excavation. When a culvert is present,

generally, water is kept flowing through the culvert as long as possible. When a culvert is near the center of the crossing, it is removed section by section, as the excavator works its way up the channel; thus water is only allowed to flow on the finished stream channel excavation, and not on partially excavated areas. If there is no culvert, the water is generally flowing along the old channel bottom gravels, buried at the base of the fill. The crossing is still excavated from the downstream end up so that water that emerges from the base of the fill is released into the finished channel. When an excavation nears its upstream end, water must flow across a partially excavated area for a brief period while the excavation of the top of the crossing is completed.

Stream channel excavations may experience minor adjustments, mostly during the first winter following excavation. The remaining road fill, wedged in the interstices of the original stream bed may be mobilized; small portions of channel sidebanks may settle or slide; the original channel bed armor may adjust in response to the logging slash up and downstream of the excavation site; decaying logging slash or natural organic debris may collapse, causing a small chain reaction up and downstream; etc. Much of the material mobilized during these adjustments is trapped by the large woody debris that is encountered during the excavation and placed back into the channel, augmenting the natural channel armor. The woody debris placed on areas adjacent to streams reduces surface erosion and provides habitat for seedlings, fungi, microorganisms, insects, birds, newts, salamanders and small mammals. This habitat enhances the recovery of the forest ecosystem across the former road corridor.

Details of Sidecast Fill Excavations

Excavation of sidecast fill reduces the amount of road fill that may fail as a mass movement, restores surface runoff patterns, and often uncovers buried topsoil. Many sections of road in RNSP are built on a layer of pioneer road logging debris and forest understory vegetation. This layer of organic material is becoming increasingly decayed, and appears to be a contributing factor to many slope failures (RNSP 1997). The configuration of the road (insloped, outsloped, ditched, rutted, etc.) controls local hillslope runoff patterns.

A bulldozer dishes down the outside edge of the road, and pushes the fill toward the cutbank. Depending on how steep the slopes are, the bulldozer may be able to complete the excavation and shape the fill to conform to local pre-disturbance landforms, or, on steeper ground an excavator assists, lifting more fill up toward the cutbank. On the steepest slopes, all of the work may be done with the excavator.

The original buried topsoil is often encountered as the sidecast excavation nears completion. Uncovering this layer of organic and nutrient rich material is one of the goals of sidecast fill excavations. It is a marker horizon that indicates original ground configuration, and thus the most potentially stable configuration for the hillslope and it provides a seedbed for forest recovery. It also contains the native seed that was present prior to road construction, some of which may still be viable.

Vegetation that is growing in the road prism is removed and stockpiled for surface erosion control in areas adjacent to streams. As slopes are finished, the vegetative debris is scattered on the surface. This helps reduce surface erosion, and also provides immediate cover for small terrestrial species. As it decays, it adds organic matter to the soil, and encourages fungi, speeding recovery of native forest vegetation.

Hazardous Materials Treatment

Equipment, both hand tools and heavy equipment, will be inspected daily to check for leaks. Equipment that may leak lubricants or fuels into drainage will not be used until the leaks are repaired. All equipment will be stored, serviced and fueled outside of riparian areas and away from stream crossings. Heavy equipment will be cleaned (e.g., power washed, steam cleaned) prior to use below the ordinary high water mark.

Petroleum products, chemicals, fresh cement, deleterious materials, or water contaminated by the aforementioned will not be allowed to enter flowing waters. A spill plan and materials for spill containment will be available to onsite personnel and all personnel shall know how to use them. In the event of a spill, work will be stopped immediately, clean up will begin and the appropriate authorities notified.

Post Excavation Monitoring

All completed projects are visited a number of times during the first winter, and photo-points established prior to excavation are re-photographed. The distribution of woody debris and rock in the excavated channel may be rearranged using hand tools, to minimize post-excavation erosion. Additional on- and off-site monitoring is described in the Post-excavation Erosion Control Plan in the Appendix 2.

Measures Taken to Minimize Impacts to Threatened Species

- 1) RNSP geologists will continue to plan and design all excavation work. The geologist that planned and designed the work will continue to directly oversee all excavation work on the ground as it proceeds and follows the POST-EXCAVATION EROSION CONTROL GUIDELINES as written in Appendix 2.
- 2) A detailed, final project summary report (one from each project leader/project per year), similar to those normally prepared by the parks, will be submitted to NOAA FISHERIES by the end of the July following project completion.
- 3) RNSP will ensure that erosion control measures are used to minimize short-term adverse effects to aquatic habitat and listed, proposed, or candidate species of Pacific salmonids.

- 4) Woody debris will be concentrated on finished slopes adjacent to stream crossings to reduce surface erosion, contribute to amounts of organic debris in the soil, encourage fungi, provide immediate cover for small terrestrial species and to speed recovery of native forest vegetation.
- 5) Large woody debris will be placed in the streams when completing crossing excavations. This will provide storage locations for trapping sediment that moves through the channel from natural upstream and post-excavation erosion, and provide immediate cover for aquatic/riparian species.
- 6) Riparian cover on fish-bearing streams and non fish-bearing (where non-fish bearing streams lead immediately into fish-bearing waters) will be protected wherever reasonably feasible, balancing quality and benefits of the riparian cover against risks of sediment delivery. Proposed treatments in riparian areas will be reviewed by an interdisciplinary team prior to implementation; the team will include a park restoration geologist and a park fishery biologist.
- 7) All non-emergency project work will be completed during the normal operating season (NOS), that is, between June 15 and October 15 of each year. If more than 0.5 inches of rain is forecast during the NOS, project operations will temporarily cease and sites will be winterized. If periods of dry weather are predicted outside of the NOS, additional work may be done, if they can be completed within the window of predicted dry weather.
- 8) Work sites will be winterized at the end of each day when significant rains are forecast that may cause unfinished excavations to erode. Winterization procedures are supervised at all times by RNSP geologists and involve taking measures necessary to minimize erosion on unfinished work surfaces. Winterization includes the following: smoothing unfinished surfaces to allow water to freely drain across them without concentrating or ponding; compacting unfinished surfaces where concentrated runoff may flow with an excavator bucket or similar to minimize surface erosion and the formation of rills; and installation of culverts, silt fences and other erosion control devices where necessary to convey concentrated water across unfinished surfaces, and trap eroded sediment before it leaves the work site.
- 9) Equipment, both hand tools and heavy equipment, will be inspected daily to check for leaks. Equipment that may leak lubricants or fuels into drainage will not be used until leaks are repaired. All equipment will be stored, serviced and fueled outside of riparian areas and away from stream crossings. Heavy equipment will be cleaned (e.g., power washed, steam cleaned) prior to use below the ordinary high water mark.
- 10) A spill plan and materials for spill containment will be available to onsite personnel and all personnel shall know how to use them. In the event of a spill, work shall be stopped

immediately, clean up shall begin and the appropriate authorities will be notified.

- 11) Petroleum products, chemicals, fresh cement, deleterious materials, or water contaminated by the aforementioned shall not be allowed to enter flowing waters.
- 12) Disruption of natural hydrologic flow paths, including diversion of streamflow and interception of surface and subsurface flows, shall be minimized during excavation.
- 13) Adequate erosion control supplies (gravel, straw bales, shovels, etc.) shall be kept at all restoration sites to ensure materials are kept out of water bodies.
- 14) Water drafting from fish-bearing streams will be conducted only at sites approved by a park fishery biologist, and shall be done in accordance with NOAA FISHERIES's "Water Drafting Specifications" (attached in Appendix 4)
- 15) Disturbed ground must receive appropriate erosion control treatment prior to the beginning of the wet season. (See Appendix 2)
- 16) Streams identified to have the capability to transport sediment off-site must be diverted around excavation areas. The diverted flows shall be returned to their natural streamcourse as soon as restoration is complete and prior to the rainy season. Any turbid wastewater from project activities and de-watering is disposed of off-site in a location that will not drain directly into a stream channel or carry sediment laden water into a stream channel.
- 17) Activities within the 5-year floodplain will not begin until all temporary erosion controls (e.g., straw bales, silt fences that are effectively keyed in) are in place, downslope of project activities within the riparian area. Erosion control structures shall be maintained throughout, and possibly after, activities. Erosion control devices such as check dams, silt fences, and other acceptable techniques, shall be used when the potential exists to have sediment or other materials entering waterbodies.

H. Annual Reporting of Effects

RNSP will report annually, in writing, to identify the amount of work accomplished under this multi-year consultation and provide information that may reduce the amount of incidental take authorized by a biological opinion. A brief report will be provided to NOAA Fisheries by the end of the July following project completion, listing the miles of road treated, the number of stream crossings treated, and the number of those stream crossings that carried significant stream flow during excavation.

V. EXISTING ENVIRONMENT

Temperature

Redwood Creek provides habitat for coho and chinook salmon, steelhead and coastal cutthroat trout. All require cold water to survive and coho salmon, chinook salmon and steelhead trout are currently listed as federally threatened species. Juvenile chinook salmon usually migrate to the estuary shortly after emerging from the gravel, where as steelhead and coho can spend more than one year in the stream and live in the stream throughout the summer. Coho are the most temperature sensitive of these cold water fish. The main channel and tributaries of Redwood Creek are recovering from past floods and the effects of extensive logging. Long-term channel studies have shown that the channel bed has returned to near pre-1964 flood levels in the upper and middle basin. Although the main channel of Redwood Creek is accessible to salmon and steelhead for most of its length, there is a noticeable lack of juvenile coho observed upstream of the park. In the late 1980's, adult coho salmon have spawned in the middle basin of Redwood Creek however, in the last four years no young coho have ever been caught in the downstream migrant trap located in the middle basin. The lack of juvenile coho in the upper watershed of Redwood Creek is puzzling.

Juvenile anadromous salmonid trapping was conducted for the second consecutive year in lower Redwood Creek, Humboldt County, California during the spring/summer emigration period (April – August). The purpose of the study was to describe juvenile salmonid out-migration from the majority of the Redwood Creek basin, and to estimate emigrant smolt population sizes for 0+ Chinook salmon, 1+ steelhead trout, 2+ steelhead trout, and 1+ coho salmon using mark/recapture methods. A rotary screw trap was deployed on April 18th 2005 and trapped 118 days out of a possible 130 days. Days missed trapping were estimated to have negligible effects on trap captures and population estimates. The trap captured 10,827 0+ Chinook salmon, 11 1+ Chinook salmon, 1,345 0+ steelhead trout, 2,033 1+ steelhead trout, 417 2+ steelhead trout, 53 0+ coho salmon, 39 1+ coho salmon, 9 cutthroat trout, and 2 0+ pink salmon to total 14,736 individuals. Trap catches in YR 2005 were much lower (by 83%) than catches in YR 2004, with percent reductions ranging from 43 to 93% for a given species at age. Weekly trapping efficiencies averaged 11.7% for 0+ Chinook salmon, 4.4% for 1+ steelhead trout, 4.3% for 2+ steelhead trout, and 5.2% for 1+ coho salmon. The total population estimate with 95% confidence intervals was 131,164 (117,259 – 145,069) for 0+ Chinook salmon, 32,901 (24,967 – 40,835) for 1+ steelhead trout, 8,754 (4,975 – 12,533) for 2+ steelhead trout, and 183 (56 – 309) for 1+ coho salmon. Population estimates in YR 2005 were also much lower than estimates determined in YR 2004, with percent reductions ranging from 55 to 76%. The largest reduction occurred with 0+ Chinook salmon, which I attribute to: 1) high bedload mobilizing flows during egg incubation in spawning redds, 2) large decrease in adult spawners upstream of the trap site, or 3) some combination of the two factors. Peak population emigration in YR 2005 occurred during June-July for 0+ Chinook salmon, and April-May for 1+ steelhead trout, 2+ steelhead trout, and 1+ coho salmon. Weekly population emigration for each species at age followed trends of actual catches. Twenty-seven pit tagged 0+ Chinook salmon fingerlings released at the

upper trap site (RM 33) were recaptured 29 miles downstream at the second trap (RM 4) in lower Redwood Creek. Travel time ranged from 1.5 – 19.5 d and averaged 7.5 d, and travel rate ranged from 1.5 – 19.3 mi/d and averaged 8.2 mi/d. On average, 0+ Chinook salmon migrated 29 miles downstream faster than 1+ and 2+ steelhead trout did in YR 2004 and YR 2005. Fifty-two percent of the recaptured 0+ Chinook salmon fingerlings in YR 2005 showed positive growth in FL and Wt, 18% showed a decrease in Wt, 48% showed no change in FL, and 30% showed no change in Wt. Growth was positively related to travel time and negatively related to travel rate. Travel time explained more of the variation in growth than any other variable tested. The percent change in FL ranged from 0.0 – 17.1 and averaged 3.6, and percent change in Wt ranged from -7.7 – 46.0 and averaged 9.6. The final size of recaptured pit tagged 0+ Chinook salmon was positively related to the initial size at tagging and release. Thus, for the pit tagged Chinook salmon juveniles, larger fish released at the upper trap were more likely to be the larger fish at the lower trap. *Sparkman MD. 2006. Draft: Lower Redwood Creek juvenile salmonid (smolt) downstream migration study, study year 2005. California Department of Fish and Game, AFRAMP, Annual Report 2005 2a7: 105p.*

Stream temperature is important to the health of the aquatic ecosystem and can control the distribution of stream amphibians and fish. Stream temperature has been monitored by RNSP since the mid-1990's and indicates that high water temperatures during the summer may negatively impact juvenile salmon and steelhead. As a result of the long-term temperature monitoring, Redwood Creek was listed as temperature impaired under the Clean Water Act in 2002. It is suspected that the lack of juvenile coho in the middle and upper basin may be due to a thermal barrier.

During the summer of 2003, the parks contracted for airborne thermal infrared imaging of Redwood Creek. The thermal images were used to measure surface water temperature along the main channel and show the distribution of summer water temperature along the entire length of Redwood Creek. Sixty miles of Redwood Creek were imaged in about 1 ½ hours on July 29, 2003. That day turned out to be the hottest day of the summer. Photographs were taken from a helicopter about 1400 feet above the ground and resulted in about 2500 overlapping thermal images. A digital video of the Redwood Creek was also taken simultaneously and provides good coverage of the channel and riparian zones.

Based on the temperature data, the creek can be divided into four main reaches that showed similar temperature characteristics.

Reach 1: Near the headwaters, water temperature generally increased as it traveled downstream. Water temperature increased from 17.9 °C (64 °F) to about 25 °C (77 °F).

Reach 2: The Hot Zone – In the middle basin, stream temperatures were relatively warm but had a high degree of variability. Water temperatures ranged from 23 °C (73 °F) to 28 °C (82 °F). For comparison the Arcata community pool is kept at a comfortable temperature of about 82 °F. Amazingly in this same reach, the USGS measured very hot water temperatures that exceeded 30 °C (> 86 °F) for several years in a row in the mid-1970's.

Reach 3: The Warm Zone – In the mid to lower basin, stream temperatures remained warm and the average surface water temperature was 24.8 °C (77 °F).

Reach 4: In the lower most section of Redwood Creek, stream temperatures generally cooled as it approached the ocean.

The temperature profile of Redwood Creek showed quite a bit of variability and large changes of temperature over relatively short distances. For example, water temperature changed greater than 1 °C (2 °F) in less than a half-mile and were usually associated with springs or tributaries. Some interesting things observed from thermal images were inflows of cooler water from tributaries and the location of seeps and springs in the channel.

As part of this project the fisheries staff conducted a presence-absence snorkel survey from the middle basin near Lacks Creek downstream to the lower river near Hayes Creek. Juvenile coho were only observed downstream of Tom McDonald Creek near the Tall Trees Grove. Those few coho generally occupied side channels and most were cooler than the mainstem.

Temperature data collected in Lost Man Creek between July 1, 2005 and August 31 2005 resulted in an average temperature of 14.34 C, a minimum temperature 12.47 C, and a maximum temperature of 16.69 C, which are acceptable ranges.

The park in cooperation with the USGS is in the process of evaluating the thermal imagery and analyzing the water temperature trends for the last seven years. This data provides good baseline temperature data for Redwood Creek and can be used to monitor future changes in stream temperature.

Lost Man Creek Setting and History

Lost Man Creek is a sixth order tributary which flows into Prairie Creek, which is itself the largest tributary of Redwood Creek and the last major tributary to join Redwood Creek before it runs into the ocean. Located approximately five road kilometers north of the town of Orick, California in Humboldt County, Lost Man Creek composes one-third of Prairie Creek's total basin area. The watershed covers approximately 12 square miles. Table 1 gives physical characteristics of sub-basins in Lost Man Creek. Originally, the entire Lost Man Creek watershed was forested with redwood, fir, spruce and hemlock, and supported healthy runs of chinook, coho and steelhead trout. Similar to most of the former old-growth redwood areas in north coastal California, Lost Man Creek was heavily logged and roaded during the 1950s, 1960s and early 1970's, prior to implementation of the state's forest practice rules in 1975.

History of Lost Man Creek Watershed Prior to Acquisition by the Parks

Lost Man Creek watershed lies within the ancestral lands of the Yurok people. Review of ethnographic literature, consultations with Native Americans, and archeological surveys have yielded little information about pre-historic use of the heavily forested Lost Man Creek watershed other than for fishing and gathering. Trails passed through the area, but no settlements

were reported. (McConnell and Eidsness, 2000).

Likewise, Humboldt County Recorder's Office research and oral history interviews conducted by Van Kirk (1994) indicate that while these public domain lands were patented in numerous 160 acre parcels following enactment of the Timber and Stone Act of 1878, and later consolidated into two large ownerships, there was no "settlement" (farms, ranches or homes) in the Lost Man Creek watershed.

After the Redwood Highway was completed in 1935 through the Orick-Prairie Creek area, a temporary fish hatchery and egg collecting station were established on Prairie Creek near Lost Man Creek. These facilities were rebuilt as a permanent facility in 1936 on Lost Man Creek, known as the Prairie Creek Fish Hatchery. Salmon and trout were the two types of fish hatched at this facility. The hatchery was closed in 1992 and has been "mothballed". The California State Historic Preservation Officer has listed it on the National Register of Historic Places.

The first significant human impacts in the watershed began with logging and associated road building following World War II. Most of the logging activities date to the 1950s and 1960s (Van Kirk, 1994). Only the lower portion of the watershed was not logged. Fir, redwood, hemlock and spruce were the principal marketable timber types harvested. The major haul roads (Geneva, Lower B500 and Holter Ridge) plus numerous spur roads, were built in incremental segments as the loggers extended their reach into the timberlands. The nearby town of Orick prospered during this period, supporting several timber mills and services for the growing community tied to the timber industry.

Forest land use during this period consisted of largely unregulated road and landing construction, and many large areas were clear-cut. Lost Man Creek experienced widespread erosion and sedimentation during the 1955, 1964 and later floods in response to this unregulated logging. The National Park Service acquired the Middle and South Forks and the remaining old growth along the lower main stem in 1968. The area north of Geneva Road, including most of the North Fork and Larry Damm Creek, was not acquired until 1978, and experienced particularly severe ground disturbance during the final phase of logging, just prior to the park expansion.

Ultimately, 76% of the watershed was logged. Over 50 miles of major logging haul roads were constructed, along with several hundred miles of skid roads, used to drag the logs to the truck roads.

Table 1. Characteristics of Lost Man Creek watershed and sub-basins.

Sub-basin	Drainage Area (mi²)	Drainage Area (acres)	Mean Basin Slope (%)	Area in Old Growth (acres)
Larry Damm Creek (LDC)	1.9	1181	27.6	245
North Fork Lost Man Creek (NFL)	2.4	1422	35.6	135
Middle Fork Lost Man Creek (MFL)	2.4	1444	37.0	35
South Fork Lost Man Creek (SFL)	4.3	2522	39.3	304
Other Areas (Interfluves)	1.1	1160	---	1116
Lost Man Creek at Hatchery (LMC): Basin Mouth Totals	12.1	7729	34.9	1835

History of Lost Man Creek Watershed Since Acquisition by the Parks

Experimental thinning was conducted in several locations in the upper portions of the Lost Man Creek watershed in the late 1970s. A picnic area was developed at the junction of Lost Man and Larry Damm Creeks in 1980. Geneva and Holter Ridge roads were opened to hiking and bicycling use in the late 1980s. Little other management activity occurred in the watershed until 2000, when restoration efforts began to address roads that had failed in the 1997 storm. Visitor use has primarily been in the lower watershed, in the old growth, and along the hiking/biking trail.

Through an analysis of road conditions, erosional threats and resources at risk, Lost Man Creek watershed was identified as a high priority watershed for restoration. Within this 12 square mile watershed, approximately 44 miles of abandoned, failing haul roads were identified for removal, and approximately 15 miles of relatively stable road will be kept and maintained. Existing vehicle access to the picnic area will remain open to the public, along with the eleven-mile hiking and bicycling route. In addition, several miles of relatively stable administrative access roads, primarily along ridges, will be maintained for future watershed management needs. Since restoration work in Lost Man Creek began in 2000, over half of these haul roads have been treated, along with associated skid roads. This work has restored natural runoff patterns to 2369 acres, or 30% of the watershed. Table 2 lists data on recent road removal work in the watershed.

Table 2. Restoration progress in Lost Man Creek as of winter, 2005.

Sub-basin	2000	2001	2002	2003	2004	Cum. To date
Larry Damm Creek						
Miles Removed	0	0.0	2.9	4.2	6.2	7.3
Acres Restored						
No. Fk Lost Man Cr						
Miles Removed	6.9	1.6	2.4	0	0	10.9
Acres Restored						
M. Fk Lost Man Cr						
Miles Removed	2.1	1.5	0	0	0	3.5
Acres Restored						
S. Fk Lost Man Cr						
Miles Removed	2.0	0.7	0	0	0	2.7
Acres Restored						
Total Miles Removed:	11.0	3.8	5.2	4.2	0.2	24.4
Total Acres Restored						

Erosion problems with roads in Lost Man Creek watershed include streamflow diversion, stream crossing failures, road-fill failures, landslides, and gully formation. Streamflow diversions occur when roads or skid roads intercept surface and subsurface water and direct the flow away from natural flow courses. Diversions typically occur at stream crossings where there is no drainage structure, or when the drainage structure plugs or storm runoff exceeds its capacity, and flow is diverted. The flow diverts from its natural course, down the road or inboard ditch and can discharge onto hillslopes that lack natural drainage channels, resulting in substantial gullying and landsliding.

Stream crossing failures occur where roads or skid roads cross stream channels. Stream crossings are composed of road fill and generally a drainage structure. Humboldt crossings (logs, placed parallel to the stream flow, buried in the road fill in place of a culvert) are common in Lost Man Creek watershed; culverts are relatively rare; many crossings have no drainage structure at all. Stream crossing failures occur when streamflow exceeds the capacity of the drainage structure and overtops and erodes the crossing fill, or when crossing fill becomes saturated and slumps. These failures happen when culvert inlets plug, pipes are undersized for storm flow, pipes collapse from rust and corrosion, Humboldt crossing logs decay and collapse, or simply when fills are saturated during heavy rains.

Road fill placed as sidecast material on steep slopes can fail as a mass movement (landslide) when saturated, when buried woody debris decays, or where roads cross natural hillslope instabilities, allowing the fill to slump or slide. On steep slopes, mass movement failures of road fills can torrent down steep hillslopes and stream channels, removing all vegetation and causing extreme erosion and sedimentation.

As the roads have aged, the mechanisms of road failure have evolved. Culverts not washed out in earlier storms are now severely corroded, allowing water to saturate and destabilize road fills. Where logs were placed in stream crossings in lieu of culverts (locally referred to as Humboldt crossings), the logs are decaying, allowing stream crossing fill to collapse into the streams. Sediment and small woody debris is washed downstream, plugging culverts and Humboldt crossings, and allowing streams to be diverted down roads, away from their natural watersheds. The diverted flow is eroding gullies, and saturating and destabilizing slopes that did not evolve under these increased moisture regimes. Woody debris buried beneath sidecast road fill is rotting, creating a zone of weakness, prone to landsliding.

FACTORS WHICH FORMED CURRENT CONDITIONS

Geology

Northern California is tectonically very active, and its complex geology and topography are controlled by movement along faults and crustal plates. The topography of the parks is influenced by several north-northwest trending faults. They range from low-angle thrusts to vertical faults and in most areas form the boundaries between major lithologic units in the parks. Two important faults cut through Redwood National and State Parks — the Lost Man and Grogan Faults. The Grogan Fault, a well-defined north-northwest lineament that also bisects the Redwood Creek basin, has brought two distinctive rock types into contact with each other. Late Cenozoic uplift and stream erosion are particularly evident in the steep inner gorges of Redwood Creek basin.

Mesozoic-age (Jurassic to Cretaceous) rocks of the Franciscan complex underlie most areas of RNSP. The Franciscan complex is bounded on the west by the Cascadia subduction zone and on the east by the South Fork Mountain fault (or Coast Range thrust). The Franciscan complex was laid down on the ocean floor as deposits of sand and mud about 150 to 100 million years ago. These deposits were carried eastward on the oceanic plate, accreted to the North American continent, and eventually uplifted to form the Coast Range. Through time, folding and faulting further complicated the Franciscan complex rocks. Bedrock beneath the parks is mostly composed of sedimentary graywacke sandstone, mudstone, metamorphic schist, and minor amounts of conglomerates and *mélange*. Pliocene/Pleistocene cobbles, sands, and silts of the Prairie Creek formation are thought to have been deposited in a river delta laid down by the Klamath River more than two million years ago. Quaternary alluvial and marine deposits blanket the stream valleys and coastal areas of the parks.

Rivers in northwestern California, such as Redwood Creek, the Mad, the Eel, and Mattole Rivers, have naturally high sediment yields because of recent tectonic activity (uplift of the mountains), relatively weak geologic materials, steep slopes, and high precipitation rates. These conditions combined with land use activities such as timber harvesting, road construction, and ranching give the region one of the highest denudation rates in the United States. The rate of erosion for the north coast region ranges from 6.4 to 16 tons per acre per year, 10–100 times the rate for other river basins in the country.

Many areas of the parks are susceptible to mass wasting processes such as debris slides and avalanches, block falls, shallow and deep-seated landslides, streamside landslides, and earthflows. During periods of high precipitation, slope failures commonly occur in watersheds impacted by logging activities, in areas along Highway 101 near Del Norte Coast Redwoods State Park and the Prairie Creek bypass, and along steep terrain throughout the parks.

Redwood Creek Area

With the exception of the northern portion of the Prairie Creek watershed, surficial rocks of the Redwood Creek basin consist almost entirely of pervasively sheared and fractured rocks of the Franciscan assemblage. This assemblage originated from metamorphism and tectonic deformation of marine sedimentary rocks and much smaller amounts of volcanic rocks during subduction of the Gorda Plate beneath the North American plate. It consists of sandstone, siltstones, schist, and minor amounts of conglomerates.

Most of the Prairie Creek watershed is underlain by the Plio-Pleistocene aged Prairie Creek Formation. This formation represents the onshore and nearshore portion of an extensive sedimentary sequence deposited near the mouth of the ancestral Klamath River. It is dominantly composed of fluvial sediments but also includes nearshore marine, beach, and estuarine deposits (Kelsey and Trexler, 1989). Lost Man Creek is a tributary to Prairie Creek.

The channel of Redwood Creek closely follows the Grogan Fault. East of Redwood Creek rocks are generally unmetamorphosed sedimentary rocks, including graywacke sandstone, mudstone, and conglomerate. These rocks show evidence of folding, faulting, and shearing. West of Redwood Creek, the Schist of Redwood Creek is the predominant bedrock. This schist is composed of metamorphosed mudstones, basalts, and tuffs.

Lost Man Creek Project Area

Geology

Lost Man Creek watershed is underlain by the Franciscan Assemblage (primarily in the southern portion of the watershed) and the Prairie Creek Formation (primarily in the northwestern portion of the watershed, and along the Holter Ridge). Quaternary alluvial deposits are found along the lower main stem of Lost Man Creek.

As with Redwood Creek, geologic structure in the Lost Man Creek watershed is governed by several parallel north-northwest trending faults (Janda and others, 1975; Harden and others, 1982; Kelsey and Trexler, 1989). These faults range from low-angle thrust faults to vertical faults and form some of the boundaries between the different lithologic units in the northern portion of the Lost Man Creek watershed.

South of Geneva Road, the geology is dominated by the Coherent Unit of Lacks Creek of the Franciscan Assemblage. Harden et al (1982) describes the predominant rock types of this unit as coherent sandstone and interbedded sandstone and mudstone with rhythmic bedding and internal

sedimentary structures typical of turbidites. Sandstone occurs as massive beds up to 10 meters thick, but most beds are between 0.1 and 3 meters thick with thinner mudstone interbeds; individual beds cannot be traced laterally for more than 100 meters due to complex folding and faulting (Harden et al., 1982). The graywacke contains abundant fine volcanic detritus (Harden et al., 1982). Volcanic detritus weathers to produce montmorillonite clays in the soil; given the proximity to the coast, salt carried inland by the fog may bind with these clays, making them dispersive, and remaining in suspension almost indefinitely (Spreiter, personal communication). This may affect the natural turbidity levels of the various tributaries of Lost Man Creek, depending on the proportions of Franciscan graywacke to Prairie Creek Formation in each tributary).

Some of the ridge tops in the southern part of the Lost Man Creek watershed are capped by the Surpur Creek Unit, a gravelly fluvial deposit within the Prairie Creek Formation. Clasts are larger and make up a greater proportion of the unit than in the more marine dominated Gold Bluffs unit.

North of Geneva Road, most of the haul roads that remain to be treated are in the northeastern portion of the watershed, and are located at or near the contact between the two rock types. In this area, referred to as the Ah Pah structural block (Kelsey and Trexlor, 1989), the Gold Bluffs unit of the Prairie Creek Formation lies unconformably on the lithic wacke of the Coherent Unit of Lacks Creek, of the Franciscan assemblage. Kelsey and Trexlor (1989) describe 2 geologic sections in the Gold Bluffs unit within the Ah Pah structural block: the lowermost deposits consist of massive pebbly sandstone overlain by approximately 36 meters of interbedded sandstone and well-rounded conglomerate of a fluvial origin; by approximately 80 meters above the contact, the sediments have transitioned to predominantly sands, silts and clays of a nearshore marine origin. The contact is often marked by seeps and springs as the groundwater seeps out of the more porous unconsolidated sediments that cap the ridge (Sanders, personal communications, 2005).

This portion of the Gold Bluffs unit in the Ah Pah structural block differs from that of the May Creek structural block in Larry Damm Creek and the lower North Fork (where restoration work has been recently completed) in that the basal deposits are coarser and of fluvial origin. Kelsey and Trexlor (1989) described a section in Larry Dam Creek, near the 560 and 540 roads. Here, the first 60 meters of sediments deposited on the Franciscan graywacke are medium to fine-grained sands. Above this, the section is dominated by sandstone and mudstone, with some intervals rich in clay and others consisting of massive conglomerate. Above 175 meters, the section becomes more conglomeratic and generally coarser.

The Prairie Creek Formation and the Franciscan/Coherent Unit of Lacks Creek are juxtaposed along the Lost Man Fault, a high angle fault trending north-northwest to south-southeast through the north central part of the watershed that is west of the any roads to be removed in this project area. According to Kelsey and Trexlor (1989), the Lost Man Fault displaces the Franciscan basement upward along its east side, exposing the Franciscan in the upper portions of Larry Damm Creek and the North Fork. Activity of the Lost Man Fault during the late Pleistocene to Holocene is not known (Kelsey and Trexlor, 1989). The fault has not been identified south of the

main stem of Lost Man Creek in the Coherent Unit of Lacks Creek, possibly due to the difficulty of identifying the fault in dense vegetation without the benefit of contrasting geologies. However, there are subtle topographic and geomorphic indications that the fault may continue to the south.

Geomorphology and Topography

The geomorphic features and the processes acting within the Lost Man Creek project area are a direct result of the distinctly different physical characteristics of the two bedrock units, tectonic activity and faulting, high rainfall and recent disturbance by intensive logging and road building activities.

The topography of the areas underlain by the Prairie Creek Formation is relatively gentle, and the sediment tends to accumulate in relatively broad, meandering stream valleys. The unconsolidated sediments of the Prairie Creek Formation are readily mobilized by surface runoff, especially where the sediments have been cut and sidecast to construct roads and lay-outs, and natural drainage patterns have been obliterated by logging disturbances. These sediments are also susceptible to natural and disturbance-induced mass wasting processes.

The relatively resistant Franciscan bedrock in the northeast and southern portions of the watershed generally results in steep slopes, narrow, confined canyons and high-energy stream flow in comparison to the gentler topography and less confined stream reaches of the Prairie Creek Formation. Hummocky earthflow-type terrain is present along the possible southern extension of the Lost Man Creek Fault, possibly a result of more extensive shearing, fracturing and weathering of the Franciscan bedrock along this lineation.

The depositional contact between the Prairie Creek Formation and the Franciscan is a probable hydrologic boundary and a potential zone of instability. Groundwater that accumulates in the relatively porous Prairie Creek “cap-rock” is likely to accumulate and move along the buried valleys or topographic lows of the ancient surface of the Franciscan Assemblage, and come to the surface as seeps and springs where the fault (or road cuts) exposes the contact (Spreiter, personal communications, 2003). This perched water table in the unconsolidated and locally saturated sediments of the Prairie Creek Formation with the steep slopes of Franciscan graywacke below may facilitate the formation of debris flows along the contact.

The lower reaches of Larry Damm Creek and the North Fork have downcut through the Prairie Creek Formation, and into the Franciscan Assemblage below. The Franciscan graywacke has inhibited downcutting, resulting in gentle stream gradients and creating natural sediment traps. The result is a large accumulation of sediment in the broad, middle reaches of these two tributaries. In comparison, the lower reaches of the Middle and South Forks are entirely within the Franciscan, and maintain relatively steep gradients along their entire length.

The lower main stem of Lost Man Creek has a gentle gradient, and meanders within the steep sided valley, with narrow intermittent floodplains. Near the junction with Prairie Creek, Lost Man Creek’s base level has been artificially raised by a 7 foot high dam at the former Prairie

Creek Fish Hatchery, constructed in the 1930's; aggradation has occurred for approximately 800 feet upstream. A second dam associated with the Hatchery, 0.8 miles upstream, was removed in 1989. Sediment that had accumulated upstream of the dam was removed, and the natural stream gradient was re-established.

Logging and Effects on Geomorphic Processes

By the time logging in Lost Man Creek began after World War II, the majority of the watershed was owned by 2 timber companies. The property line between these 2 owners roughly split the basin along a north-south line: Hill-Davis owned the western portion, and Sage Land and Lumber owned the eastern portion.

Virtually all of the logging occurred prior to the establishment of the California Forest Practice Rules. Logging south of Geneva road on both ownerships ended with park establishment in 1968. North of Geneva Road, logging in the middle and lower portions of Larry Damm and the North Fork watersheds culminated in the early 1970's just prior to park expansion.

The Sage Land and Lumber Company land included the relatively steep Franciscan graywacke slopes and the gentle "cap" terrain of the Prairie Creek Formation along Holter Ridge. Their holdings were logged and tractor-yarded primarily in the 1950's; scattered old growth was left for seed trees. The Hill-Davis holdings were primarily composed of the fine to medium grained sediments of the Gold Bluffs Unit of the Prairie Creek Formation sediments, and were clear-cut logged and tractor-yarded in the 1960's to early 1970's. The Hill-Davis lands in the middle and lower portions of Larry Damm and the North Fork watersheds suffered extreme ground disturbance. This level of disturbance was made possible due to the combination of the increased power developments in large bulldozers of the era and associated old-growth tractor-yarding methods, and the highly remoldable unconsolidated geology of the Prairie Creek Formation, and resulted in construction of large haul roads and landings with little regard for the natural drainage network.

Storm events in 1955, 1964, 1972 and 1975 in combination with the high level of ground disturbance from recent logging resulted in accelerated erosion and large quantities of sediment being entrained in the stream systems. Aerial photos of the Larry Damm and North Fork watersheds taken immediately after the 1972 storm show extensive erosion, with numerous washed out roads and diverted streams; many of the skid roads exhibit dual rills, one per bulldozer track. The skid trail network essentially became the new hillslope drainage pattern, particularly in areas underlain by the Prairie Creek Formation.

The lower mainstem of Lost Man Creek has been noted for its relatively good channel conditions. Lost Man Creek lower mainstem has an average stream gradient of 0.01, good water temperature, year round stream flow, good riparian cover, no migrational barriers, large riffles with a wide variety of gravel sizes for spawning adults of all salmonid species, many deep pools for rearing, instream cover provided by LWD, boulders and bedrock. In spite of the fact its headwaters having been essentially clear-cut, compared with other streams in Redwood National and State Parks.

This may be in part due to the damming actions of the stream crossings, trapping the massive quantities of fine sediment washing off the skid roads. The damming effect of these crossings has undoubtedly delayed the full impacts of the logging from reaching the lower portions of Lost Man Creek, where aquatic habitat is still relatively healthy. However, woody debris incorporated in the sidecast fills and stream crossings is decaying and becoming less stable as time passes. As the woody debris rots, fills are beginning to lose their integrity, and failure is imminent in many locations. As these failures occur, not only will much of the material making up the road fills erode and enter the stream transport system, but the accumulated sediment trapped by the crossings will also begin to mobilize, and move downstream, threatening the prime aquatic habitat of the lower Lost Man Creek watershed.

VI. STATUS AND DISTRIBUTION OF LISTED SPECIES

1. California Coastal Chinook Salmon (*Oncorhynchus tshawytscha*), Threatened

A. Species Account

Chinook salmon populations have declined along the Pacific coast to the degree that certain evolutionarily significant units (ESUs) were listed as threatened by NOAA FISHERIES under the Endangered Species Act (USDC 1999a). Based on the best biological and commercial information available NOAA FISHERIES identified 19 ESUs from populations in Washington, Idaho, Oregon, and California. Genetic data were the primary evidence considered for the reproductive isolation criterion, supplemented by inferences about barriers to migration, human-induced changes resulting from artificial propagation, and harvest. Chinook salmon historically ranged as far south as the Ventura River, California, and north as far as the Russian Far East (USDC 1999a). The California Coastal ESU (Redwood Creek and south) was listed as threatened in 1999 (USDC 1999a).

Chinook typically return from the ocean to rivers, larger streams, and larger tributaries to spawn between November and early January after three to four years in the ocean, although two year old male spawners are commonly observed. Winter-run chinook constitute the main chinook runs in RNSP streams. These fish begin their upstream migration around November, if access through the Redwood Creek estuary is possible, and have spawned and died by the end of January. Adult spring-run chinook were observed in only one season since 1981, when the park began Summer steelhead surveys, but are not typically considered to use the Redwood Creek watershed. Chinook salmon spawning in the RNSP tributaries may be impeded by stream barriers, but they may be able to surmount some barriers that may impede the smaller coho salmon. Lost Man Creek lower mainstem has an average stream gradient of 0.01, good water temperature, year round stream flow, good riparian cover, no migrational barriers, large riffles with a wide variety of gravel sizes for spawning adults of all salmonid species, many deep pools for rearing, instream cover provided by LWD, boulders and bedrock.

Juvenile chinook salmon in the Redwood Creek, Lost Man Creek and Prairie Creek watersheds do not spend time rearing in upstream areas (Anderson and Brown 1982), but instead, utilize the

Redwood Creek estuary. In spring, chinook salmon fry migrate downstream to rear in the estuary before entering the ocean in the fall. Thus, the Redwood Creek estuary is important as the sole rearing habitat for this ESU in the park. Research shows that if given the opportunity the juveniles will spend an extended period (to late summer) in the estuary before entering the ocean. Reimers (1973) documented the role estuaries play in fall chinook salmon production. From scale analysis of spawning fall chinook from the Sixes River, Oregon, he determined that the majority of returning adults spent June, July, and August as juveniles within the estuary before completing their seaward migration. His investigations determined that juvenile chinook spending less than three months in the estuary seldom returned to spawn in the natal stream. He concluded that these fish did not survive as well in the ocean as the fish that had spent three months in the estuary. Apparently a survival advantage was conferred upon the fish that remained in the estuary and grew to a larger size before entering the ocean.

Prior to 1978 most young chinook salmon were released from Prairie Creek Fish Hatchery in the early spring. These were fish hatched from eggs taken only four or five months earlier. Capturing sufficient numbers of chinook to obtain their eggs was difficult because of the low numbers of returning adult fish. The low numbers of returning adult chinook are probably related in part to the conditions in the Redwood Creek estuary. Winter spawning/carcass counts from Lost Man Creek continue to indicate low numbers of returning salmon (see table 3).

Table 3.		
Historical Lost Man Creek Reach Chinook Spawning/Carcass Count Results		
Year	Live	Carcass
2004-2005	27	9
2003-2004	29	0
2002-2003	6	29
2001-2002	38	8
2000-2001	34	16
1999-2000	8	5

B. Habitat Status

Chinook salmon rearing habitat was degraded when flood control levees that bisect the Redwood Creek estuary were constructed in 1968. The levees altered the physical and biological functions of the estuary and adjacent wetlands and confined the stream channel to a width of 300 ft. The flood control project reduced the amount of riparian vegetation and tree cover, reduced adjacent wetlands, altered valley drainage patterns, decreased the amount of instream woody debris, and caused decreased pool depths along lower Redwood Creek. The levees bypassed and isolated the last downstream meander of Redwood Creek, reduced circulation into the north and south sloughs, and contributed to 50% of the lower estuary between zero and four feet Mean Sea Level filling with sediment or becoming isolated from the embayment (Ricks 1983). Adjacent land uses, e.g., cattle grazing on the flood plain and uncontrolled breaching of the sand berm (which forms a barrier to the ocean across the mouth), also have contributed to habitat degradation of the

estuary.

Critical habitat for California Coastal ESU chinook salmon was re-designated effective January 2, 2006. Potentially suitable habitat for this ESU in RNSP occurs in the Redwood Creek basin and includes all stream and estuarine reaches accessible to the species. Accessible reaches are those within the historical range of the ESU that can still be occupied by any life stage of the species.

Chinook Critical Habitat

Lost Man Creek is a sixth order tributary, which flows into Prairie Creek approximately five road kilometers north of the town of Orick, California in Humboldt County (Figure 1). It is located within the National Park unit of Redwood National and State Parks (RNSP). The 32.1 km² basin has an average stream gradient of 0.01 on the lower portion of the creek. Lost Man Creek was split in two reaches, Lower Lost Man reach and Upper Lost Man reach. The Lower Lost Man reach begins at the confluence of Prairie Creek and continues 2.7 km to the second of the double bridges where Holter Ridge Road/bike-hike trail crosses Lost Man Creek and has been surveyed for spawning adults and carcasses since the 1980's. The Upper Lost Man reach begins at the second double bridges and continues for 2 km to an extremely large logjam, which may be a fish barrier. Surveys on the Upper Lost Man reach began in December 2001. Lost Man Creek has 4.8km of habitat. Lost Man Creek's lower mainstem has good riparian cover which keeps the water temperature low, large riffles with a wide variety of gravel sizes for spawning adults of all salmonid species, many deep pools for rearing, and instream cover provided by LWD, boulders and bedrock this provides protection for both adult and juvenile fish.

Critical habitat is defined in Section 3(5)A of the Endangered Species Act as "...the specific areas within the geographical area occupied by the species... on which are found those physical or biological features (a) essential to the conservation of the species and (b) which may require special management considerations or protection". In designating critical habitat NOAA FISHERIES considers habitat elements and conditions required for all life stages of the species. In addition, NOAA FISHERIES also focuses on the known physical and biological features (primary constituent elements) within the designated area that are essential to the conservation of the species. These essential features may include, but are not limited to, spawning sites, food resources, water quality and quantity, and riparian vegetation.

In California Coastal, NOAA FISHERIES has designated critical habitat for this ESU to include all naturally spawned populations of chinook salmon from rivers and streams south of the Klamath River to the Russian River, California, as well as seven artificial propagation programs: the Humboldt Fish Action Council (Freshwater Creek), Yager Creek, Redwood Creek, Hollow Tree, Van Arsdale Fish Station, Mattole Salmon Group, and Mad River Hatchery fall-run chinook hatchery programs.

2. Northern California Steelhead (*Oncorhynchus mykiss*), Threatened

A. Species Account

Steelhead trout were distributed historically throughout the North Pacific Ocean from the Kamchatka Peninsula in Asia to the northern Baja peninsula. Presently, the distribution extends from the Kamchatka Peninsula, east and south along the Pacific Coast of North America, to at least Malibu Creek in southern California. Steelhead likely inhabited most coastal streams in Washington, Oregon and California as well as many inland streams in these states and Idaho.

During this century, over 23 naturally reproducing stocks of steelhead are believed to have been extirpated, and many more are thought to be in decline in numerous coastal and inland streams in Washington, Oregon, California, and Idaho. Forty-three stocks have been identified as being at moderate or high risk of extinction. For these reasons, steelhead were listed as endangered in two environmentally significant units (DPSs) and threatened in four DPSs. The Northern California DPSs, from Redwood Creek south, falls within the boundaries of RNSP; it was listed as threatened on June 7, 2000.

Steelhead trout are found in most small order, high gradient tributaries to Redwood Creek. They are able to leap above barriers that might impede coho salmon (D. Anderson personal communication). Whether logjams are barriers to movement depends upon stream dynamics such as the size of the logjam and the stream discharge as well as the timing and duration of the steelhead migration. These events change from year to year.

Steelhead spawners are the last of the anadromous salmonid species to return to freshwater in the annual cycle, generally between January and April. Juveniles rear in the streams for one to four years before their downstream migration to the ocean. The majority of juvenile steelhead in Redwood Creek spend their second year of life in the estuary and lower part of Redwood Creek (Anderson 1988). They reside in marine waters typically for two or three years prior to returning to the natal stream to spawn. Unlike other Pacific salmon, steelhead trout are capable of spawning more than once before they die.

Summer steelhead surveys began in the park in 1981 and survey data have indicated a continuous decline since that time. Forty-four is the highest total number of adult fish observed during summer surveys of portions of the mainstem of Redwood Creek. No adult fish were seen in 1989 or 2001. The number of adult steelhead counted in 2005 was 22, in 2004 eight adults were counted. No other park streams in the Redwood Creek basin have been surveyed for summer steelhead; the smaller streams do not have pools large enough to support fish during the warm summer months.

Winter-run steelhead numbers are higher than summer steelhead numbers. Juvenile winter-run steelhead are the most common and widely distributed fish in the Redwood Creek basin. During sampling efforts in the summers of 1980 and 1981, steelhead trout occurred in 57 of the 111 tributaries surveyed (Anderson 1988, Brown 1988). In recent years winter stream surveys have been conducted along the mainstem of Redwood Creek (flows permitting), Lost Man Creek (see

table 4), Little Lost Man Creek, Prairie Creek, Mill Creek, and Bridge Creek. In the winter of 2000-2001 ten live Winter steelhead were observed in Redwood Creek (Holden 2002).

Table 4. Historical Lost Man Creek Reach Steelhead Spawning/Carcass Count Results		
Year	Live	Carcass
2004-2005	4	0
2003-2004	8	0
2002-2003	1	1
2001-2002	3	0
2000-2001	2	0
1999-2000	0	0

B. Habitat Status

Steelhead habitat requirements change as they go through different life phases. Adult steelhead need to have access to their natal streams, therefore, it is important that streams are free of barriers to migration, as the majority of spawning occurs in the upper reaches of tributaries. Adults also need access to spawning gravel in areas free of heavy sedimentation with adequate flow and cool, clear water. Steelhead utilize gravel that is 0.5-6 inches in diameter, dominated by 2 to 3 inch gravel. Escape cover for spawning adults also is important.

Steelhead eggs and pre-emergent fry require cool water with adequate dissolved oxygen. Fine sediment smothers developing eggs, so the area must be free of silt and the water clear. During their first summer, juvenile steelhead are typically found in relatively shallow areas with cobble and boulder bottoms. They reside at the downstream end of shallow places or in riffles less than two feet deep in areas with woody debris accumulation (logs or tree roots). Cover structures such as boulder clusters and root wads provide both summer and winter rearing habitat. Surface turbulence (or white water) provides another source of cover during the summer months. As juvenile steelhead grow, pools become an important habitat component. The best pools for habitat are those with abundant escape cover in the form of large woody debris, undercut banks, root masses, and large boulders.

Many of the small order, high gradient tributaries to Redwood Creek provide suitable habitat for steelhead in RNSP. Lost Man Creek's lower mainstem has good riparian cover which keeps the water temperature low, large riffles with a wide variety of gravel sizes for spawning adults of all salmonid species, many deep pools for rearing, and instream cover provided by LWD, boulders and bedrock this provides protection for both adult and juvenile fish. Critical habitat for Northern California DPS steelhead trout was designated effective January 2, 2006. Potentially suitable habitat for this DPS in RNSP occurs in the Redwood Creek basin and includes all stream and estuarine reaches accessible to the species. Accessible reaches are those within the historical range of the DPS that can still be occupied by any life stage of the species.

Steelhead Critical Habitat

Lost Man Creek is a sixth order tributary, which flows into Prairie Creek approximately five road kilometers north of the town of Orick, California in Humboldt County (Figure 1). It is located within the National Park unit of Redwood National and State Parks (RNSP). The 32.1 km² basin has an average stream gradient of 0.01 on the lower portion of the creek. Lost Man Creek was split in two reaches, Lower Lost Man reach and Upper Lost Man reach. The Lower Lost Man reach begins at the confluence of Prairie Creek and continues 2.7 km to the second of the double bridges where Holter Ridge Road/bike-hike trail crosses Lost Man Creek and has been surveyed since the 1980's. The Upper Lost Man reach begins at the second double bridges and continues for 2 km to an extremely large logjam, which may be a fish barrier. Surveys on the Upper Lost Man reach began in December 2001.

Critical habitat is defined in Section 3(5)A of the Endangered Species Act as "...the specific areas within the geographical area occupied by the species... on which are found those physical or biological features (a) essential to the conservation of the species and (b) which may require special management considerations or protection". In designating critical habitat NOAA FISHERIES considers habitat elements and conditions required for all life stages of the species. In addition, NOAA FISHERIES also focuses on the known physical and biological features (primary constituent elements) within the designated area that are essential to the conservation of the species. These essential features may include, but are not limited to, spawning sites, food resources, water quality and quantity, and riparian vegetation. NOAA FISHERIES designated critical habitat for this DPS between Redwood Creek, California and Russian River, California.

3. Southern Oregon/Northern California Salmon (*Oncorhynchus kisutch*), Threatened

A. Species Account

Coho or "silver" salmon are found in streams and rivers throughout much of the Pacific Rim, from central California to Korea and northern Japan. Coho are anadromous and have a life history similar to chinook. However, the time they spend in fresh and salt water is relatively fixed, compared to the more variable life history of chinook. North of central British Columbia, coho tend to spend two years in freshwater, while south of this point they spend only one year in the freshwater. Unlike chinook, where most production comes from mainstem spawning areas, coho tend to use smaller streams and tributaries. North American coho spawn in tributaries from the San Lorenzo River in Monterey Bay, California to Point Hope, Alaska, and throughout the Aleutian Islands. They are most abundant in coastal areas from central Oregon to southeast Alaska.

Coho salmon have shown substantial decreases throughout their range (Konkel and McIntyre 1987). In the U.S. Pacific Northwest, they are now extinct in the eastern half of their former range, and badly depleted over most of the western half (Frissell 1993). At least 33 populations have been identified by agencies and conservation groups for being at moderate or high risk of extinction. Overall a geographic trend for west coast coho salmon stocks has developed with the southernmost and easternmost stocks in the worst condition. In California, including hatchery

stocks, current abundance could be less than 6% of estimates for the period 1940 to 1949. Populations now are at least 70% lower than during the 1960s (CDFG 1994). The Southern Oregon/Northern California Coasts ESU for coho salmon, where RNSP is located, were designated as threatened in 1997 (USDI 1997).

The anadromous fish populations of Redwood Creek have experienced a substantial reduction during the last 30 years, in part due to severe flood events that moved large amounts of sediment from highly eroded hill slopes to the stream channels of the Redwood Creek basin. Current fish runs are far below those that occurred 70-80 years ago. News accounts and recollections of longtime residents of the Redwood Creek watershed suggest that both the size and numbers of salmonids have declined in recent decades (Van Kirk 1994). The total population in the Redwood Creek system may have numbered more than 2,000 adult coho; most occurred in the Prairie Creek drainage and probably originated from the Prairie Creek Hatchery (D. Anderson field notes). Since the closure of the hatchery in 1992 the number of coho are probably much lower (see table 5).

After hatching juvenile coho salmon generally spend one full year rearing in freshwater before entering the ocean. However, Bell (2001) determined a two-year freshwater life history component, 28%, in Prairie Creek smolts. Downstream migration of coho to the ocean from upstream Redwood Creek rearing areas occurs in early spring (March-April). Survey data from RNSP indicate that these young salmon move directly into the ocean, spending a minimal amount of time in the Redwood Creek estuary (Anderson 1995). Migration through the Redwood Creek estuary is dependent upon the mouth being open to the ocean. Adult coho typically run upstream to spawn from late October to early March depending on access through the estuary (Anderson 1995). The conditions at the mouth depend on a combination of wave action on the sand berm, the volume of water in the estuary, and the flow of water in the stream.

Coho salmon distribution in the Redwood Creek basin is limited to the mainstem and the larger low gradient tributaries. The park conducted general stream surveys of the basin in 1980 and 1981 to describe and characterize the salmonid rearing habitat and distribution of juvenile salmonids (Anderson 1988, Brown 1988). Migrational barriers were identified during those electrosurveys; no coho were found above the barriers. However, subsequent surveys in the 1990s have detected coho in streams that did not have coho in 1980-81.

B. Habitat Status

Based on data collected by RNSP fishery biologists, it was estimated that coho can be found occupying 26 miles of stream within the Lower Redwood Creek Basin (RNSP unpub. data). Lost Man Creek's lower mainstem has good riparian cover which keeps the water temperature low, large riffles with a wide variety of gravel sizes for spawning adults of all salmonid species, many deep pools for rearing, and instream cover provided by LWD, boulders and bedrock this provides protection for both adult and juvenile fish.

Table 5. Historical Lost Man Creek Reach Coho Spawning/Carcass Count Results		
Year	Live	Carcass
2004-2005	36	10
2003-2004	13	3
2002-2003	21	19
2001-2002	46	11
2000-2001	22	1
1999-2000	1	3

Coho Critical Habitat

Lost Man Creek is a sixth order tributary, which flows into Prairie Creek approximately five road kilometers north of the town of Orick, California in Humboldt County (Figure 1). It is located within the National Park unit of Redwood National and State Parks (RNSP). The 32.1 km² basin has an average stream gradient of 0.01 on the lower portion of the creek. Lost Man Creek was split in two reaches, Lower Lost Man reach and Upper Lost Man reach. The Lower Lost Man reach begins at the confluence of Prairie Creek and continues 2.7 km to the second of the double bridges where Holter Ridge Road/bike-hike trail crosses Lost Man Creek and has been surveyed since the 1980's. The Upper Lost Man reach begins at the second double bridges and continues for 2 km to an extremely large logjam, which may be a fish barrier. Surveys on the Upper Lost Man reach began in December 2001. Lost Man Creek has three miles of suitable habitat.

Critical habitat is defined in Section 3(5)A of the Endangered Species Act as "...the specific areas within the geographical area occupied by the species... on which are found those physical or biological features (a) essential to the conservation of the species and (b) which may require special management considerations or protection". In designating critical habitat NOAA FISHERIES considers habitat elements and conditions required for all life stages of the species. In addition, NOAA FISHERIES also focuses on the known physical and biological features (primary constituent elements) within the designated area that are essential to the conservation of the species. These essential features may include, but are not limited to, spawning sites, food resources, water quality and quantity, and riparian vegetation. Structurally complex streams containing stones, logs, brush, and aquatic macrophytes support larger numbers of rearing coho juveniles (Scrivener and Andersen 1982) than do streams that lack these structural features.

In southern Oregon and northern California, NOAA FISHERIES has designated critical habitat for this ESU between Cape Blanco, Oregon and Punta Gorda, California. The critical habitat unit is all stream and estuarine reaches accessible to the species and includes water, substrate, and the adjacent riparian zone. Accessible reaches are those within the historical range of the ESU that can still be occupied by any life stage of coho. The adjacent riparian zone is the area that provides shade, sediment transport, nutrient or chemical regulation, streambank stability, and input of large woody debris or organic matter. Habitat quality in this zone is related to the quality of riparian areas, upland areas, and inaccessible or headwater or intermittent streams that

provide key habitat elements, such as large woody debris and gravel, that are crucial for coho in downstream reaches (USDC 1999b). Thus, the width of the riparian zone included as critical habitat is variable depending upon consideration of these factors.

VII. IMPACTS TO THREATENED AND ENDANGERED SPECIES

The following is an analysis of the potential direct, indirect, and cumulative effects the Watershed Restoration Program on coho salmon, steelhead, and chinook salmon.

Direct and Indirect Effects

The activities proposed in this document will minimize the potential for catastrophic failures from the landscape and chronic inputs of moderate scale erosion. Large volumes of road fill will be excavated using heavy equipment, and redistributed to stable locations. Stream channels and hillslopes will be restored to their original configuration wherever reasonably feasible. Complete excavation of essentially all sidecast road fill and stream channel fill is planned where long term benefits of excavation exceed short – term negative impacts of restoration disturbance.

Human induced points of sediment input will be virtually eliminated by excavating all sites where road fill has been placed in potentially unstable locations. Sites where catastrophic events are not as likely, yet have the potential to produce chronic pulses of sediment during smaller storm events will also be treated. While some sediment will be produced due to the fresh disturbance of soil, on an average annual basis, the quantity will be an order of magnitude less than what is going into the stream system if no action was taken.

The restoration work itself has the potential to cause short-term negative effects on salmonids and their habitat through sedimentation and the removal of riparian vegetation. Post-excavation erosional adjustments are expected to occur. Post qualitative excavation observations have revealed that the comparatively higher level of adjustments to restoration sites came the first winter after excavation, with a lesser amount of erosion the second, and an imperceptible amount of erosion the third winter after excavation. Onsite turbidities reflect temporal trends (see WY2004 report). Moreover, by three years after the restoration, the volunteer reestablishment of vegetation had eliminated surface erosion and in some cases started to encroach on the line-of-site for the photographic documentation. Similarly, the turbidity data indicate that erosion at new stream crossing excavations was generally most severe in the earliest large storms of the first season and diminished as the winter runoff season progressed. The highest turbidity concentrations peaked around 1900 NTU following extensive restoration work in 2003 (from WY2004 monitoring data), but this level only last about an hour during the peak of a large storm event. In subsequent years, the highest measured peak turbidities were successively lower; 1400 NTU in WY2004 and 900 in WY2005.

The monitoring site at the former fish hatchery is located about 1.5 stream miles downstream of the nearest restoration site (in Larry Damm Creek). Because the monitoring site at the former fish hatchery is our downstream-most site, we cannot quantify how far downstream turbidity from restoration work might have been detected. However, we acknowledge that turbidity from

restoration work in Lost Man Creek would have affected turbidities in Prairie Creek below the confluence of the two creeks for some distance.

In order to minimize disturbance to the buried natural stream channel armor, heavy equipment excavates down to the top of the armor layer. A minor amount of road fill remains in the crevices of this armor, and some of this is flushed downstream during first winter's heavy flows. Experience has shown it is better to leave this small amount of fill in the crevices of the natural armor than to disturb the interlocked nature of the original bed's rock and wood. Large woody debris encountered during excavation is added to the finished channels to supplement the natural sediment trapping action of woody debris. However, the total volume of post-excavation erosion is small in comparison to the volumes being prevented from eroding by removing road fill from removed stream systems (See Appendix 3).

Information on the effects of turbidity and suspended sediment on the survival of young salmonids has raised concerns about the surface erosion that may occur during the first winter post-excavation. Although no direct mortality is expected, reduced growth, delayed migration, and other behavioral changes, which may reduce fitness, may be expected due to the results to surface erosion downstream of the project area for juvenile chinook, coho, and steelhead.

Sediment, predominantly in the form of turbidity, appears to be flushed out of the system during the first winter storms. The highest concentrations typically leave the project basin prior to the arrival of incoming listed salmonids. The mouth of Redwood Creek is usually closed to anadromous migration from June through November. The mouth remains closed until the first winter storms. Lesser turbidity concentrations may impact spawning during the midwinter storms, in the 2003-2004 sampling season the midwinter turbidity ranged from 150 NTU to less than 100 NTU, with very low turbidity associated with the spring events in the 2003-2004 sampling season the spring turbidity were less than 100 NTU. Turbidity at this level could reduced growth, delayed migration, and other behavioral changes, which may reduce fitness due to the results to surface erosion downstream of the project area for juvenile chinook, coho, and steelhead. Juvenile salmonids are more sensitive to increases in suspended sediment because of their extended fresh water residency, compared to adult anadromous salmonids. In order to minimize surface erosion that has potential to contribute fine sediment to the system, vegetative debris and slash is spread on side banks of stream crossings as mulch. Large woody debris is placed in the excavated channel to trap coarse sediment during the initial adjust winter. This technique has been observed to be very effective. In most cases, coarse sediment deposition rarely exceeds a few meters beyond the lower limit of excavation.

Loss of Riparian Vegetation at Stream Crossing Excavations

The vast majority of the trees removed during these program activities are relatively young alder, redwood and Douglas Fir. After excavating small watercourse crossings, no live vegetation will remain on the newly established stream bank. In many locations, none exists currently because the roadbed material is too compacted or unstable. Loss of riparian vegetation may result in a short-term loss of nesting habitat for terrestrial species and decreased water quality for aquatic species. The precise effects are unknown but believed to be negligible. Vegetation recovery at

recently completed watershed restoration projects reveal a dense canopy of alders 6-10 feet tall will exist on virtually all disturbed surfaces within 4 years. Vegetative debris will be stockpiled and spread on finished surfaces adjacent to live streams to reduce surface erosion and encourage rapid re-establishment of native forest vegetation.

Water temperature will not experience significant increase as a result of road removal projects. The distance the streams are exposed to direct sunlight is generally between 100 to 500 feet at each site. Duration of direct sunlight is generally limited to a few hours daily, due to steep topography and surrounding overstory trees. Many of the stream crossings and stream courses are located in steep terrain so water velocities are relatively fast. Thus, water will not pool up along areas of excavation. The projected slope of the streams will range from 15 to 40 percent. Second growth or old-growth forest canopy typically exists between proposed projects and habitat occupied by threatened anadromous fish. This canopy provides suitable shade to prevent changes in downstream water temperature as a result of the proposed actions.

Increase in Woody Debris in Stream Channels

Woody debris in the stream channel would increase as a result of the stream crossing excavations. Woody debris uncovered during excavation is stockpiled and placed in the finished channel excavation to mimic natural woody debris. Much of the vegetation removed during excavation is stockpiled and then evenly distributed along the finished surface of the stream crossing. This woody debris reduces surface erosion, captures sediment moving through the excavation area, and provides cover for aquatic and terrestrial species.

Cumulative Effects

Future state, local and private actions that are reasonably certain to occur within this action area are as follows:

The goal of the South Fork Lost Man Creek Second Growth Management Plan (SFLMCSGMP) is to restore old growth redwood forest characteristics to the project area more quickly than would occur through natural forest regeneration. This goal will be accomplished by increasing tree growth rates through the thinning of existing stands as well as restoring native tree species composition by preferentially removing tree species which are non-native or are overly represented when compared to native, unmanaged old growth redwood forest. All Heavy equipment will be excluded from riparian areas.

No other additional work will occur in the project area. Using the guidelines outlined in this document, cumulative adverse effects to Southern Oregon/Northern California Coasts coho salmon, California Coastal chinook salmon and Northern California steelhead trout or their habitat are not expected. Drainage patterns and geomorphic processes will be restored and re-establishment of native forest vegetation will be encouraged.

DETERMINATIONS

The proposed project has the potential to cause short-term negative effects on three miles of Southern Oregon/Northern California Coasts coho salmon, California Coastal chinook salmon and Northern California steelhead trout individuals and their habitat through sedimentation, however, because of a logjam downstream of the proposed project area, anadromy appears to be blocked, approximately 1.25 miles downstream of the A130 (See Map 2). Cutthroat trout and resident rainbow trout, are known to occur above the logjam, however, the stream gradient steepens quickly beyond this point becoming a migratory barrier. In the winter of 2002, after large stream flows one adult steelhead trout was observed directly above the logjam. (*This is the only known sighting of any adult anadromous salmonid to date.*) Surveys were conducted the following summer and winter, however, no juvenile anadromous salmonids were detected. The Park views this logjam as a long term less than permanent feature, which was likely formed during the 1964 flood. It will take a flood of equal or greater magnitude to remove.

Upstream of the logjam, the effects to non-listed resident rainbow trout will be indirect. An unknown quantity of the sediment will move downstream into the three miles of occupied habitat below the logjam, however, the effects to listed salmonids are expected to be more indirect.

Although no direct mortality is expected, reduced growth, delayed migration, and other behavioral changes, which may reduce fitness, may be expected due to the results of the proposed action and related activities downstream of the project area for juvenile chinook, coho, and steelhead.

Based on the size, nature and duration of these proposed actions, it is the determination of the Park's Fishery Biologist that the proposed project may affect and is likely to adversely affect Southern Oregon/Northern California Coasts coho salmon), California Coastal chinook salmon and Northern California steelhead trout, their habitat, and Essential Fish Habitat, however, the short term adverse affects will be outweighed by the long-term benefits to the species and their habitats.

VIII. MANAGEMENT RECOMMENDATIONS

There are no management recommendations.

VIX. CONTRIBUTORS

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Appendix 1

Task Order
Conduct Streamflow, Turbidity and Suspended Sediment Monitoring
Within the Lost Man Creek Watershed in Redwood National and State Parks
Winter 2006-2009

(R. Klein version, Nov. 17, 2005)

Background

An extensive network of abandoned and failing logging roads threatens the water quality of streams, ancient redwood forests and associated endangered species within Redwood National and State Parks (RNSP). Following expansion of the park in 1978 (PL 95-250), RNSP initiated a watershed rehabilitation program for the primary purpose of reducing erosion and sedimentation associated with logging and road construction. Ultimately the effort should result in the restoration of natural ecosystems to a condition similar to what would have existed without disturbance by man (RNP Watershed Rehabilitation Plan, 1981, page 1).

RNSP is presently in the process of removing 40 miles of road in the Lost Man Creek watershed, a biologically significant tributary of Redwood Creek. In Lost Man Creek watershed, federally listed salmonids and other sensitive species are present in and immediately downstream of work sites. Here, restoration efforts are focused on minimizing downstream turbidity and suspended sediment concentrations (SSC) as well as reducing the total quantity of sediment entering the stream system from road-related failures.

Watershed rehabilitation efforts within RNSP typically involve extensive road removal work as the first step in ecosystem recovery. Stream crossing road fills are completely excavated, and road-related sediment that has accumulated upstream of the crossing is removed. This restores the pre-disturbance morphology to the stream channels. Sidecast road fill between stream crossings is excavated and placed against the cutbanks, reconstructing a hillslope morphology that mimics the pre-disturbance landscape. This reduces future mass wasting potential and restores natural runoff patterns. Often, buried topsoil is uncovered in the restoration process. This soil is rich in organics and nutrients, and contains native seed. The nutrient-rich soil and native seeds contribute to rapid reestablishment of native vegetation. The final step in RNSP watershed restoration efforts involves placing woody debris in the stream channels and on the finished slopes to minimize surface erosion and inhibit mass movements.

Following road removal, freshly recontoured slopes, especially those near stream crossings, have the potential to erode by rainsplash, rilling, and channel erosion processes. While the woody debris that is scattered on the finished slopes protects these slopes, it is physically impossible to completely prevent all erosion following road removal. RNSP is required to measure the potential impacts of road removal projects (funded by Line Item Construction Project 277/6568 and 355/59730) on federally listed endangered fish species and water quality. This monitoring is necessary to comply with the Endangered Species Act (ESA) requirements set forth by the National Oceanic and Atmospheric Administration (NOAA) through the recently completed consultation process.

The purpose of this Task Order is to specify the objectives, tasks and costs associated with conducting turbidity and suspended sediment concentration monitoring in relation to logged areas and watershed rehabilitation sites in the Lost Man Creek watershed of Redwood National and State Parks (see map), for the 2004-2005 water year.

Objectives for this project are:

- 1) To document the turbidity and suspended sediment concentrations in streams draining recently treated areas and in similar untreated areas;
- 2) To differentiate between turbidity and suspended sediment generated by watershed restoration activities (road decommissioning) and that generated by the historical logging legacy that continues to affect the stream system;
- 3) To follow erosional responses at stream crossing excavations through time and determine, where feasible, possible reasons for excessive erosion;
- 4) To adaptively manage the road decommissioning program at RNSP by incorporating any revisions that appear to be necessary based on these study results.

Tasks:

For safety reasons, prior to all field work, the Contractor shall notify the COTR or PI's for weekday sampling, or South Area Rangers (via NOR-COM) for weekend or holiday sampling (see contact information on last page). A note/map should be left visible on the dashboard of any contractor vehicle indicating who is out there, and probable destinations, in case of emergency.

The following task descriptions are designed to assist in meeting the project objectives stated above. We note that onsite (upstream and downstream sampling with stream crossing excavations) water sampling for turbidity has been dropped from the program beginning in WY2004 (winter 2003-2004). The reasons for this were: 1) the usefulness of the results was limited by the necessity of manual sampling: while providing 'snapshots' of effects of post-excavations channel adjustments and sideslope erosion, lack of continuous data failed to provide enough information for a well-founded assessment of water quality impacts ; 2) after two years of collecting and analyzing onsite data, it was apparent that we had learned all we could: that occasionally large increases in turbidity occurred with recently excavated stream crossings and that the effects were short-lived; and 3) the limited utility of onsite sampling results did not justify the high expense.

1. Continuous Recording Stations:

The contractor shall operate and maintain the five continuous recording stations established in previous years to record stream stage and turbidity: North Fork Lost Man Creek (NFL), Middle Fork Lost Man Creek (MFL), South Fork Lost Man Creek (SFL), Larry Damm Creek (LDC) and mainstem Lost Man Creek (LMC) below the confluence with Larry Damm Creek at the former Prairie Creek Fish Hatchery site.

This task includes operation and maintenance of all five (5) stations, construction/verification of a stage-discharge rating for each gage, storm sampling for turbidity and suspended sediment, laboratory analysis of grab samples, and preliminary data checking and processing. It also includes removal of turbidity sensors after the rainy season ends (June, 2005) and calibration costs of the sensors, and re-installation in September, 2005. It also includes any station maintenance in September, 2005, to ensure the stations are fully functional for the new water year (WY2006).

Each monitoring facility includes a staff gage and electronic data logger (Campbell Scientific CR-10X) with sensors for stage (Druck 1830-8388) and turbidity (Forest Technology Systems DTS-12). Water stage data will be collected automatically on 10-minute intervals and will be used to calculate stream discharge using the stage-discharge rating curve. Discharge measurements will be made at these stations on frequent enough basis so that reliable stage-discharge rating curves can be developed and/or verified.

Preliminary data processing (importing to a spreadsheet, raw data plotting, gross error checking) will follow immediately after retrieval from the field to check station operation and review the hydrograph for the period. If the raw data indicate the need for station maintenance or repair, the COTR will be immediately notified and arrangements will be made for any necessary work. Costs associated with repairing damage to facilities and/or breakdowns in equipment that exceed allowances in this contract shall be approved in advance by the COTR.

Grab sampling will occur at all 5 stations on at least **ten visits** during the 2004-2005 winter period. If flows are changing significantly, additional samples shall be taken during each visit. Sampling times will attempt to coincide with major storm peaks as well as storm recessionary flows to characterize chronic turbidity and SSC. Laboratory analyses for turbidity and SSC will follow standard methods. It is expected that approximately **200 samples** will be collected at these five stations, depending on frequency and severity of storm events.

Successful completion of this task is dependent on the contractor's ability to travel to the sites during the significant rainstorms that may occur at anytime (weekday, weekend or holiday), and to gather samples during each storm within a relatively short time period so that rainfall and flows are as similar as possible at sampling time. Driving and hiking time must be taken into account in planning the number of people needed to collect the data; radio communication (or similar) between field crews will be critical in coordinating sampling times.

2. Data Downloading and Sample Processing:

Downloading (retrieval) of data from the recording stations shall occur at approximately two-week intervals throughout the primary rainy season (Nov-Mar), and these visits may coincide with discharge measurements and grab sampling. Data downloading during other parts of the year can occur on a less frequent basis. The downloaded data shall be immediately checked for possible equipment malfunctions. Any suspected malfunctions shall be immediately corrected, if possible, and reported to the COR.

Water sample turbidity levels will be measured using a recently calibrated turbidity meter (HACH 2100P or 2100AN, as appropriate). Samples shall be tested for turbidity as soon as possible following collection. The meter used for turbidity shall be calibrated to manufacturer's specifications prior to use on these samples. Suspended sediment concentration (SSC) will be determined by vacuum filtration consistent with other stream water samples collected at other RNSP gaging stations (1 micron glass filters, sand breaks as needed). The contractor shall compile data from onsite, offsite, and recording stations and provide the available data to RNSP in a timely manner. It is recognized that SSC data may not be available as soon as other data.

3. Reporting:

At the end of the winter runoff season the contractor shall prepare and submit a monitoring report. This report shall include the data (on CD), description of procedures, unusual circumstances and problems encountered, a schedule of site visits, anecdotal observations, and copies of field notes. A draft of the monitoring report including all data collect to date shall be submitted to RNSP by May 15, 2005; the final report shall be delivered to RNSP no later than July 15, 2005, and shall include all data collected to date. RNSP shall make final corrections of the turbidity data and incorporate on-site qualitative observations, ultimately producing an annual monitoring report for NOAA Fisheries.

RNSP Contacts:

COTR: Greg Gibbs, Geologist, 866-464-4101, x5239
Project Inspectors: Randy Klein, Hydrologist, 707-825-5111
Chris Heppe, Natural Resource Program Manager, 866-464-6101, x5440
South Area Rangers: Call Nor-Com dispatch, 916-358-1300 and notify them of what area they will be in; Nor-Com will then radio the ranger on duty.

Performance Period:

October 1, 2004 through Sept. 30, 2005

Deliverables/Schedule: The Contractor shall provide:

- 1) Raw data files within one month of downloading
- 2) Draft Monitoring Report May 15, 2005
- 3) Final Monitoring Report July 15, 2005

The contractor shall submit three (3) hard copies and one (1) CD of the Draft and Final Monitoring Reports to RNSP. Data collected after the final monitoring report is submitted will simply be emailed to the COTR. The contractor shall consult with RNSP staff regarding format for data and report prior to submittal of the draft report.

Equipment:

All equipment purchased for use in this task order shall become property of RNSP upon completion of the project.

Appendix 2

POST-EXCAVATION EROSION CONTROL GUIDELINES

INTRODUCTION

Studies have shown that erosion from roads is a primary cause of the decline in salmonids throughout the Pacific Northwest. In Redwood National and State Parks (RNSP), the erosion and resultant sedimentation downstream is also threatening streamside ancient redwoods by increased bank erosion and flooding. The parks are actively involved in watershed restoration work, with the goals of reducing unnaturally accelerated erosion, restoring natural geomorphic and hydrologic processes, and speeding the recovery of native forest vegetation in areas disturbed by the logging and road building that occurred before park acquisition.

These goals are achieved by:

- completely excavating stream crossing fills,
- excavating potentially unstable sidecast road fills,
- uncovering buried topsoil where reasonably feasible,
- placing native vegetative debris and large woody debris on the finished surfaces, and
- transplanting native plant species on finished slopes where a boost to re-establishment of vegetation is needed.

During the restoration process, large volumes of road fill are excavated using heavy equipment, and re-distributed to stable locations. The potential exists for post-excavation erosional adjustments to occur, particularly if the excavations do not uncover the original channel beds and banks, or where roads are located on unstable slopes. Generally the total volume of post-excavation erosion is small in comparison to the volumes being prevented from eroding by moving road fill from removed stream systems. However, new information on the effects of turbidity and suspended sediment on the survival of young salmonids has raised concerns about the surface erosion that may occur during the first winter post-excavation. This document describes measures that will be taken to control this erosion, and minimize management-related contributions to downstream turbidity and suspended sediment.

BACKGROUND

The watershed restoration program goals of erosion control and restoring geomorphic/hydrologic processes focus on removing road fill from stream crossings, minimizing failure of sidecast road fill into streams, and reducing driving forces on management-related mass movements. Initial adjustments and potential for continued post-treatment erosion were generally most pronounced in the early years of the watershed restoration program before more effective excavation techniques were developed. Myriad combinations of ground cover and vegetation were used to reduce surface erosion from treated areas. Various methods were tried to reduce fluvial erosion following the stream channel treatments, including building check dams and placing rock armor in the flow courses. As heavy equipment techniques were improved, more complete excavations became cost-effective, and the need for secondary erosion control treatments declined. Extensive monitoring and cost-effectiveness analyses were undertaken during this period, providing

feedback to the restoration project leaders. This information is described in RNSP's technical report series and numerous other papers.

SURFACE EROSION CONTROL

In the early years of the restoration program, the park relied on imported mulch and other surface erosion control blankets reduce post-excavation surface erosion. At that time, there was little vegetation that had to be removed in order to do the work, or to spread on finished surfaces, and there was little choice but to import mulch or other blanket materials. In the late 1980's, approximately \$50,000, or 10% of the erosion control and watershed restoration implementation budget, was being invested in straw mulch (includes purchase, delivery and spreading costs).

In 1989, the cost-effectiveness of controlling surface erosion was reviewed, particularly in light of the improving efficiency of heavy equipment excavation techniques. The \$50,000 spent on straw would also move 25,000 cubic yards of sediment from the stream system, or completely recontour 5 miles of road. Minimizing the small volume of sediment generated from surface erosion post-excavation was not viewed as cost-effective in addressing the large-scale problems associated with abandoned logging roads. The decision was made to greatly reduce straw mulching, and concentrate on more complete excavations of stream channels and sidecast road fills (Spreiter, personal communications).

Aside from the benefit of removing more sediment from the stream system, other restoration goals were addressed by the additional earthmoving. Natural hillslope drainage patterns were restored, potentially unstable sidecast fills were stabilized, and buried topsoil was uncovered beneath the fill. Native forest species quickly re-established on the organic and nutrient rich soil. Meanwhile, the heavy applications of straw most effective at controlling surface erosion were found to slow the re-establishment of native forest species, and straw, although certified weed-free, generally introduced exotic species. The additional earthmoving also eliminated long term maintenance and potential future failures associated with inboard ditch and cross-road ditch systems that had been constructed along many of the treated roads in the early years.

At the same time, the density and size of vegetation along the road corridors was increasing. On a few projects, large amounts of vegetative debris were buried in fillsites. This practice was quickly discontinued, with the realization that large voids would develop as the debris decayed, potentially affecting slope drainage and stability. Vegetative debris began to be stockpiled and scattered on the finished slopes. Benefits to re-establishment of vegetation were quickly noted, as many of the first successful plants were those protected by the cover of the debris. It was also noted that where shallow slumping occurred on finished slopes, the vegetative debris acted as a "binder", trapping much of the mobilized material. This has been the standard practice for the last 10 years.

New Developments

Recently, concerns have been raised about post-excavation surface erosion potentially contributing to turbidity and suspended sediment in the fish-bearing streams, impacting young

salmonids. These concerns have caused RNSP to re-evaluate the importance of surface erosion control measures.

In order to address these new concerns, the parks propose to alter the distribution of the vegetative debris. Rather than random scattering of debris, vegetative material will be collected and concentrated on slopes adjacent to live streams and other locations where fine sediment may be mobilized and enter the stream system. If there is not enough on-site vegetative debris to achieve the desired level of ground cover, additional materials may be imported to the site. Materials will be selected to comply with NPS guidelines to minimize introduction of exotics and interference with re-establishment of native forest species. Shredded redwood bark is the current preferred material.

Guidelines have been established to help determine where surface erosion control materials will be most useful, and in what quantities, based on the factors that affect erosion and transport of fine sediment, described below. Interactions between these factors are often complex and somewhat unpredictable. Best professional judgement will be used in analysis of these factors in the field.

The potential for surface erosion from a completed watershed restoration project is largely a function of:

Material properties (e.g., texture, cohesion, coarse fragment content, etc.) of the soil subject to erosive forces.

Slope length of the finished area (in a downslope direction).

Slope steepness of the of the finished area (in a downslope direction)

Slope form or convergence of the finished slopes.

Surface treatments applied to control erosion following earthmoving activities (ground cover type and degree of cover or rate of application).

The potential for sediment delivery to a stream channel is largely a function of buffer characteristics:

Slope steepness of the hillslope between the treated area and the stream.

Slope length from the treated road segment down to a stream channel

Surface conditions of the intervening slope (e.g., slope form, ground cover) that control the ability of the intervening slope to trap sediment delivered from upslope prior to reaching the channel.

A chart (Figure 1) has been developed to help plan the surface erosion control efforts. The rationale for the chart is that the potential for sediment delivery from finished slopes to streams is largely a function of the ability of the intervening ground to trap eroded sediment as it moves downslope. In general, excavated stream crossing side slopes have the highest risk of sediment delivery if not treated with preventative measures. Adjacent recontoured road segments that approach a stream crossing will have a relatively moderate to high sediment delivery risk, depending on the buffering factors. Road segments that are not near a stream crossing will have

relatively low risk of sediment delivery, except: 1) where such segments are crossed by fluvial transport features (rills, gullies, swales), and 2) where such segments are located low on the hillslope, in close proximity to stream channels. Low risk areas may be left bare in order to insure adequate cover at the higher risk locations.

Controlling post-earthmoving erosion and sediment delivery from watershed restoration projects in a cost-effective manner requires balancing erosion and sedimentation risks with treatment costs and site logistics. While the chart provides guidance, site-specific conditions both on the finished slope and within the buffer will affect the amount of ground cover actually needed to achieve the goals of reducing downstream turbidity and suspended sediment. For example, the greater the levels of duff, live vegetation, downed woody debris and micro-topography within the buffer, the greater the natural trapping efficiency, and the less ground cover needed on the finished slope directly above. Where particularly vulnerable species or habitat are located immediately downstream, or where highly erodible soils are found, the guidelines shall be adjusted to favor more complete surface erosion control. Conversely, some areas may allow relaxing of guidelines, for example where buffer zones have atypically high sediment trapping efficiency due to topographic benches or particularly dense understory and litter accumulations or where excavated materials contain large coarse fragment content that would readily form an erosion pavement.

These guidelines will be used and adapted as needed to actual field conditions to insure that fine sediment is prevented from entering the stream systems as much as is reasonably possible. Best professional judgement of an interdisciplinary team including a park geologists and park biologist will be used in analysis of these factors in the field.

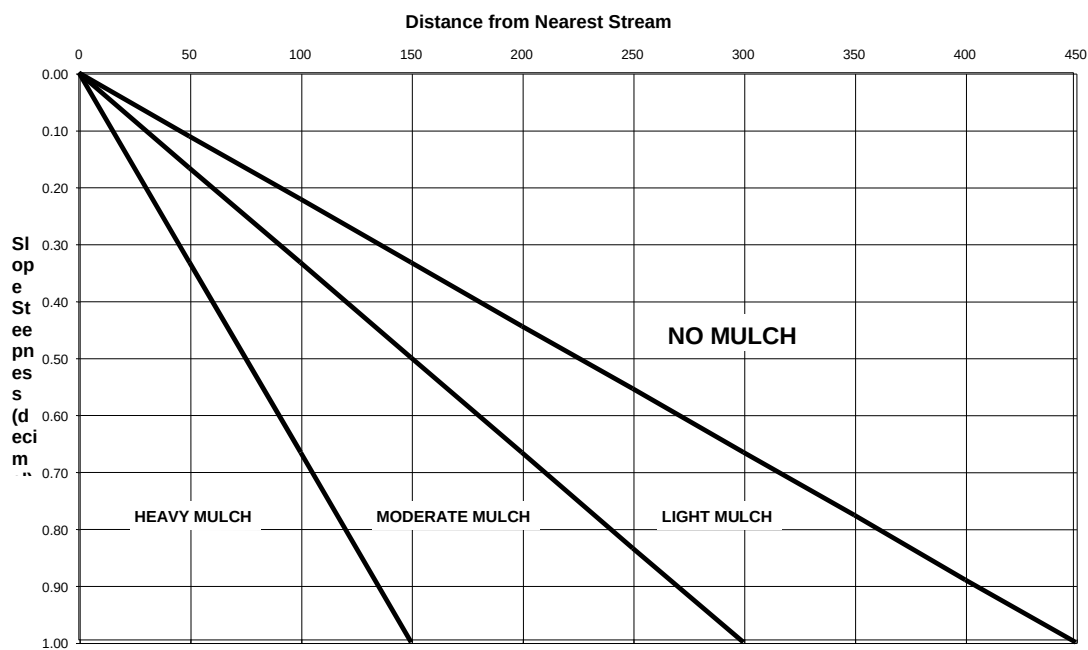


Figure 1. Mulching Guidelines

In planning ground cover needs, the site geologist will estimate the finished slope steepness and length along road segments with potential to contribute surface erosion to streams, and use the guidelines to determine appropriate ground cover rates. Where flow is expected to cross the finished slopes, ground cover will be increased to reduce erosion and trap sediment. Small swales that may not exhibit signs of surface runoff will also be covered with vegetative debris to reduce erosion and sediment delivery. Ground cover in both cases will be done to “moderate” specifications. As excavations proceed, and slopes are finished, final adjustments to ground cover rates will be made to insure the intent of reducing downstream turbidity and suspended sediment is achieved.

There is abundant vegetation that must be disturbed in order to get to the fill that needs to be excavated, and this material provides a good source of on-site, native material that can be used as ground cover. Recently, this material has been spread relatively evenly over all finished slopes, but observations show that this often results in insufficient ground cover to control surface erosion adjacent to streams. Practices are being changed to collect this material and concentrate the vegetative debris on finished slopes leading directly to streams, and on recontoured slopes where the downslope buffer is inadequate to catch mobilized fine sediments.

Where surface erosion control is critical equipment operators will be asked to “mash” the woody debris to increase ground contact. If needed, hand crews will cut and lop debris that is suspended to further increase ground contact, following placement of the debris with the heavy equipment. Woody debris scattering may have to be supplemented with imported mulching material (shredded bark, wood chips, etc.) to achieve the needed ground coverage. This would consist of applying the imported mulch over small bare areas that compose gaps in woody debris application.

From previous monitoring studies, surface erosion from bare areas is greatest the first winter following earthmoving, then declines exponentially in subsequent years as erosion pavements and leaf litter accumulate and revegetation proceeds. To speed re-establishment of vegetation, and provide long-term surface erosion control, seed bearing vegetation may be collected and scattered on the slopes to spread native seed. Similarly, duff, laden with seed, nutrients and fungi may be collected and scattered. Care will be taken not to impact source areas.

Figure 2 represents a hypothetical application of the surface erosion control guidelines to a watershed restoration project.

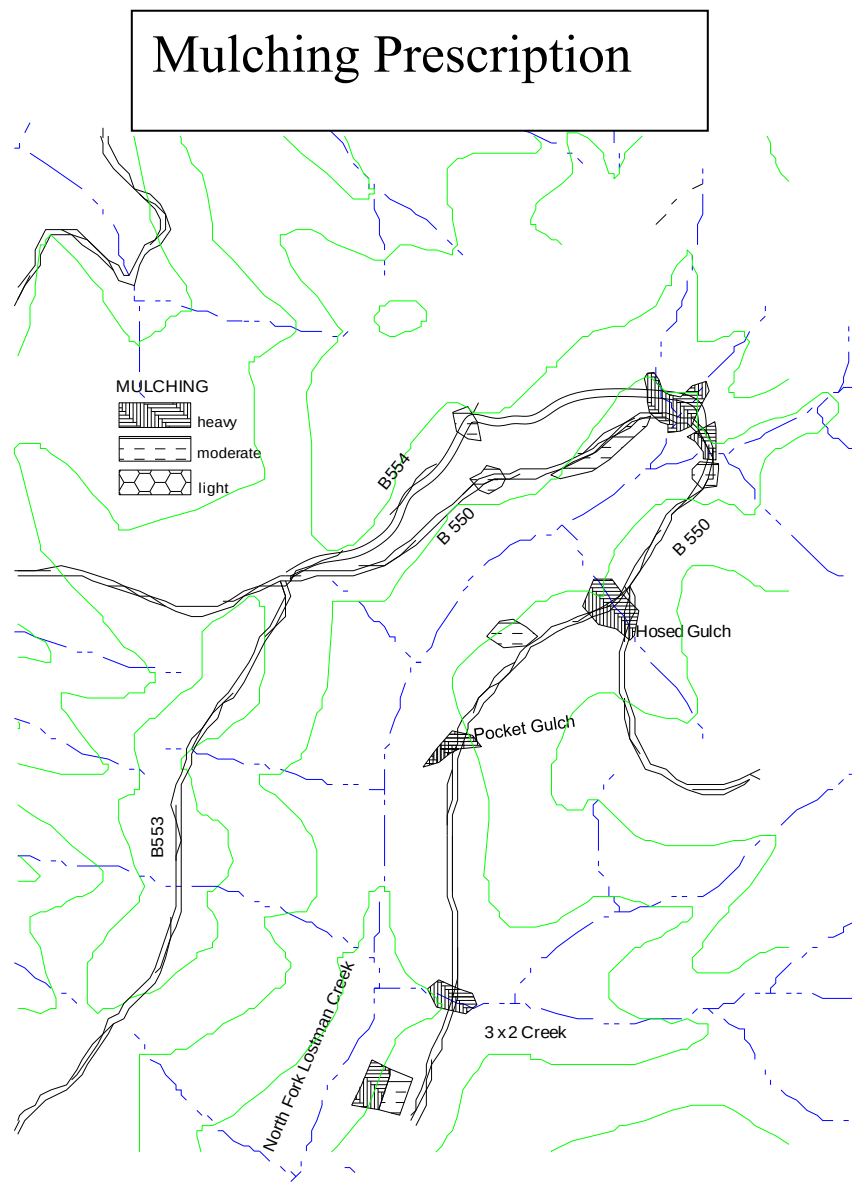


Figure 2. Hypothetical application of surface erosion control guideline on a watershed restoration project. Roads, streams, and contour lines are shown on this plan view.

Figure 3. Vegetative debris mulching on excavation sideslopes provides for control of surface and fluvial erosion (this depicts a heavy rate of mulch application). Note the excavated stream channel with large woody debris placement in the foreground.



CHANNEL EROSION CONTROL

With the parks' goal of re-exposing the natural channel bed and banks, stream channel adjustments following excavation are generally small in volume (less than 5%), relative to the amount of material removed from the stream system during excavation. Adjustments are most pronounced during the first winter, but the erosional response is also affected by the sequence of high flow events following excavation.

The potential for channel erosion from a completed stream crossing excavation is largely a function of:

Stream power during storm runoff events (proportional to drainage area and channel gradient).

Material properties (e.g., texture, cohesion, coarse fragment content, etc.) of the soil subject to erosive forces.

Length of the excavated channel.

Steepness of the excavated channel.

The degree to which intact **original channel structure** (woody debris, boulders, bedrock) was

exhumed upon completion of the excavation.

The type and degree of **treatments** applied to control channel scour following earthmoving activities.

Sediment delivery resulting from scour processes in stream channels is immediate and total. While many types of channel erosion control measures might be considered (and have been used in the past at RNSP), the park relies on finding original channel structure, supplemented by large woody debris placement. Check dams or import rock riprap to armor channels were tried and abandoned primarily due to the high cost, high maintenance and questionable ecological consequences of using non-native materials and structures. The best case scenario for avoiding significant channel adjustment (scour) is successful excavation of original channel beds and banks. Fortunately this is usually possible. In addition, large woody debris encountered during excavation is placed in arrangements that mimic natural accumulations observed in stream channels. In most cases, abundant woody debris is available for placement in stream crossing excavations. Figure 4 shows a completed stream crossing excavation with extensive woody debris placement as it appeared in spring, 2001, following a relatively mild winter. While channel scour will occur even with woody debris placement, the extent of scour will be minimized, much of the sediment is trapped within the excavated reach, and the channel will have the structural elements needed to re-establish a natural morphology relatively quickly with this approach.

Figure 4. A stream crossing excavation with extensive woody debris placement. This photo was taken after the first winter following excavation.



Adaptive Management

It is anticipated that the guidelines for preventing surface and fluvial erosion included herein will be sufficient for achieving the desired level of protection for downstream resources. However, the monitoring program included in this biological assessment will provide feedback on the performance of these guidelines through time. Insights gained through monitoring will be used to adapt these criteria as may be required to achieve the desired level of protection in a cost-efficient manner.

Appendix 3

Sediment Savings and Restoration Effectiveness

Many attempts have been made to quantify the effectiveness of restoration work within Redwood National and State Parks. Most have focused on post-excavation erosion as a surrogate to effectiveness, the idea that more site erosion following restoration represents the inverse of effectiveness. However, the main purpose of restoration is to prevent erosion from a whole myriad of problems, many which are not measurable after excavation. Examples range from eliminating diversion potentials, preventing fill failures and subsequent catastrophic debris flows, and removing the connectedness of road surfaces and dispersing surface runoff instead of allowing chronic turbidity to reach flow courses.

The difficulty and near impossibility is applying a quantity to a potential failure. All diversion potentials do not divert and even those that do may not result in considerable hillslope gully. However, there are several examples that do illustrate the potential for hillslope gully. A diversion may cause. Sizeable gullies (in excess of 30,000 yd³) have been measured within Redwood National and State Parks. In addition, diversions that have been intercepted by other flow courses may have caused immeasurable adjustment to streambed geology, the quantity of which is hard to affix to purely the diversion.

Even more difficult to predict are the future debris flows that will occur in the event of a large storm. Past history has shown these features to be the most subtle and unpredictable. Additionally, the magnitude of devastation is equally unpredictable. Does one apply the “worse case” scenario? Clearly, not all headwater swales crossed by roads will result in a catastrophic fill failure but surely, over time, a fair number will. Did the headwater swale that was just excavated during restoration have the potential to generate a debris flow or was it relatively benign?

This situation was most apparent with the consequences of the 1997 New Years Storm. Investigation of the damage caused to remaining roads in Redwood National and State Parks as a result of the storm indicated both the shortfalls of identifying possible sites for failure as well as the magnitude of damage. In an effort to direct future restoration, Redwood National and State Parks conducted a comprehensive road inventory between 1990 and 1994. The primary objective of the inventory was to identify both the location and magnitude of future erosion caused by roads remaining within the parks. Estimates for magnitude of impacts were based on a recurrent interval of 100 years. Those conducting the inventory were park geologists and physical science technicians whose primary aptitudes included geomorphology, hillslope and fluvial processes. The road inventory identified 1224 sites with a potential erosion volume of 448,000 yd³ of which 321,000 yd³ would be delivered to stream channels. Results for a comprehensive inventory of the damage caused by the 1997 New Years Storm indicated that 120 sites had generated 166,000 yd³ of material which was delivered to stream courses and these sites had the future to generate another 408,000 yd³ of material. Also, of these 120 sites which experienced damage, approximately 50% were identified in the original road inventory.

Presently, road removal and watershed restoration at Redwood National and State Parks focuses on complete recontouring. Not only does this prescription address erosion concerns associated

with stream crossings and headwater swales but also outslopes road reaches which, presently, exhibit a low potential for future failure. Consequently, outslope prescriptions are not necessary for preventing sediment from being delivered to a stream course. (The corollary, of course, is that a road bench that presently appears stable may become considerably unstable in the future.) Thus, of primary concern for stream courses are the excavations associated with stream crossings and headwater swales. For the period of 1995 through 2004, volumes for the three major categories of excavation on restoration projects in Redwood National and State Parks are shown in Table 1. For these three categories, Stream crossings (RX) and export outslope (EOS) prescriptions accounted for approximately 1,257k yd³ and 821k yd³, respectively. For these projects, the sum of the RX and EOS prescriptions represents the total potential sediment that could be delivered to stream courses, of which RX account for 60.5% and EOS for 39.5%.

Table 1
Excavation Volumes Based on Prescription for Restoration Projects
for the Period of 1995-2004 in Redwood National and State Parks

Year	Project Number	Road Name	Sub-Basin or Watershed	Prescriptions					
				Road/Stream Xings (RX)		Export Outslope (EOS)		Outslope (OS)	
				Volume (yd ³)	# Sites	Volume (yd ³)	# Sites	Volume (yd ³)	# Sites
1995	95-1	Ah Pah ^B	Prairie	55565	15	6057	4	24706	9
	95-2	K&K	Redwood	7268	2	21499	8	15206	10
	95-3	210/220	Prairie	37563	20	1065	1	21905	11
1996	96-1	230	Prairie	27057	6	0	0	4500	2
	96-2	K&K	Redwood	8574	4	3137	1	14691	7
1997	97-1	C-Line South	Tom McDonald	63700	5	9600	2	16150	7
	97-2	M-8	Redwood	2652	2	6697	4	5057	3
	97-3	M-Line/RCT ^B	Redwood	0	0	47931	8	30493	7
1998	98-1	C-Line South	Tom McDonald	22900	2	9600	2	4800	5
	98-2	M-8/M-Line ^A	Redwood	33891	8	110964	26	49274	15
	98-3	M-Line/RCT ^B	Redwood	0	0	0	0	10406	1
	98-4	C-Line North	Tom McDonald	43606	4	8017	3	5228	4
	98-5	L-2-2-1	McArthur	830	3	7752	5	3801	1
	98-6	A-9-7-1	McArthur	7409	3	9118	4	13727	5
1999	99-1	C-Line South	Tom McDonald	17000	1	24900	5	2100	3
	99-2	A120/A100 Rebuild	Lost Man Creek	4500	2	0	0	0	0
	99-3	M-Line/RCT	Redwood	19837	12	61492	12	62139	18
	99-4	C-Line North	Tom McDonald	43444	10	4026	1	12066	18
	99-5	L-2-2-1	McArthur	27320	8	23063	18	6423	9
	99-6	A-9-7-1	McArthur	34709	15	13894	14	47545	17
	99-7	Mill B ^D	Prairie	0	0	0	0	0	0
2000	00-1	A100/A200	Lost Man Creek	22441	16	8806	6	15937	13
	Y2K-1	A110	Lost Man Creek	30560	4	10870	7	40558	13
	00-3	B550 Complex	Lost Man Creek	110271	11	51192	6	40289	4
	00-4	C-Line North	Tom McDonald	76664	12	20725	3	36434	23
	00-5	A140	Lost Man Creek	13021	10	5084	3	20164	15
	00-5	L-2-2-1	McArthur	25684	8	8588	7	12263	7
	00-6	A100	Lost Man Creek	46216	9	11167	5	16176	6
2001	01-1	A100	Lost Man Creek	22709	7	17300	6	31968	5
	01-2	B550 Complex	Lost Man Creek	54595	11	36408	9	24403	3
	01-03	A300	Lost Man Creek	12419	4	2872	4	7791	7
	01-04	C-Line North	Tom McDonald	37767	7	61208	9	11661	7
2002	02-01A	B550 Complex, Pt 1	Lost Man Creek	10790	3	17587	2	2880	2
	02-01B	B550 Complex, Pt 2	Lost Man Creek	37096	12	44519	11	12821	18
	02-02	B530/B560 NRPP	Lost Man Creek	90350	13	14862	5	22160	11
	02-03	LB500	Lost Man Creek	8506	7	50903	17	15164	21
	02-04	AA1 ^C	Lost Man Creek	45218	4	6693	3	4323	7
2003	03-01	AA2/PT ^C	Lost Man Creek	60019	13	34924	5	4926	4
	03-02	530/560 NRPP	Lost Man Creek	39009	15	20479	15	31536	20
	03-03	Y-Zone/540/Lower B500	Lost Man Creek	47032	11	24697	6	6209	5
2004	04-01	Anthrop's Landing ^D	Lost Man Creek	8699	3	3140	3	0	0
Totals:^C				1256891	302	820836	250	707880	343

^A M-8/M-Line Project lasted 2 years; data consolidated into year project started.

^B Portions of these projects were not included in the original 1992 Road Inventory and are not incorporated in analysis for projected restoration work.

^C Total potential sediment delivered to stream courses is the sum of the RX volumes and the EOS volumes.

Based upon these values, 60.5% of potential sediment is derived for RXs and 39.5% is derived from EOS.

^D Mill B project was funded by CalTrans and was performed under hourly contract.

Volume estimates were complicated by both a restoration component and a development component to the project.

Table 2 Comparison Between Estimated and Actual Excavation Volumes for Restoration Projects between 1995-2004, Redwood National and State Parks						
Roadname	Estimated ^A		Actual ^B		Percent Difference	
	Volume (yd ³)	# Sites	Volume (yd ³)	# Sites	Volume	# Sites
K&K	11150	9	40478	15	263.0%	66.7%
210/220	4200	8	38628	21	819.7%	162.5%
230	10270	6	27057	6	163.5%	0.0%
C-Line South	17000	11	147700	17	768.8%	54.5%
C-Line North	27583	31	295457	49	971.2%	58.1%
M-8/M-Line	9200	18	154204	40	1576.1%	122.2%
A-9-7-1	27388	27	65130	36	137.8%	33.3%
L-2-2-1	4210	12	93237	49	2114.7%	308.3%
A100/A200	4240	12	31247	22	637.0%	83.3%
A100	10150	16	97392	27	859.5%	68.8%
A110	15030	10	41430	11	175.6%	10.0%
A140	6550	11	18105	13	176.4%	18.2%
A300	2850	3	15291	8	436.5%	166.7%
B550	34450	38	434187	82	1160.3%	115.8%
B530/B560	24725	31	164700	48	566.1%	54.8%
LB500	700	3	59409	24	8387.0%	700.0%
Totals:	209696	246	1723652	468	722.0%	90.2%

^A Road Inventory estimates include all sites identified as having erosion potential for treated road segment.

^B Actual includes ONLY RX and EOS prescriptions.

For the same segments of road treated between 1995 and 2004, Table 2 compares the actual excavation volumes (Table 1) with the estimated volumes from the Road Inventory. For all the segments that had been inventoried, the estimated and actual excavation volumes were approximately 210k yd³ and 1,724k yd³, respectively. Consequently, actual excavation volumes exceed estimates by an average of 722.0%. It is also noted that number of sites which warranted treatment exceeded the original inventory by 90%. Using this as an average for the remaining roads in the Redwood Creek basin of Redwood National and State Parks, a projected potential volume for excavation is shown in Table 3. From the estimated volumes from the original road inventory, the total excavation volume is increased by a factor of 722.0%. The main cause for the discrepancy between the estimated and the actual stems from the high amount of additional work treating the impacted slopes above and below the inventoried road segments. Many of these slopes were heavily impacted due to tractor yarding, a common signature for most of the logged lands in Redwood National and State Parks. From the revised total excavation volume, the relative percentages that is RX and EOS volumes are 60.5% and 39.5%, respectively. Thus, Table 3 also shows what are the projected volumes of all RX and EOS prescriptions for the remaining roads in the Redwood Creek basin of Redwood National and State Parks.

Table 3 Estimated Excavation Volumes for Remaining Roads in the Redwood Creek Basin, Redwood National and State Parks						
Watershed	Estimated ^A		Projected ^B			
	Total Volume (yd ³)	Total # Sites	Total Volume (yd ³)	Total # Sites	RX Vol. (yd ³) ^C	EOS Vol. (yd ³) ^C
Bond	13784	16	113301	30	68547	44754
Bridge	108229	90	889617	171	538218	351399
Coyote Creek	39956	177	328429	337	198700	129729
Devils Creek	28034	27	230433	51	139412	91021
Elam	60274	61	495438	116	299740	195698
Forty Four	65892	61	541617	116	327678	213939
Lost Man	104450	190	858555	361	519425	339129
McArthur	14460	51	118858	97	71909	46949
Prairie	67402	115	554029	219	335187	218841
Redwood Creek	64161	115	527388	219	319070	208318
Tom McDonald	22001	42	180843	80	109410	71433
Totals:	588643	945	4838508	1798	2927297	1911210

^A Volumes estimates generated from Road Inventory, 1990-1994.

^B Projected excavation volumes derived from applying overage factor based on comparisons generated in Table 2.

^C RX and EOS volumes based on relative percentages of excavations from 1995-2004. (See Note C, Table 1.)

Table 4 estimates the actual sediment savings through watershed restoration and treatment of the remaining roads in the Redwood Creek basin of Redwood National and State Parks. This estimate assumes that 50% of the projected excavation volume for stream crossings (RX) and 25% of the projected excavation volume for headwater swales (EOS) for the will be delivered to a stream course in the event of a major (100 year) storm. Thus, for Lost Man Creek, it is estimated that effective road removal and watershed restoration will effectively save an estimated 344k yd³ of sediment from entering the stream course.

Table 4 Estimated Volumes of Sediment Saved for Remaining Roads in Redwood National and State Parks within the Redwood Creek Watershed				
Watershed	Projected Excavation Volumes ^A			Potential Sediment Savings (yd ³) ^D
	Total Volume (yd ³) ^B	RX Vol. (yd ³) ^C	EOS Vol. (yd ³) ^C	
Bond	113301	68547	44754	45462
Bridge	889617	538218	351399	356959
Coyote Creek	328429	198700	129729	131782
Devils Creek	230433	139412	91021	92461
Elam	495438	299740	195698	198795
Forty Four	541617	327678	213939	217324
Lost Man	858555	519425	339129	344495
McArthur	118858	71909	46949	47692
Prairie	554029	335187	218841	222304
Redwood Creek	527388	319070	208318	211615
Tom McDonald	180843	109410	71433	72563
Totals:	4838508	2927297	1911210	1941451

^A Projected excavation volumes derived from applying overage factor based on comparisons generated in Table 2.

^B Total Volume does not include Outsloping prescriptions. Total Volume includes all portions of roads where failure is likely in the event of a large magnitude event and failure will result in direct contribution of sediment to an active stream course.

^C RX and EOS volumes based on the relative percentages of excavations from 1995-2004. Percentages exclude Outslope prescriptions. (See Table 2.)

^D Assumes 50% of stream crossing (RX) failure and 25% headwater swale (EOS) failure from storm event.

Appendix 4

WATER DRAFTING SPECIFICATIONS

National Marine Fish Service
Southwest Region

August 2001

"Water-drafting" is a short-duration, small-pump operation that withdraws water from streams or impoundments to fill conventional tank trucks or trailers. Usually, this water is used to control road dust, or for wildfire management.¹ Short term water drafting is also used to temporarily de-water a construction site, or to temporarily divert water around a construction site.

The specifications below are given primarily for the protection of juvenile anadromous salmonids, in waters where they are known to exist; but they also may be applied to protect a host of other aquatic organisms as well. The issue of sufficient in-stream flow for life support of the aquatic ecosystem should be addressed by a local Fish & Game biologist. Temporal and cumulative effects should be considered on a watershed scale. While we give some guidelines in that area, the actual impact of water drafting on stream ecology should be assessed and monitored at the local level by qualified personnel.

The main focus of this guidance is the construction, operation, and maintenance of a fish screen module(s) that must be installed at the in-stream end of the drafting hose to protect small salmon and steelhead fry from being entrained in the hose, or impinged on the surface of the screen. The specifications are based on the critical "approach velocity" at the screen surface², and a recognition that many temporary screens will not be outfitted with automatic cleaning devices to remove debris buildup. Since it is difficult to measure water velocities in the field, only the construction, pumping capacities, and operations are specified. Variances from these specifications may be considered on a case-by-case basis.

¹ In case of emergency wildfire, where human life is in danger, the operator may disregard the screening requirement if a suitable screen is not immediately accessible.

² Approach velocity is the horizontal velocity vector component, typically measured at a distance of 3

Operating Guidelines

1. Operations are restricted to one hour after sunrise to one hour before sunset.³
2. Pumping rate shall not exceed 350 gallons per minute.
3. The pumping rate shall not exceed ten percent of the stream flow.⁴
4. Seek streams and pools where water is deep and flowing, as opposed to streams with low flow and small isolated pools.
5. Pumping shall be terminated when the tank is full. The effect of single pumping operations, or multiple pumping operations at the same location, shall not result in obvious draw-down of either upstream or downstream pools.
6. Each pumping operation shall use a fish screen. The screen face should be oriented parallel to flow for best screening performance. The screen shall be designed and used such that it can be submerged with at least one-screen-height-clearance above and below the screen.
7. Operators shall keep a log on the truck containing the following information: *Operator's Name, Date, Time, Pump Rate, Filling Time, Screen Cleaned (Y or N), Screen Condition, Comments*. These guidelines should be included as instructions in a logbook with serially numbered pages. This assures each truck operator easy access to this information.

Screen Construction Criteria

1. Surface Area

The total (unobstructed) surface area of the screen shall be at least 2.5 square feet, based on the upper limit of pumping of 350 gpm⁵. Larger surface areas are recommended where debris buildup is anticipated, and where stream depth is adequate to keep the screen submerged at approximately mid-depth.

2. Screen Mesh

Screen Mesh must be in good repair and present a sealed, positive barrier- effectively preventing entry of the "design fish" into the intake. The design fish in this case is an immature (20-30mm) salmon or steelhead fry.

The screen mesh size shall be: Round openings - maximum 3/32 inch diameter (.09 inch)
Square openings - maximum 3/32 inch diagonal (.09 inch) Slotted
openings - maximum 1/16 inch width (.07 inch)

3. Screen Design

Water drafting screens may be off-the-shelf products, but they are often custom-made devices

³ Restricting operations to daylight-only prevents the use of lights that will attract fish to the drafting pool

⁴ Restricting drafting to ten percent of the stream flow provides adequate downstream flow to support fish, aquatic insects, amphibians, and other biota. Ten percent of flow may be estimated by pump operators.

⁵ If larger pumping volumes are needed, or if the pumping application is continuous, refer to

<http://swr.nmfs.noaa.gov/habitat.htm> review addendum for small pump intakes.

appropriate to the scale and duration of pumping operation. To keep the screen supported and correctly positioned in the water column, adjustable support legs are advised. Screen geometry can be configured either as rectangular or cylindrical, i.e. - as a shallow "box-shape" or tubular. The intake structure shall be designed to promote uniform velocity distribution at all external mesh surfaces. This can be accomplished with a simple internal baffle device that distributes the flow evenly across the entire surface of the screen. In order to accomplish this, the designer needs to understand the hydraulic characteristics of these devices. There is a tendency for most of the intake water to enter the screen near the hose end, so a typical internal baffle would consist of a pipe (or a manifolded set of pipes) which have variable porosity holes at predetermined spacing. We recommend starting near the hose end with approximately 5-10% average open area, and gradually increasing the porosity toward the length of the screen. At a point where screen length exceeds three times the diameter of the suction hose, the baffling effect tends to diminish rapidly. At this point the baffle porosity may approach 100%. A successful baffle system will functionally distribute flow to all areas of the screen. A poorly designed screen may result in high-velocity "hot spots," which could lead to fish impingement on the screen face. Hydraulic testing of prototype screen designs is recommended where the application is on-going and extensive.

4. Screen Structure

The screen frame must be strong enough to withstand the hydraulic forces it will experience. However, structural frames, braces, and other elements that block the flow, change flow direction, or otherwise decrease the screen surface area should be minimized.

5. Screen Cleaning

The screen shall be cleaned as often as necessary to prevent approach velocity from exceeding 0.33 feet per second. Operators should withdraw the screen and clean it after each use, or as necessary to keep screen face free of debris. Pumping should stop for screen cleaning when approximately fifteen percent or more of the screen area is occluded by debris. A suitable brush shall be on board the truck for this cleaning operation.

If the operator notes (a) impingement of any juvenile fish on the screen face or (b) entrainment of any fish through the screen mesh, he/she should stop operations and notify the Department of Fish & Game and/or NMFS hydraulic engineering staff:

National Marine Fisheries Service
Engineering Section
777 Sonoma Avenue, Suite 325
Santa Rosa, CA. 95404
(707) 575-6050

Rebecca Lent, Ph.D.
Regional Administrator



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213

SEP 08 2006

In response reply to:
2004/02180:LW

Mr. Rick Nolan
Acting National Park Service Superintendent
United States Department of the Interior
Redwood National and State Parks
1111 Second Street
Crescent City, CA 95531

Dear Mr. Nolan:

This letter transmits NOAA's National Marine Fisheries Service's (NMFS) biological opinion (Opinion) based on our review Redwood National and State Parks' (RNSP) proposed Lost Man Creek Erosion Control and Disturbed Land Restoration Plan (hereafter referred to as LMCRP), and its effects on Southern Oregon/Northern California Coast (SONCC) coho salmon (*Oncorhynchus kisutch*), California Coastal (CC) Chinook salmon (*O. tshawytscha*), Northern California (NC) steelhead (*O. mykiss*), and their designated critical habitats pursuant to section 7(a)(2) of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 *et seq.*). This Opinion (enclosure 1) is based on the best available information provided to NMFS by RNSP, and other relevant published studies and unpublished information.

After reviewing the best available scientific and commercial information, the current status of SONCC coho salmon, CC Chinook salmon and NC steelhead, the environmental baseline for the action area, the anticipated effects of the LMCRP, and the cumulative effects, it is NMFS' biological opinion that the LMCRP, as proposed, is not likely to jeopardize the continued existence of these three species or result in the destruction or adverse modification of their designated critical habitats.

The Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267; U.S.C. 1801 *et seq.*), requires Federal agencies to consult with NMFS regarding any action or proposed action that may adversely affect EFH for Federally-managed fish species. NMFS evaluated the LMCRP for potential adverse effects to EFH pursuant to section 305(b)(2) of the MSFCMA. The action area of the LMCRP includes areas identified as EFH for various life stages of Pacific coast salmon. NMFS has concluded the LMCRP would adversely affect EFH for coho salmon and Chinook salmon managed within the Pacific Coast Salmon Fishery Management Plan. Thus, this letter also transmits NMFS' Essential Fish Habitat (EFH) consultation (enclosure 2), which includes the following EFH Conservation Recommendation:

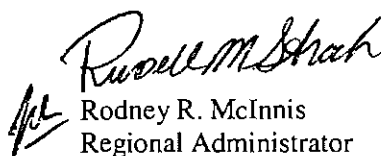


1. In addition to the on-site and turbidity monitoring described in RNSP (2006), RNSP shall include in its monitoring an erosional response assessment of every excavated stream crossing, with photopoints documenting the condition of the stream crossing post-treatment, but prior to the onset of the winter storm season, and photopoints during the two winter storm seasons following treatment.

Please be advised that regulations at section 305(b)(4)(B) and 50 CFR 600.920(k) of the MSFCMA require your office to provide a written response to this letter within 30 days of its receipt. Your final response must include a description of measures to be required to avoid, mitigate, or offset the adverse impacts of the activity. If your response is inconsistent with our EFH Conservation Recommendation, you must provide an explanation of the reasons for not implementing that recommendation.

Please contact Ms. Leslie Wolff at (707) 825-5172, or via email at leslie.wolff@noaa.gov if you have any questions regarding this consultation.

Sincerely,


Rodney R. McInnis
Regional Administrator

Enclosures

Reference

Redwood National and State Parks. 2006. A Biological Assessment of Impacts to Aquatic Threatened Species from Lost Man Creek Erosion Control and Disturbed Land Restoration Plan, Redwood National and State Parks. April.

cc: Copy to file – ARN 151422SWR2004AR9099

Endangered Species Act - Section 7 Consultation

BIOLOGICAL OPINION

ACTION AGENCY: Redwood National and State Parks

ACTIVITY: Lost Man Creek Watershed Restoration Program

**CONSULTATION
CONDUCTED BY:** Southwest Region, National Marine Fisheries Service

FILE NUMBER: 2004/02180

DATE ISSUED: *September 8, 2006*

I. BACKGROUND AND CONSULTATION HISTORY

One of the management goals for Redwood National and State Parks (RNSP) is the protection of coho salmon, Chinook salmon, steelhead, and their habitats in Redwood Creek. The *General Management Plan/General Plan and Environmental Impact Statement/Report for Redwood National and State Parks* [hereinafter GMP; United States Department of the Interior-National Park Service (USDI) and California Department of Parks and Recreation (CDPR) 1999] provides comprehensive guidance for managing the national and state parks as one complex with similar resources. Endangered Species Act (ESA) consultation on the RNSP GMP was completed on March 30, 2000. Relative to management of threatened and endangered species, the GMP directs RNSP staff to "...avoid, minimize, rectify, reduce, compensate, or otherwise mitigate any potential adverse impacts on state or federally listed or proposed or candidate threatened or endangered species..." in association with construction, visitor use, or restoration activities (USDI and CDPR 1999). These measures will be achieved primarily by restricting work temporally and spatially so as not to disturb Threatened and Endangered species and by designating almost one-third of RNSP as "primitive" zones where disturbance to all species from human activities would be limited to those "...necessary to restore and maintain ecosystem function" (USDI and CDPR 1999). Some of the past damage to these species' habitats in Redwood Creek has come from a tremendous increase in sediment loads carried by the stream channels that has altered stream channel morphology and reduced the quantity and quality of habitat available for these fishes (RNSP 2002, 2006). The reduction of sediment yield into stream channels, which the LMCRP will achieve through removal of abandoned roads and repair of water diversions, should aid in the efforts to protect and recover ESA-listed salmonids in these watersheds.

RNSP has been conducting watershed restoration work since the early 1980s, and began consulting with the National Marine Fisheries Service (NMFS) in 1998 on the potential effects of

NMFS issued two biological opinions (Opinions) to RNSP for road removal work, the first one on July 7, 1998, for the watershed restoration and road maintenance programs, and the second on July 3, 2003, for the Lost Man Creek Watershed Restoration Program. Both of these previous Opinions have expired, and RNSP is now proposing to continue restoration work in the Lost Man Creek watershed by removing 28 miles of roads over the next 4 years.

RNSP requested that NMFS provide technical assistance during an interagency field trip to South Fork Lost Man Creek on July 14, 2004. The intent of the field trip was to view the A130 road, its stream crossings, and the various problems associated with erosion at this site. Subsequently, there were three Interagency Consultation Team (ICT) meetings on February 8 and 16, 2005, and March 9, 2005, to discuss RNSP's road removal program. During these meetings RNSP presented information on erosion potential, potential sediment yield volumes, and delivery potential along various road locations within the Lost Man Creek watershed. Potential impacts to listed salmonids with and without road removal, and with different levels of treatment, were discussed.

During the ICT meetings, RNSP also presented field assessment data, and maps showing locations of all road-related erosion sites in the portions of the Lost Man Creek watershed proposed for treatment. The erosion sites were color-coded to show their erosion potential rating of high, medium or low. Pie charts were presented showing the volume of sediment from each road that would be delivered to the stream system (total yield) without treatment, first for all potential sites, and then just for sites with a medium or high erosion potential rating. The sites with a low erosion potential rating represent only 2 percent of the total yield, indicating that the majority of the erosion is moderately or highly likely to happen in a large storm event, indicating RNSP's purpose and need for the project.

On December 1, 2005, NMFS received the first draft of a biological assessment (BA) on the Lost Man Creek Erosion Control and Disturbed Land Restoration Plan (LMCRP) from RNSP. NMFS received a final BA and request to initiate formal consultation on the LMCRP on April 6, 2006 (RNSP 2006).

This Opinion evaluates the effects of the LMCRP on Southern Oregon/Northern California Coast (SONCC) coho salmon (*Oncorhynchus kisutch*), California Coastal (CC) Chinook salmon (*O. tshawytscha*), Northern California (NC) steelhead (*O. mykiss*), and their designated critical habitats. A complete administrative record for this consultation is on file at the Arcata Area Office of NMFS.

II. DESCRIPTION OF THE PROPOSED ACTION

RNSP proposes to remove approximately 28 miles of abandoned logging roads and associated skid roads in the Lost Man Creek watershed from 2006 through 2009 to minimize future erosion and restore natural watershed and ecosystem function (figure 1). Along these roads, there are approximately 165 stream crossings that are proposed for excavation, none of which are on fish-bearing streams. Road removal work involves completely excavating stream crossings, restoring natural contours and landforms along road corridors and old landing sites by retrieving sidecast

road fill, uncovering buried topsoil, spreading woody debris on finished surfaces and replanting with native species (if needed). The roads that are planned for removal are currently delivering sediment, or have the potential to deliver sediment, into stream channels. All road and stream crossing removal sites are proposed to occur upstream of two large log jams, one on Lost Man Creek, and the other on South Fork Lost Man Creek. RNSP considers these log jams to be barriers to fish migration (RNSP 2006).

A. Summary of Proposed Action by Implementation Year

1. Implementation Year 2006

RNSP proposes to remove 2.58 miles of road from portions of the A130 and A140 roads in the South Fork Lost Man and Manning Creek sub-watersheds in 2006 (figure 1). This includes removal of 6 stream crossings in the South Fork Lost Man Creek sub-watershed and removal of 10 stream crossings in the Manning Creek sub-watershed. In addition to these stream crossings, 1.76 miles of road will be fully re-contoured to mimic pre-road topography, while 0.37 miles of road will be partially re-contoured. Disturbance area associated with the proposed watershed restoration projects will be 18.58 acres, with 3.96 acres of that area being within 100 feet of a stream. The closest worksite to the South Fork Lost Man Creek fish migration barrier is on the A130 road; the worksite is located 184 feet upstream of the barrier. All of the stream crossings proposed for excavation are upstream of current anadromous salmonid habitat.

The A130 road is located above the inner gorge of South Fork Lost Man Creek and all proposed restoration along the A130 road and associated skid roads will occur outside of the inner gorge. Removal of stream crossings along the A130 road will result in the removal of a small amount of vegetation on non-fish bearing streams. RNSP has determined that the A130 road has the largest future erosion and sediment yield potential of the abandoned roads in the Lost Man Creek watershed, and is also currently contributing a considerable amount of sediment to South Fork Lost Man Creek (RNSP 2006). Based upon preliminary field reconnaissance, RNSP estimates that it will take 3 seasons to complete all the restoration work along the A130 road and associated skid roads.

2. Implementation Year 2007

RNSP proposes to remove 8.24 miles of road from portions of the A100 (south), A130, A140 and Shangri La roads and the entire length of the A110, A120, A121, A142, A160 and North Branch North Fork roads. The work will be distributed amongst the North Fork Lost Man Creek, Middle Fork Lost Man Creek, South Fork Lost Man Creek and Larry Damm Creek sub-watersheds. The proposal includes the removal of 14 stream crossings in the North Fork Lost Man Creek sub-watershed, 3 stream crossings in the Middle Fork Lost Man Creek sub-watershed and 34 stream crossings in the South Fork Lost Man Creek sub-watershed. In addition to the stream crossing removal, there will 5.33 miles of road fully re-contoured to mimic pre-road

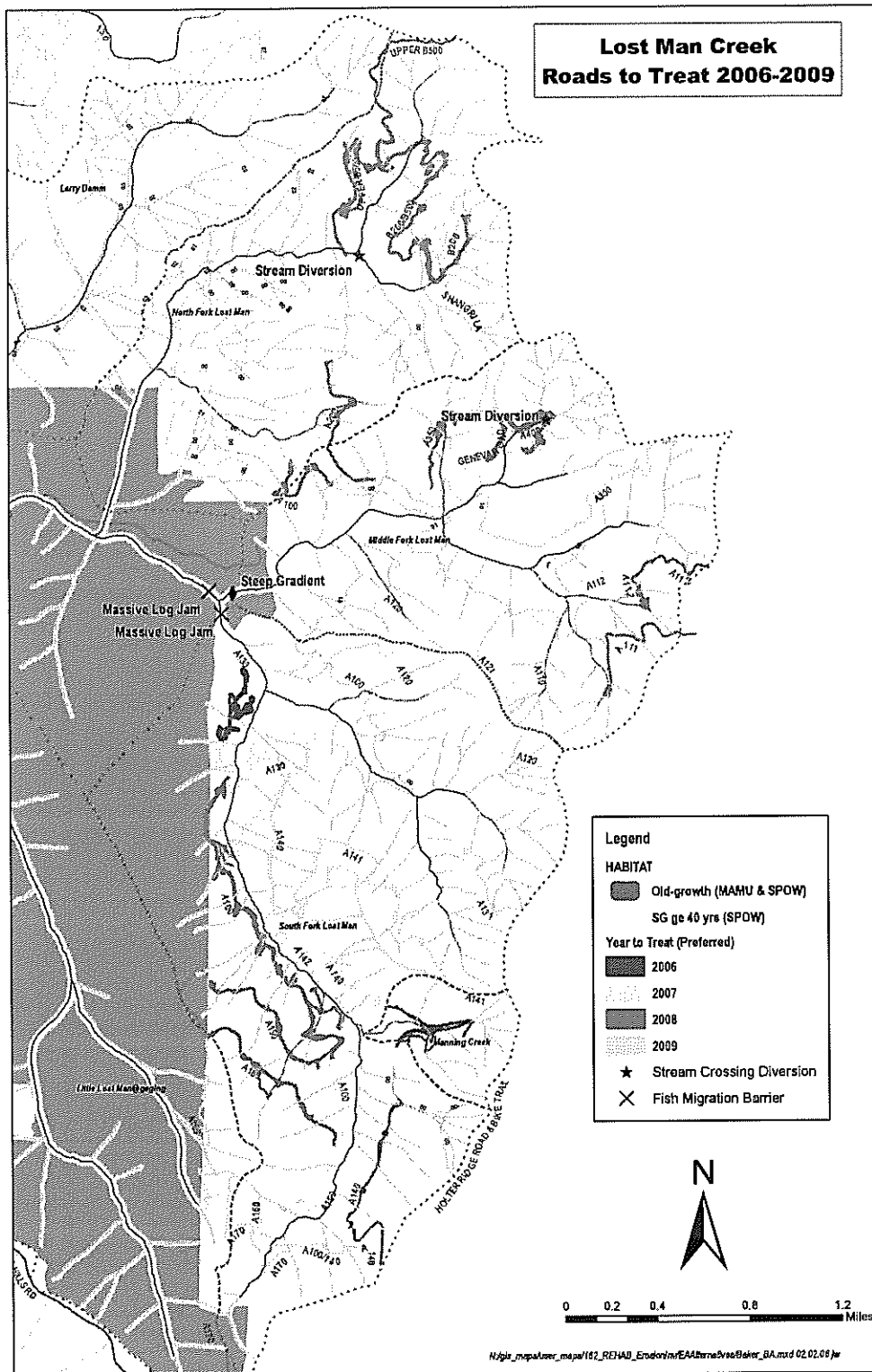


Figure 1:

topography, while 2.86 miles of road will be partially re-contoured. Disturbance area associated with the proposed watershed restoration projects will be 76.55 acres, with 21.58 acres of that area being within 100 feet of a stream. The closest worksite to the South Fork Lost Man Creek fish migration barrier is on the A130 road, and is located 2,879 feet upstream of the barrier. The closest worksite to the mainstem Lost Man Creek fish migration barrier is on the A120 road, and is located 6,383 feet upstream of the barrier. All of the sites proposed for treatment are upstream of current anadromous salmonid habitat.

Proposed restoration includes the removal of a road predominately underlain by the erodible Prairie Creek Formation, removal of landings built within intermittent streamcourses, removal of a road built 50 feet upslope of a perennial stream channel, and removal of two large landings and a large stream crossing from a perennial stream channel.

3. Implementation Year 2008

RNSP proposes to remove 10.36 miles of road from portions of the A100 (south), A130, A160 and Shangri La roads and the entire length of the A100 (North), A111, A112, A150, A200, A350, A400, B200/B500 connector, and upper B500 roads. The work will be distributed amongst the North Fork Lost Man Creek, Middle Fork Lost Man Creek, South Fork Lost Man Creek, and Larry Damm Creek sub-watersheds. The proposal includes the removal of 18 stream crossings in the North Fork Lost Man Creek sub-watershed, 19 stream crossings in the Middle Fork Lost Man Creek sub-watershed, and 40 stream crossings in the South Fork Lost Man Creek sub-watershed. In addition to stream crossing removal, there will 5.73 miles of road fully re-contoured to mimic pre-road topography, while 4.64 miles of road will be partially re-contoured. Disturbance area associated with the proposed watershed restoration projects will be 85.73 acres, with 22.97 acres of that area being within 100 feet of a stream. The closest worksite to the South Fork Lost Man Creek fish migration barrier is on the A100 road at a distance of 4,543 feet. The closest worksite to the mainstem Lost Man Creek fish migration barrier is on the A350 road at a distance of 5,774 feet. All of the sites proposed for treatment are upstream of current anadromous salmonid habitat.

4. Implementation Year 2009

RNSP proposes to remove 9.74 miles of road from portions of the A100 (south), A140 and A160 roads and the entire length of the A100/A140 connector road, A131, A141, A170/A160 connector road, A300 and B200 roads. The work will be distributed amongst the North Fork Lost Man Creek, Middle Fork Lost Man Creek, and the South Fork Lost Man Creek sub-watersheds. The proposed work includes the removal of 2 stream crossings in the North Fork Lost Man Creek sub-watershed, 3 stream crossings in the Middle Fork Lost Man sub-watershed and 12 stream crossings in the South Fork Lost Man Creek sub-watershed. In addition to stream crossing removal, there will 3.46 miles of road fully re-contoured to mimic pre-road topography, while 6.27 miles of road will be partially re-contoured. Disturbance area associated with the proposed watershed restoration will be 38.97 acres, with 5.5 acres of that area being within 100 feet of a stream. The closest worksite to the South Fork Lost Man Creek fish migration barrier is on the A140 road at a distance of 4,730 feet. The closest worksite to the mainstem Lost Man Creek fish migration barrier is on the A300 road at a distance of 9,116 feet. All of the sites

proposed for treatment are upstream of current anadromous salmonid habitat.

B. Watershed Restoration Methods

The goal of the RNSP watershed restoration program is to minimize human-induced erosion by re-creating landforms that existed prior to road construction and to encourage the return of a natural vegetation pattern. The proposed LMCRP will focus on removing road fill from stream channels and headwater swales, stabilizing sidecast fill material, and restoring natural hillslope topography and drainage patterns. Removal of roads and skid roads will include retrieving material sidecast during road construction, excavating stream crossing fill material, placing the excavated material in stable locations and shaping it to blend with the surrounding topography. The objective is to re-create landforms that existed prior to road construction as much as is reasonably feasible, in order to restore natural stream channel and hillslope hydrology, and to prevent road-related sediment from entering stream channels. Stream crossings will be excavated to near original width, depth and slope to expose natural channel armor. Side slopes will generally match original contours above and below the road. Material excavated from the channels will be placed in stable locations away from streams. Road reaches will be re-contoured, with excavated material placed against the cutbank locally (outsloping) or, where slopes are potentially unstable, moved to stable locations (exported outsloping). All excavated material is shaped to mimic and blend with the surrounding topography, recreating natural landforms and drainage patterns.

1. Details of Stream Crossing Excavations

Stream crossing excavations involve the removal and disposal of road fill, culverts, and organic debris from a stream channel, and shaping the completed excavation to blend with the surrounding land. The finished product mimics the original (pre-road construction) stream channel and side bank configuration. Generally, the original buried topsoil and channel armor beneath the fill are exposed during this process. Large woody debris (LWD) that is uncovered during excavation is placed in the restored channel, providing both sediment control and habitat complexity. Bare soils adjacent to live channels will be treated for surface erosion as prescribed in RNSP's Watershed Restoration Erosion Control and Monitoring Plan (RNSP 2006).

Stream crossings may have a functioning culvert, a culvert that is no longer functioning to convey water (by either being plugged, crushed, through leaking, or buried), or no culvert at all. Many of the crossings in the Lost Man Creek watershed have acted as dams, trapping a large wedge of sediment upstream of the crossing. Sooner or later, all stream crossings will fail. When they fail, either a significant proportion of the road fill placed in the stream valley and the accumulated sediment will erode, or the stream will divert and run down the road or local hillslopes, eroding gullies or initiating landslides. The majority of sediment eroded as a result of stream crossing failure delivers into the stream system.

A bulldozer begins a stream crossing excavation by dishing down the road fill, scooping out as much fill as possible, and pushing it along the road to a stable storage location. The excavation work does not disturb the bottom of the stream channel nor is it near flowing water during this time. Once the bulldozer has removed as much fill as possible without assistance, an excavator

is moved onto the downstream portion of the remaining fill, and begins excavating the remaining fill from the channel, beginning at the downstream extent of the fill and moving in the upstream direction. The goal of the stream channel excavation is to uncover, yet not disturb, the buried natural channel armor, usually a combination of rock and woody debris. The LWD that is encountered during the excavation is placed in the channel, augmenting the natural channel armor.

Streams with surface flow capable of sediment transport off-site are diverted around excavation areas. Streams with only subsurface seepage through the buried streambed gravels are not diverted because the flow is not disturbed during excavation. When a culvert is present, generally, water is kept flowing through the culvert as long as possible. When a culvert is near the center of the crossing, it is removed section by section, as the excavator works its way up the channel. Thus, water is only allowed to flow on the finished stream channel excavation, and not on partially excavated areas. If there is no culvert, the water is generally flowing along the old channel bottom gravels, buried at the base of the fill. The crossing is still excavated from the downstream end up so that water that emerges from the base of the fill is released into the finished channel. When an excavation nears its upstream end, water must flow across a partially excavated area for a brief period while the excavation of the top of the crossing is completed.

Stream channel excavations experience minor adjustments, mostly during the first winter following excavation (Klein *et al.* 2006). The remaining road fill, wedged in the interstices of the original stream bed may be mobilized; small portions of channel sidebanks may settle or slide; the original channel bed armor may adjust in response to the logging slash up and downstream of the excavation site; decaying logging slash or natural organic debris may collapse, causing a small chain reaction up and downstream (RNSP 2006). Much of the material mobilized during these adjustments is trapped by the LWD that is encountered during the excavation and placed back into the channel, augmenting the natural channel armor. The woody debris placed on areas adjacent to streams reduces surface erosion and provides habitat for seedlings, fungi, microorganisms, insects, birds, newts, salamanders and small mammals. This habitat accelerates the recovery of the forest ecosystem across the former road corridor.

2. Details of Sidecast Fill Excavations

Excavation of sidecast fill reduces the amount of road fill that may fail as a mass movement, restores surface runoff patterns, and often uncovers buried topsoil. Many sections of road in RNSP are built on a layer of pioneer road logging debris and forest understory vegetation. This layer of organic material is becoming increasingly decayed, and appears to be a contributing factor to many slope failures (RNSP 1997). The configuration (insloped, outsloped, ditched) and condition (*e.g.*, rutted) of the road determines local hillslope runoff patterns.

A bulldozer dishes down the outside edge of the road, and pushes the fill toward the cutbank. Depending on how steep the slopes are, the bulldozer may be able to complete the excavation and shape the fill to conform to local pre-disturbance landforms, or, on steeper ground an excavator assists, lifting more fill up toward the cutbank. On the steepest slopes, all of the work may be done with the excavator.

The original buried topsoil is often encountered as the sidecast excavation nears completion. Uncovering this layer of organic and nutrient-rich material is one of the goals of sidecast fill excavations that indicate original ground configuration, and thus, the most potentially stable configuration for the hillslope. It also provides a seedbed for forest recovery, and contains the native seed that was present prior to road construction, some of which may still be viable.

Vegetation that is growing in the road prism is removed and stockpiled for surface erosion control. As slopes are finished, the vegetative debris is scattered on the surface. This helps reduce surface erosion, and also provides immediate cover for small terrestrial species. As it decays, it adds organic matter to the soil, and encourages fungi, speeding recovery of native forest vegetation.

All locations along haul roads and most locations along skid roads that have the potential to erode and deliver sediment to the stream system would be fully excavated and restored to their pre-disturbance form and function. Some sections of haul roads and skid roads that have potential to erode, but where the sediment would be unlikely to be delivered to the stream system, would not be fully excavated. There are a few sites that have the potential to erode and deliver sediment to the stream system that cannot be safely accessed due to erosion that has already occurred and/or excessively steep slopes; these sites would not be treated.

3. Exported Outsloping

An exported outslope treatment can either remove the entire road bench width or only the outboard portion of the road bench, leaving an inboard road bench. Generally, the original buried topsoil beneath the fill is exposed during this process. In either case, some or all of the excavated fill is exported to a stable fill site location. Any fill that remains locally on the bench is placed in a stable location, shaped to re-create or mimic the pre-road construction landforms and to create a free-draining surface.

4. Outsloping

An outslope treatment removes fill material from the outer edge of a road or landing and stores this fill locally on the remaining road or landing bench. Generally, the original buried topsoil beneath the fill is exposed during this process. The fill is placed in a stable location, and is shaped to re-create the pre-road construction landforms.

C. Additional Measures Proposed to Minimize Impacts to Listed Salmonids

The following measures are proposed by RNSP in the LMCPR BA (RNSP 2006) to minimize impacts to listed salmonids within the action area.

1. RNSP geologists will continue to plan and design all excavation work. The geologist that planned and designed the work will continue to directly oversee all excavation work on the ground, will follow RNSP's Post-Excavation Erosion Control Guidelines (RNSP 2006), and ensure that all of the prescribed erosion control measures are used prior to the beginning of the wet season

2. Riparian cover in areas where non-fish bearing streams lead immediately into fish-bearing waters will be protected wherever reasonably feasible, balancing quality and benefits of the riparian cover against risks of sediment delivery. Proposed treatments in riparian areas will be reviewed by an interdisciplinary team prior to implementation; the team will include a RNSP geologist and a RNSP fishery biologist.
3. Work will be completed during the normal operating season (NOS), that is, between June 15 and October 15 of each year. If more than 0.5 inches of rain during a 24-hour period is forecast during the NOS, project operations will temporarily cease and sites will be winterized. Winterization procedures are supervised at all times by RNSP geologists and involve taking measures necessary to minimize erosion on unfinished work surfaces. Winterization includes: smoothing unfinished surfaces to allow water to freely drain across them without concentrating or ponding; compacting unfinished surfaces with an excavator bucket, or similar equipment, to minimize surface erosion and the formation of rills; and installation of culverts, silt fences and other erosion control devices where necessary to convey concentrated water across unfinished surfaces, and trap eroded sediment before it leaves the work site. If windows of dry weather are predicted for the 5-day forecast beyond October 15, and there are small additional work items that can be completed within the predicted window, then NMFS will be contacted by phone or email, and if agreement is reached, work may continue.
4. Equipment, both hand tools and heavy equipment, will be inspected daily to check for leaks.
5. Equipment that will leak lubricants or fuels into drainages will not be used until leaks are repaired. All equipment will be stored, serviced and fueled outside of riparian areas and away from stream crossings. Heavy equipment will be cleaned (*e.g.*, power washed, steam cleaned) prior to use below the ordinary high water mark.
6. A spill plan, and materials for spill containment, will be available to onsite personnel, and all personnel will know how to use them. In the event of a spill, work will stop immediately, clean up will begin, and NMFS will be notified.
7. Disruption of natural hydrologic flow paths, including diversion of streamflow and interception of surface and subsurface flows, will be minimized during excavation.
8. Adequate erosion control supplies (gravel, straw bales, shovels, *etc.*) will be kept at all restoration sites to minimize the amount of sediment that enters stream channels.
9. Water drafting from fish-bearing streams will be conducted only at sites approved by a RNSP fishery biologist, and will be done in accordance with NMFS' "Water Drafting Specifications" (NMFS 2001).
10. Streams identified to have the capability to transport sediment off-site will be diverted around excavation areas. The diverted flows will be returned to their natural

streamcourses as soon as restoration is complete and prior to the rainy season. Any turbid wastewater that is from the project, and associated dewatering, is disposed of off-site in a location that will not drain directly into a stream channel or carry sediment-laden water into a stream channel.

11. Implementation of the project within the 5-year floodplain will not begin until all temporary erosion controls (*e.g.*, straw bales, silt fences that are effectively keyed in) are in place, downslope of the project within the riparian area. Erosion control structures will be maintained throughout, and possibly after, the project is implemented. Erosion control devices, such as check dams, silt fences, and other acceptable techniques, will be used when the potential exists to have sediment or other materials entering stream channels.
12. All roads used to access restoration sites will be maintained and winterized in order to minimize erosion and to provide for free drainage. Road maintenance attempts to minimize the impacts of roads on watersheds by reducing dust, preventing drainage diversions by maintaining drainage structures, and reducing sediment runoff by reshaping road surfaces, unpaved shoulders, cutbanks and fill slopes (RNSP 2002).
13. Experienced heavy equipment contractors will be employed through a well-established contracting framework. A RNSP geologist will be present on-site 90 percent of the time during critical excavations, in order to make any needed adjustments to excavation design, and to ensure resource protection and quality control.
14. Prior to excavation, RNSP geologists will identify and map all springs, seeps, steep slopes and other unstable areas in relation to potential fill sites. The geologist on-site during project implementation will ensure that the contractor is fully aware of potential unstable areas and any wet soil conditions. The geologist on-site will also ensure that the final fill, if placed by the excavator, will be limited to safe locations with no chance of “light compaction” that would contribute sediment into live streams.
15. RNSP will continue to apply natural mulch consisting of huckleberry, alder, fir and redwood, which will be supplemented with shredded redwood bark or weed-free straw, in accordance with established erosion control guidelines. Mulching prescriptions will be modified to provide a clear path (approximately 4-foot wide corridor) along the upper edge of finished slopes to reduce life and safety hazards to RNSP staff while they access restoration sites for post-treatment monitoring.
16. Accomplishing more treatment sites will not become a driving focus at the expense of limiting the time available to devote to any given site. RNSP is dispersing the work in the Lost Man Creek watershed across time and space in order to reduce the occurrence of a “hurry up and get it done” mind set.

D. Documentation

A brief report will be provided to NMFS by the end of the July for all of the work completed the

previous year, listing the miles of road treated, the number of stream crossings treated, and the number of those stream crossings that carried surface flow during excavation. The annual report will provide information that may, in future years, help guide adaptive management with the objective of reducing the effects of the action on listed salmonids.

Road removal work will continue to be thoroughly documented. Original documents including geomorphic mapping, field notes and survey data will be archived at RNSP. Each road segment to be removed will be surveyed and monumented for planning and contracting purposes, resulting in estimates of volume of material to be excavated and fill storage areas. Excavations will be surveyed again, following restoration work and prior to the onset of the winter season, to determine actual volumes of material removed during the project. Information gathered by RNSP geologists during the excavations will include equipment hours and specifics such as ground conditions and excavation methods employed by operators. Final excavation costs and volumes for each treatment will be compiled. RNSP geologists will establish and monument photo points to document conditions before, during, and after excavation. Photo documentation will serve as a baseline for future vegetation growth studies, soil movement, or any other changes that may take place after restoration work has been completed.

E. Monitoring

All completed projects are visited a number of times during the first winter, and photographs taken at photo-points established prior to excavation. The distribution of woody debris and rock in the excavated channel may be rearranged using hand tools to minimize post-excavation erosion. Onsite and offsite monitoring are described in *RNSP Streamflow, Turbidity and Suspended Sediment Monitoring within the Lost Man Creek Watershed* (RNSP 2006, appendix 1), and summarized below.

1. Onsite Monitoring

RNSP will monitor erosion sources using several techniques. Photopoints will be established throughout a project area both before and after implementation. The post-project condition will serve as the baseline for comparison with conditions following significant rainstorms. Site erosion reconnaissance will be performed following the first significant rainfall event (*i.e.*, 2 or more inches over 24 hours). This typically occurs in November or December of each year. During this reconnaissance, photographs will be repeated, descriptions of notable erosion processes (*e.g.*, surface erosion, rilling, channel erosion, slumping) will be made and their volumes estimated, and sediment delivery to stream channels will be investigated by following erosion features downslope to the nearest channel. Such a reconnaissance will be repeated following at least two other significant rainstorms following treatment.

RNSP will continue to monitor a sample of fill sites in an attempt to determine the causes of any fill site failure. Information collected will include:

1. Notes on how fill was placed at the site that may provide clues as to whether or not there are infiltration boundaries within the fill.
2. Steepness and length of finished fill site surfaces.

3. Length of time from fill site completion to first significant rains.
4. Detailed sketch maps of failures, including location and quantity of any newly exposed springs.
5. Dimensions of failures, including volume mobilized, delivered to channel, and stored in channel.
6. Any other field observations that help determine factors contributing to failure.
7. A map showing all failure locations, overlaid on geology.

Following the winter monitoring period, a monitoring report will be prepared and incorporated into the annual report to NMFS. The report will include qualitative observations, erosion volume estimates by process, photos, and the turbidity data described below. A synthesis section will be included that attempts to compare and explain water quality trends (spatial and temporal) with erosion monitoring results. In addition, a description of any obvious successes and/or failures in the way a project was implemented, and recommendations for altering how future projects are implemented, will be provided.

2. Offsite Monitoring

Offsite monitoring will consist of measuring turbidity at a suite of locations within Lost Man Creek. Monitoring locations will, to the extent feasible, be selected to compare and contrast sub-basins with varying levels of road removal projects. Data will reflect contributions from all sediment sources upstream of each site. Consequently, attributing turbidity sources to specific road removal projects versus legacy effects from past logging will be difficult. However, the onsite monitoring described above may help describe differences observed between sampling sites.

Objectives for the turbidity monitoring include:

1. To document the turbidity in streams draining recently treated areas and in similar untreated areas;
2. To differentiate between turbidity and suspended sediment generated by the watershed restoration project (road decommissioning) and that generated by the historical logging legacy that continues to affect the stream system;
3. To follow erosional responses at stream crossing excavations through time and determine, where feasible, possible reasons for excessive erosion; and
4. To adaptively manage the road decommissioning program at RNSP by incorporating any revisions that appear to be necessary based on these study results.

Sampling locations are of similar drainage area and are arranged to provide data from the major subbasins within the Lost Man Creek watershed. Five continuous recording stations have been established in previous years to record stream stage and turbidity: North Fork Lost Man Creek, Middle Fork Lost Man Creek, South Fork Lost Man Creek, Larry Damm Creek, and mainstem Lost Man Creek below the confluence with Larry Damm Creek at the former Prairie Creek Fish Hatchery site. All five of these continuous recording stations will continue to be monitored during implementation of the LMCRP.

An annual monitoring report will be prepared for the offsite monitoring program. The report will include turbidity data and any other observations, measurements or photos. It will also include a crosswalk to the road removal project monitoring results to make inferences about possible influences of road removal on downstream water quality.

F. Action Area

Action area includes “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). The action area for the LMCRRP includes all 28 miles of road segments, adjacent streams, and all downstream aquatic habitat in Lost Man Creek, Prairie Creek and approximately 3.5 miles of Redwood Creek downstream of the Prairie Creek confluence, including the Redwood Creek estuary.

III. STATUS OF THE SPECIES AND CRITICAL HABITAT

The following listed threatened species, and designated critical habitat, occur in the action area and may be affected by the proposed action: SONCC coho salmon, CC Chinook salmon, NC steelhead, and designated critical habitat for these three species.

Table 1 presents a summary of the *Federal Register (FR)* Notice dates and citations, and geographic distributions for these species and critical habitat. This section summarizes the status of critical habitat, and species life history and population trends at the Evolutionarily Significant Unit (ESU) scale, and in the case of NC steelhead, at the Distinct Population Segment (DPS) scale. Abundance and distribution information along with a description of designated critical habitat in the action area is provided in the *Environmental Baseline*.

A. Critical Habitat

This Opinion analyzes the effects of the proposed action on designated critical habitat for SONCC coho salmon, CC Chinook salmon, and NC steelhead.

Critical habitat is defined as the specific areas within the geographical areas occupied by the species, at the time it is listed, on which are found those physical and biological features essential to the conservation of the species and which may require special management considerations or protection, or specific areas outside the geographical area occupied by the species at the time it is listed when the Secretary determines that such areas are essential for the conservation of listed species. The ESA further defines conservation as “to use all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to the ESA are no longer necessary.” As a result, NMFS approaches its “destruction and adverse modification” determinations by examining the effects of actions on the conservation value of the designated critical habitat, that is, the value of the critical habitat for the conservation of threatened or endangered species.

Table 1. The scientific name, listing status under the ESA, FR notice citation, and geographic distribution of the ESUs and DPS addressed in this Opinion.

	SONCC coho salmon ESU	NC Steelhead DPS	CC Chinook Salmon ESU
Scientific Name	<i>Oncorhynchus (O.) kisutch</i>	<i>O. mykiss</i>	<i>O. tshawytscha</i>
Listing Status	Threatened	Threatened	Threatened
<i>Federal Register Notice</i>	June 28, 2005 (70 FR 37160)	ESU listed on June 7, 2000 (65 FR 36074) Relisted as a DPS on January 5, 2006 (71 FR 834)	June 28, 2005 (70 FR 37160)
Geographic Distribution	from Cape Blanco, Oregon, to Punta Gorda, California	from Redwood Creek (Humboldt County), south to the Gualala River, inclusive	from Redwood Creek (Humboldt County) south through the Russian River
Critical Habitat Designation	May 5, 1999 (64 FR 24049)	September 2, 2005 (70 FR 52488)	September 2, 2005 (70 FR 52488)

1. SONCC Coho Salmon Designated Critical Habitat

Critical habitat for SONCC coho salmon includes all accessible waterways, substrate, and adjacent riparian zones. Excluded are: (1) areas above specific dams identified in the FR notice; (2) areas above longstanding natural impassible barriers (*i.e.*, natural waterfalls); and (3) tribal lands.

Designated critical habitat for SONCC coho salmon (May 5, 1999, 64 FR 24049) overlaps the action area of the proposed action. In designating critical habitat, NMFS focuses on the known physical and biological features within the designated area that are essential to the conservation of the species. These essential features may include, but are not limited to, spawning sites, food resources, water quality and quantity, and riparian vegetation. Within the essential habitat types (spawning, rearing, migration corridors), essential features of coho salmon critical habitat include adequate (1) substrate, (2) water quality, (3) water quantity, (4) water temperature, (5) water velocity, (6) cover/shelter, (7) food, (8) riparian vegetation, (9) space, and (10) safe passage conditions (May 5, 1999, 64 FR 24049). Current condition of critical habitat for SONCC coho salmon is discussed in the factors affecting the species below.

2. CC Chinook Salmon and NC Steelhead Designated Critical Habitat

Designated critical habitat for CC Chinook salmon and NC steelhead includes the stream channels within the stream reaches and includes a lateral extent as defined by the ordinary high-water line (33 CFR 329.11). In areas where the ordinary high-water line has not been defined pursuant to 33 CFR 329.11, 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 which generally has a recurrence level of 1 to 2 years on the annual flood series. Critical habitat in estuaries is defined by the perimeter of the water body as displayed on standard 1:24,000 scale topographic maps or the elevation of extreme high water, whichever is greater.

Designated critical habitat for CC Chinook salmon and NC steelhead (September 2, 2005, 70 FR 52488) overlaps the action area. In designating critical habitat, NMFS focuses on the known primary constituent elements (PCEs) essential for the conservation of the species. These PCEs are those sites and habitat components that support one or more life stages, including: (1) freshwater spawning, (2) freshwater rearing, (3) freshwater migration, (4) estuarine areas, (5) nearshore marine areas, and (6) offshore marine areas. Within the PCEs, essential elements of CC Chinook salmon and NC steelhead critical habitat include adequate (1) substrate, (2) water quality, (3) water quantity, (4) water temperature, (5) water velocity, (6) cover/shelter, (7) food, (8) riparian vegetation, (9) space, (10) safe passage conditions, and (11) salinity conditions (December 10, 2004, 69 FR 71880).

B. Species Life History and Population Trends

1. Coho Salmon

a. General Life History

In contrast to the life history patterns of other Pacific salmonids, coho salmon generally exhibit a relatively simple 3-year life cycle. Most coho salmon enter rivers between September and February. Coho salmon river entry timing is influenced by many factors, one of which appears to be river flow. In addition, many small California stream systems have their mouths blocked by sandbars for most of the year except winter. In these systems, coho salmon and other Pacific salmonid species are unable to enter the rivers until sufficiently strong freshets open passages through the bars (Weitkamp *et al.* 1995). Coho salmon spawn from November to January (Hassler 1987), and occasionally into February and March (Weitkamp *et al.* 1995).

Although each native stock appears to have a unique time and temperature for spawning that theoretically maximizes offspring survival, coho salmon generally spawn at water temperatures within the range of 50-55EF (Bell 1991). Bjornn and Reiser (1991) found that spawning occurs in a few third-order streams, but most spawning activity was found in fourth- and fifth-order streams. Nickelson *et al.* (1992) found that spawning occurs in tributary streams with a gradient of 3 percent or less. Spawning occurs in clean gravel ranging in size from that of a pea to that of an orange (Nickelson *et al.* 1992). Spawning is concentrated in riffles or in gravel deposits at the downstream end of pools featuring suitable water depth and velocity (Weitkamp *et al.* 1995).

The favorable thermal range for coho salmon egg incubation is 50-55EF (Bell 1991). Coho salmon eggs incubate for approximately 35-50 days, and start emerging from the gravel 2 to 3 weeks after hatching (Hassler 1987, Nickelson *et al.* 1992). Following emergence, fry move into shallow areas near the streambanks. As coho salmon fry grow, they disperse upstream and downstream to establish and defend territories (Hassler 1987).

Juvenile rearing usually occurs in tributary streams with a gradient of 3 percent or less, although they may move up to streams of 4 percent or 5 percent gradient. Juveniles have been found in streams as small as 3 to 6 feet wide. At a length of 1.5-1.75 inches, the fry may migrate upstream a considerable distance to reach lakes or other rearing areas (Godfrey 1965 *op cit* Sandercock 1991, Nickelson *et al.* 1992). Rearing requires temperatures of 68EF or less, preferably 53-58EF (Reiser and Bjornn 1979, Reeves *et al.* 1987, Bell 1991). Coho salmon fry are most abundant in backwater pools during spring. During the summer, coho salmon fry prefer pools featuring adequate cover such as LWD, undercut banks, and overhanging vegetation. Juvenile coho salmon prefer to over-winter in large mainstem pools, backwater areas and secondary pools with LWD, and undercut bank areas (Hassler 1987, Heifetz *et al.* 1986). Coho salmon rear in fresh water for up to 15 months, then migrate to the sea as smolts between March and June (Weitkamp *et al.* 1995).

The ideal food channel for maximum coho salmon smolt production would have shallow depth (3-24 inches), fairly swift mid-stream flows (2 feet/sec), numerous marginal back-eddies, narrow width, copious overhanging mixed vegetation (to lower water temperatures, provide leaf litter, and contribute terrestrial insects), and banks permitting hiding places (Boussu 1954 *op cit* Mundie 1969). The early diets of emerging fry include chironomid larvae and pupae (Mundie 1969). Juvenile coho salmon are carnivorous opportunists that primarily eat aquatic and terrestrial insects. They do not appear to pick stationary items off the substratum (Sandercock 1991, Mundie 1969).

In preparation for their entry into a saline environment, juvenile salmonids undergo physiological transformations known as smoltification that adapt them for their transition to saltwater (Hoar 1976). These transformations include different swimming behavior and proficiency, lower swimming stamina, and increased buoyancy that also make the fish more likely to be passively transported by currents (Saunders 1965, Folmar and Dickhoff 1980, Smith 1982). In general, smoltification is timed to be completed as fish are near the freshwater to saltwater transition. Too long a migration delay after the process begins is believed to cause the fish to miss the biological window of optimal physiological condition for the transition (Walters *et al.* 1978).

Little is known about residence time or habitat use in estuaries during seaward migration, although it is usually assumed that coho salmon spend only a short time in the estuary before entering the ocean (Nickelson *et al.* 1992). Growth is very rapid once the smolts reach the estuary (Fisher *et al.* 1984 *op cit* Sandercock 1991). While living in the ocean, coho salmon remain closer to their river of origin than do Chinook salmon (Weitkamp *et al.* 1995). Nevertheless, coho salmon have been captured several hundred to several thousand kilometers away from their natal stream (Hassler 1987). After about 12 months at sea, coho salmon gradually migrate south and along the coast, but some appear to follow a counter-clockwise circuit in the Gulf of Alaska (Sandercock 1991). Coho salmon typically spend two growing seasons in the ocean before returning to their natal streams to spawn as 3 year-olds. Some precocious males, called "jacks," return to spawn after only 6 months at sea.

b. Range-wide (ESU) Status and Trends of SONCC Coho Salmon

Available historical and recent published coho salmon abundance information are summarized in the NMFS coast-wide status review (Weitkamp *et al.* 1995). The following are excerpts from that document:

■Gold Ray Dam adult coho passage counts provide a long-term view of coho salmon abundance in the upper Rogue River. During the 1940s, counts averaged ca. 2,000 adult coho salmon per year. Between the late 1960s and early 1970s, adult counts averaged fewer than 200. During the late 1970s, dam counts increased, corresponding with returning coho salmon produced at Cole Rivers Hatchery. Coho salmon run size estimates derived from seine surveys at Huntley Park near the mouth of the Rogue River have ranged from ca. 450 to 19,200 naturally-produced adults between 1979 and 1991. In Oregon south of Cape Blanco, Nehlsen *et al.* (1991) considered all but one coho salmon population to be at 'high risk of extinction.' South of Cape Blanco, Nickelson *et al.* (1992) rated all Oregon coho salmon populations as 'depressed.'

Brown and Moyle (1991) estimated that naturally-spawned adult coho salmon returning to California streams were less than one percent of their abundance at mid-century, and indigenous, wild coho salmon populations in California did not exceed 100 to 1,300 individuals. Further, they stated that 46 percent of California streams which historically supported coho salmon populations, and for which recent data were available, no longer supported runs.

No regular spawning escapement estimates exist for natural coho salmon in California streams. California Department of Fish and Game (CDFG 1994) summarized most information for the northern California region of this ESU. They concluded that 'coho salmon in California, including hatchery populations, could be less than six percent of their abundance during the 1940's, and have experienced at least a 70 percent decline in the 1960's.' Further, they reported that coho salmon populations have been virtually eliminated in many streams, and that adults are observed only every third year in some streams, suggesting that two of three brood cycles may already have been eliminated.

The rivers and tributaries in the California portion of this ESU were estimated to have average recent runs of 7,080 natural spawners and 17,156 hatchery returns, with 4,480 identified as 'native' fish occurring in tributaries having little history of supplementation with non-native fish. Combining recent run-size estimates for the California portion of this ESU with Rogue River estimates provides a rough minimum run-size estimate for the entire ESU of about 10,000 natural fish and 20,000 hatchery fish.●

Schiewe (1997) summarized updated and new data on trends in abundance for coho salmon from the northern California and Oregon coasts. The following are excerpts from this document regarding the status and trends of the SONCC coho salmon ESU:

■Information on presence/absence of coho salmon in northern California streams has been updated since the study by Brown *et al.* (1994) cited in the status review. More recent data [Table 2] indicates that the proportion of streams with coho salmon present is lower than in the earlier study (52% vs. 63%). In addition, the BRT [Biological Review Team] received updated estimates of escapement at the Shasta and Willow Creek weirs in the Klamath River Basin, but these represent primarily hatchery production and are not useful in assessing the status of natural populations.

New data on presence/absence in northern California streams that historically supported coho salmon are even more disturbing than earlier results, indicating that a smaller percentage of streams in this ESU contain coho salmon compared to the percentage presence in an earlier study. However, it is unclear whether these new data represent actual trends in local extinctions, or are biased by sampling effort.”

NMFS (2001a) updated the status review for coho salmon from the Central California Coast (CCC) and the California portion of the SONCC ESUs. The following is a summary of the updated status review:

■In the California portion of the SONCC coho salmon ESU, there appears to be a general decline in abundance, but trend data are more limited in this area and there is variability among streams and years. In the California portion of the SONCC coho salmon ESU, Trinity River Hatchery maintains large production and is thought to create significant straying to natural populations. In the California portion of the SONCC coho salmon ESU, the percent of streams with coho present in at least one brood year has shown a decline from 1989-1991 to the present. In 1989-1991 and 1992-1995, coho were found in over 80 percent of the streams surveyed. Since then, the percentage has declined to 69 percent in the most recent three-year interval.

Both the presence-absence and trend data presented in this report suggest that many coho salmon populations in this ESU continue to decline. Presence-absence information from the past 12 years indicates fish have been extirpated or at least reduced in numbers sufficiently to reduce the probability of detection in conventional surveys. Unlike the CCC ESU, the percentage of streams in which coho were documented did not experience a strong increase in the 1995-1997 period. Population trend data were less available in this ESU, nevertheless, for those sites that did have trend information, evidence suggests

declines in abundance.

After considering this information, we conclude that the Southern Oregon/Northern California Coasts ESU is presently not at risk of extinction, but it is likely to become endangered in the foreseeable future. The conclusion is tempered by the fact that population trend data was limited, and further analysis may reveal declines sufficient to conclude that the California portion of this ESU is in danger of extinction.”

Table 2. Summary statistics of historical and current presence-absence data for coho salmon from the California portion of the SONCC ESU (from Schiewe 1997).

Area	Streams historically inhabited by coho salmon	Streams recently surveyed	Number of streams with coho salmon present	Percent of streams with coho salmon present	
				New data (refer to Schiewe 1997 for data sources used)	Brown <i>et al.</i> (1994)
Del Norte County	130	46	21	46	55
Humboldt County	234	130	71	55	69
Total	364	176	92	52	63

Based on the very depressed status of current coho salmon populations discussed above as well as insufficient regulatory mechanisms and conservation efforts over the ESU as a whole, NMFS concluded that the ESU is likely to become endangered in the foreseeable future (May 6, 1997, 62 FR 24588). A more recent status update (Good *et al.* 2005) indicates a continued low abundance with no apparent trends in abundance and possible continued declines in several California populations. The relatively strong 2001 brood year, likely due to favorable conditions in both freshwater and marine environments was viewed as a positive sign, but was a single strong year following more than a decade of generally poor years (Good *et al.* 2005).

2. Steelhead

a. *General Life History*

Biologically, steelhead can be divided into two basic run-types, based on the state of sexual maturity at the time of river entry and duration of spawning migration (Burgner *et al.* 1992 *op cit* Busby *et al.* 1996). The stream-maturing type, or summer steelhead, enters freshwater in a sexually immature condition and requires several months in freshwater to mature and spawn. The ocean-maturing type, or winter steelhead, enters freshwater with well-developed gonads and spawns shortly after river entry (August 9, 1996, 61 FR 41541; Barnhart 1986). Variations in migration timing exist between populations. Some river basins have both summer and winter steelhead, while others only have one run-type. South of Cape Blanco, Oregon, summer

steelhead are known to occur in the Rogue, Smith, Klamath, Trinity, Mad, and Eel Rivers, and in Redwood Creek (Busby *et al.* 1996), in addition to the winter runs present in these basins.

Summer steelhead enter freshwater between May and October in the Pacific Northwest (Busby *et al.* 1996, Nickelson *et al.* 1992). They require cool, deep holding pools during summer and fall, prior to spawning (Nickelson *et al.* 1992). They migrate inland toward spawning areas, over winter in the larger rivers, resume migration in early spring to natal streams, and then spawn (Meehan and Bjornn 1991, Nickelson *et al.* 1992) in January and February (Barnhart 1986).

Winter steelhead enter freshwater between November and April in the Pacific Northwest (Nickelson *et al.* 1992, Busby *et al.* 1996), migrate to spawning areas, and then spawn, generally in April and May (Barnhart 1986). Some adults, however, do not enter some coastal streams until spring, just before spawning (Meehan and Bjornn 1991).

There is a high degree of overlap in spawn timing between populations within a DPS regardless of run type (Busby *et al.* 1996). Difficult field conditions at that time of year and the remoteness of spawning grounds contribute to the relative lack of specific information on steelhead spawning. Unlike Pacific salmon, steelhead are iteroparous, or capable of spawning more than once before death (Busby *et al.* 1996). However, it is rare for steelhead to spawn more than twice before dying; most that do so are females (Nickelson *et al.* 1992). Iteroparity is more common among southern steelhead populations than northern populations (Busby *et al.* 1996).

Steelhead spawn in cool, clear streams featuring suitable gravel size, depth, and current velocity. Intermittent streams may be used for spawning (Everest 1973, Barnhart 1986). Steelhead enter streams and arrive at spawning grounds weeks or even months before they spawn and are vulnerable to disturbance and predation. Cover, in the form of overhanging vegetation, undercut banks, submerged vegetation, submerged objects such as logs and rocks, floating debris, deep water, turbulence, and turbidity (Giger 1973 *op cit* Bjornn and Reiser 1991) are required to reduce disturbance and predation of spawning steelhead. It appears that summer steelhead occur where habitat is not fully utilized by winter steelhead, with summer steelhead usually spawning further upstream than winter steelhead (Withler 1966, Behnke 1992).

Steelhead require a minimum depth of 7 inches and a maximum velocity of 8 feet/sec for active upstream migration (Smith 1973). Spawning and initial rearing of juvenile steelhead generally take place in small, moderate-gradient (generally 3-5 percent) tributary streams (Nickelson *et al.* 1992). A minimum depth of 7 inches, water velocity of 1-3 feet/sec (Thompson 1972, Smith 1973), and clean substrate 0.25-4 inches (Hunter 1973 *op cit* Bjornn and Reiser 1991, Nickelson *et al.* 1992) are required for spawning. Steelhead spawn in 39-49°F water (Bell 1991).

Depending on water temperature, steelhead eggs may incubate for 1.5-4 months before hatching, generally between February and June (Bell 1991). Bjornn and Reiser (1991) noted that steelhead eggs incubate about 85 days at 39°F and 26 days at 54°F to reach 50 percent hatch. Nickelson *et al.* (1992) stated that eggs hatch in 35-50 days, depending upon water temperature.

After 2 to 3 weeks, in late spring, and following yolk sac absorption, alevins emerge from the gravel and begin actively feeding. After emerging from the gravel, fry usually inhabit shallow

water along banks of perennial streams. Fry occupy stream margins (Nickelson *et al.* 1992). Older fry establish and defend territories.

Summer rearing takes place primarily in the faster parts of pools, although young-of-the-year are abundant in glides and riffles. Winter rearing occurs more uniformly at lower densities across a wide range of fast and slow habitat types. Productive steelhead habitat is characterized by complexity, primarily in the form of large and small in-stream wood. Some older juveniles move downstream to rear in larger tributaries and mainstem rivers (Nickelson *et al.* 1992).

Juvenile steelhead migrate little during their first summer and occupy a range of habitats featuring moderate to high water velocity and variable depths (Bisson *et al.* 1988). Rearing juveniles prefer water temperatures ranging from 54-59°F (Reeves *et al.* 1987). Juvenile steelhead feed on a wide variety of aquatic and terrestrial insects (Chapman and Bjornn 1969), and older juveniles sometimes prey on emerging fry. Steelhead hold territories close to the substratum where flows are lower and sometimes counter to the main stream. From these, they can make forays up into surface currents to take drifting food (Kalleberg 1958 *op cit* Mundie 1969). Juveniles rear in freshwater from 1 to 4 years (usually 2 years in the California DPSs), then smolt and migrate to the ocean in March and April (Barnhart 1986). Winter steelhead generally smolt after 2 years in freshwater (Busby *et al.* 1996). Steelhead smolts are usually 6-8 inches total length and migrate to the ocean in the spring (Meehan and Bjornn 1991). Based on incidental purse seine catches, juvenile steelhead tend to migrate directly offshore during their first summer from whatever point they enter the ocean, rather than migrating along the coastal belt as salmon do. During the fall and winter, juveniles move southward and eastward (Hartt and Dell 1986 *op cit* Nickelson *et al.* 1992).

Steelhead typically reside in marine waters for 2 or 3 years prior to returning to their natal stream to spawn as 4- or 5-year olds (August 9, 1996, 61 FR 41542). Populations in Oregon and California have higher frequencies of age-1 ocean steelhead than populations to the north, but age-2 ocean steelhead generally remain dominant (Busby *et al.* 1996). Age structure appears to be similar to other west coast steelhead, dominated by 4-year-old spawners (Busby *et al.* 1996). Some steelhead return to freshwater after only 2 to 4 months in the ocean and are termed "half-pounders" (Snyder 1925). Half-pounders generally spend the winter in freshwater and then out migrate again the following spring for several months before returning to freshwater to spawn. Half-pounders occur over a relatively small geographic range in southern Oregon and northern California, and are only reported in the Rogue, Klamath, Mad, and Eel Rivers (Snyder 1925, Kesner and Barnhart 1972, Everest 1973, Barnhart 1986).

b. Range-Wide Status and Trends of NC Steelhead

Available historical and most recent published steelhead abundance are summarized in the NMFS west coast steelhead status review (Busby *et al.* 1996). The following are excerpts from that document:

"Prior to 1960, estimates of abundance specific to this ESU were available from dam counts in the upper Eel River (Cape Horn Dam, annual average of 4,400 adult steelhead in the 1930s), the South Fork Eel River (Benbow Dam, annual average of 19,000 adult

steelhead in the 1940s), and the Mad River (Sweasey Dam annual average of 3,800 adult steelhead in the 1940s).

In the mid-1960s, estimates of steelhead spawning populations for many rivers in this ESU totaled 198,000. The only current run-size estimates for this area are counts at Cape Horn Dam on the Eel River where an average of 115 total and 30 wild adults were reported.

Adequate adult escapement information was available to compute trends for seven stocks within this ESU. Of these, five data series exhibit declines and two exhibit increases during the available data series, with a range from 5.8% annual decline to 3.5% annual increase. Three of the declining trends were significantly different from zero. We have little information on the actual contribution of hatchery fish to natural spawning, and little information on present total run sizes for this ESU. However, given the preponderance of significant negative trends in the available data, there is concern that steelhead populations in this ESU may not be self-sustaining."

Schiewe (1997a) summarized more recent data on trends in abundance for summer and winter steelhead in the Northern California ESU. The following are excerpts from this document:

"Updated spawner surveys of summer steelhead in Redwood Creek, the south fork of the Van Duzen River (Eel River Basin), and the Mad River suggest mixed trends in abundance: the Van Duzen fish decreased by 7.1% from 1980-96 and the Mad River summer steelhead have increased by 10.3% over the same time period. The contribution of hatchery fish to these trends in abundance is not known.

New weir counts of winter steelhead in Prairie Creek (Redwood Creek Basin, Humboldt County) show a dramatic increase (over 36%) in abundance during the period 1985-1992. This increase is difficult to interpret because a major highway construction project during this time period resulted in intensive monitoring of salmonids in the basin and Prairie Creek Hatchery was funded to mitigate lost salmonid production. Therefore, it is unclear whether the increase in steelhead reflects increased monitoring effort and mitigation efforts or an actual recovery of Prairie Creek steelhead."

In 2000, NMFS concluded that the status of the population had changed little since the 1997 evaluation. Based on this and a lack of implementation of State conservation measures, NMFS concluded that the Northern California steelhead ESU warranted listing as a threatened species (June 7, 2000, 65 FR 36074). A more recent review of the status of NC steelhead (Good *et al.* 2005) indicates that none of the recent data suggest any improvements in the status of the species. Following this, NMFS relisted the NC steelhead ESU as a DPS (January 5, 2006, 71 FR 834).

3. Chinook Salmon

a. General Life History

Of the Pacific salmon, Chinook salmon exhibit arguably the most diverse and complex life history strategies. Healey (1986) described 16 age categories for Chinook salmon, 7 total ages with 3 possible freshwater ages. Two generalized freshwater life-history types were described by Healey (1991): "stream-type" Chinook salmon reside in freshwater for a year or more following emergence, whereas "ocean-type" Chinook salmon migrate to the ocean within their first year. In the Eel River Basin, both life-history types are present.

Chinook salmon mature between 2 and 6+ years of age (Myers *et al.* 1998). Freshwater entry and spawning timing are generally thought to be related to local water temperature and flow regimes (Miller and Brannon 1982). Runs are designated on the basis of adult migration timing. However, distinct runs also differ in the degree of maturation at the time of river entry, thermal regime and flow characteristics of their spawning site, and actual time of spawning (Myers *et al.* 1998).

Run timing for spring-run Chinook salmon in the CC Chinook salmon ESU typically begins in March and continues through July, with peak migration occurring in May and June. Spawning begins in late August and can continue through October, with a peak in September. Historically, spring-run Chinook salmon spawning areas were located in the river headwaters (generally above 1,300 feet). Run timing for fall-run Chinook salmon varies depending on the size of the river. Adult Rogue, Upper Klamath, and Eel River fall-run Chinook salmon return to freshwater in August and September and spawn in late October and early November (Stone 1897, Snyder 1931, Nicholas and Hankin 1988, Barnhart 1995). In other coastal rivers and the lower reaches of the Klamath River, fall-run freshwater entry begins later in October, with peak spawning in late November and December--often extending into January (Leidy and Leidy 1984, Nicholas and Hankin 1988, Barnhart 1995). Late-fall or "snow" Chinook salmon from Blue Creek, on the lower Klamath River, were described as resembling the fall-run fish from the Smith River in run and spawning timing, as well as the degree of sexual maturation at the time of river entry (Snyder 1931).

When they enter freshwater, spring-run Chinook salmon are immature and must stage for several months before spawning. Their gonads mature during their summer holding period in freshwater. Over-summering adults require cold-water refuges such as deep pools to conserve energy for gamete production, redd construction, spawning, and redd guarding. The upper limit of the optimal temperature range for adults holding while eggs are maturing is 59-61°F (Hinz 1959). The upper preferred water temperature for spawning adult Chinook salmon is 55-57°F (Reiser and Bjornn 1979). High stream temperatures during spawning migration and adult holding periods can alter or delay migration timing, accelerate maturation, and increase fish susceptibility to diseases. Sustained water temperatures above 80°F are lethal to adults (Cramer and Hammack 1952, CDFG 1998).

Spring-run Chinook salmon eggs generally incubate between October to January, and fall-run Chinook salmon eggs incubate between October and December (Bell 1991). The length of time required for eggs to develop and hatch is dependent on water temperature and is quite variable, typically ranging from 3-5 months. The optimum temperature range for Chinook salmon egg incubation is 45-54°F (Rich 1997). Incubating eggs show reduced egg viability and increased

mortality at temperatures greater than 57°F and show 100 percent mortality for temperatures greater than 63°F (Velson 1987). Velson (1987) found that developing Chinook salmon embryos exposed to water temperatures of 36°F or less before the eyed stage experienced 100 percent mortality (CDFG 1998). Emergence of spring- and fall-run Chinook salmon fry begins in December and continues into mid-April (Leidy and Leidy 1984, Bell 1991). Fry use woody debris, interstitial spaces in cobble substrates, and undercut banks as cover (Everest and Chapman 1972). As the fry grow, habitat preferences change. Juveniles move away from stream margins and begin to use deeper water areas with slightly higher water velocities.

Post-emergent fry seek out shallow, nearshore areas with slow current and good cover, and begin feeding on small terrestrial and aquatic insects and aquatic crustaceans. As they grow to 2 to 3 inches in length, the juvenile salmon move out into deeper, swifter water, but continue to use available cover to minimize the risk of predation and reduce energy expenditure. The optimum range for rearing Chinook salmon fry is 50-55°F (Rich 1997, Seymour 1956) and for fingerlings is 55-61°F (Rich 1997). Data from the Mad River (Sparkman 2002) and nearby Redwood Creek (Sparkman 2003) indicate that emergent Chinook salmon fry develop rapidly following emergence. Over a 15-week period in the spring of 2001, Chinook salmon fry increased in average length from 1.6 inches to 2.6 inches with the bulk of this growth occurring during a 10-week period in May and June (Sparkman 2002). The months of May and June accounted for 91.5 percent of the total captures of migrating young-of-the-year Chinook salmon in 2001 (Sparkman 2002).

The majority of fish emigrate to the ocean as sub yearlings, although yearling smolts can constitute up to approximately one-fifth of out-migrants from the Klamath River Basin, and to a lesser proportion in the Rogue River Basin. However, the proportion of fish which smolted as sub yearling vs. yearling varies from year to year (Snyder 1931, Schluchter and Lichatowich 1977, Nicholas and Hankin 1988, Barnhart 1995). This fluctuation in age at smoltification is more characteristic of an ocean-type life history. Furthermore, the low flows, high temperatures, and barrier bars that develop in smaller coastal rivers during the summer months would favor an ocean-type (sub yearling smolt) life history (Kostow 1995).

Ocean-type juveniles enter saltwater during one of three distinct phases. ■Immediate■ fry migrate to the ocean soon after yolk resorption at 1.2-1.8 inches in length (Lister *et al.* 1971 *op cit.* Myers *et al.* 1998, Healey 1991). In most river systems, however, fry migrants, which migrate at 50-150 days post-hatching, and fingerling migrants, which migrate in the late summer or autumn of their first year, represent the majority of ocean-type emigrants. Stream-type Chinook salmon migrate during their second or, more rarely, their third spring (Healey 1991). Under natural conditions, stream-type Chinook salmon appear to be unable to smolt as sub yearlings (Healey 1991).

The diet of out-migrating ocean-type Chinook salmon varies geographically and seasonally, and feeding appears to be opportunistic (Healey 1991). Aquatic insect larvae and adults, *Daphnia*, amphipods (*Eogammarus* and *Corophium* spp.), and *Neomysis* have been identified as important food items (Kjelson *et al.* 1982 *op cit* Myers *et al.* 1998, Healey 1991).

Juvenile stream- and ocean-type Chinook salmon have adapted to different ecological niches. Ocean-type Chinook salmon tend to utilize estuaries and coastal areas more extensively for juvenile rearing. In general, the younger (smaller) juveniles are at the time of emigration to the estuary, the longer they reside there (Kjelson *et al.* 1982 *op cit* Myers *et al.* 1998, Levy and Northcote 1982 *op cit* Myers *et al.* 1998, Healey 1991). Stream-type juveniles are much more dependent on freshwater stream ecosystems because of their extended residence in these areas. A stream-type life history may be adapted to those watersheds, or parts of watersheds, that are more consistently productive and less susceptible to dramatic changes in water flow, or which have environmental conditions that would severely limit the success of sub yearling smolts (Miller and Brannon 1982, Healey 1991).

Chinook salmon spend between 1 and 4 years in the ocean before returning to their natal streams to spawn (Myers *et al.* 1998). Fisher (1994 *op cit* Sandercock 1991) reported that 87 percent of returning spring-run adults are 3-year-olds based on observations of adult Chinook salmon trapped and examined at Red Bluff Diversion Dam on the Sacramento River between 1985 and 1991.

b. Range-Wide Status and Trends of CC Chinook salmon

Available historical and most recent published Chinook salmon abundance information are summarized in Myers *et al.* (1998). The following are excerpts from this document:

"Estimated escapement of this ESU was estimated at 73,000 fish, predominantly in the Eel River (55,500) with smaller populations in; Redwood Creek, Mad River, Mattole River (5,000 each), Russian River (500), and several small streams in Del Norte and Humboldt Counties.

Within this ESU, recent abundance data vary regionally. Dam counts of upstream migrants are available on the South Fork Eel River at Benbow Dam from 1938 to 1975. Counts at Cape Horn Dam, on the upper Eel River are available from the 1940s to the present, but they represent a small, highly variable portion of the run. No total escapement estimates are available for this ESU, although partial counts indicate that escapement in the Eel River exceeds 4,000.

Data available to assess trends in abundance are limited. Recent trends have been mixed, with predominantly strong negative trends in the Eel River Basin, and mostly upward trends elsewhere. Previous assessments of stocks within this ESU have identified several stocks as being at risk or of concern. Nehlsen *et al.* (1991) identified seven stocks as at high extinction risk and seven stocks as at moderate extinction risk. Higgins *et al.* (1992) provided a more detailed analysis of some of these stocks, and identified nine Chinook salmon stocks as at risk or of concern. Four of these stock assessments agreed with

Nehlsen *et al.* (1991) designations, while five fall-run Chinook salmon stocks were either reassessed from a moderate risk of extinction to stocks of concern (Redwood Creek, Mad River, and Eel River) or were additions to the Nehlsen *et al.* (1991) list as stocks of special concern (Little and Bear Rivers). In addition, two fall-run stocks (Smith and Russian Rivers) that Nehlsen *et al.* (1991) listed as at moderate extinction risk were deleted from the list of stocks at risk by Higgins *et al.* (1992), although the U.S. Fish and Wildlife Service reported that the deletion for the Russian River was due to a finding that the stock was extinct."

Observed widespread declines in abundance and the present distribution of small populations with sometimes sporadic occurrences contribute to the risks faced in this ESU. Based on this information, NMFS concluded that the CC Chinook salmon ESU is likely to become endangered in the near future (September 16, 1999, 64 FR 50393).

More recent information for the status of CC Chinook salmon (Good *et al.* 2005) continues to support this conclusion:

"No information exists to suggest new risk factors or substantial effective amelioration of risk factors noted in the previous status reviews, except for recent changes in ocean conditions. Recent favorable ocean conditions have contributed to apparent increases in abundance and distribution for a number of anadromous salmonids, but the expected persistence of this trend is unclear."

B. Factors Affecting the Species and Critical Habitat

Salmonids on the west coast of the United States have experienced declines in abundance in the past several decades as a result of loss, damage or change to their natural environment. Studies indicate that in most western states, about 80-90 percent of the historic riparian habitat has been eliminated (Norse 1990, California State Lands Commission 1993). Loss of habitat complexity and habitat fragmentation have also contributed to the decline of salmonids. For example, in national forests within the range of the northern spotted owl in western and eastern Washington, there has been a 58 percent reduction in large, deep pools due to sedimentation and loss of pool-forming structures such as boulders and large wood (Forest Ecosystem Management and Assessment Team 1993). Similar effects are likely in California. The California Advisory Committee on Salmon and Steelhead Trout (1988) reported habitat blockages and fragmentation, logging and agricultural activities, urbanization, and water withdrawals as the most predominant problems for anadromous salmonids in California's coastal basins. It identified associated habitat problems for each major river system in California. CDFG (1965, Vol. III, Part B) reported that the most vital habitat factor for coastal California streams was "degradation due to improper logging followed by massive siltation, log jams, *etc.*" It cited road building as another cause of siltation in some areas. It identified a variety of specific critical habitat problems in individual basins, including extremes of natural flows (Redwood Creek and Eel River), logging practices (Mad, Eel, Mattole, Ten Mile, Noyo, Big, Navarro, Garcia, and Gualala Rivers), dams with no passage facilities (Eel and Russian Rivers), and water diversions (Eel and Russian Rivers).

Since the studies cited above were published in the 1980s and 1990s, effort has been focused on restoring freshwater habitat for listed salmonids across the ESUs and DPS, especially on Federal lands, but also on private lands. Hundreds of miles of roads have been removed, reducing active erosional sources, and the risk of sediment inputs to downstream habitat. In addition, miles of instream habitat have been improved with the introduction of large wood or boulders, and hundreds of culverts have been upgraded to allow for fish passage at all life history stages, increasing the amount of accessible habitat. Thus, NMFS believes that the condition of designated critical habitats has improved since the 1990s, especially on Federal lands, but we are unable to quantify the specific habitat improvements at this time.

The factors for decline among populations of SONCC coho salmon, CC Chinook salmon, and NC steelhead are similar and are discussed collectively below. Factors affecting only a particular species are highlighted, where appropriate. For more detailed discussions on factors for decline of SONCC coho salmon, refer to Weitkamp *et al.* (1995) as updated by Schiewe (1997) and CDFG (2002). Factors causing NC steelhead declines are described in Busby *et al.* (1996). Factors influencing CC Chinook salmon are discussed in Myers *et al.* (1998).

1. Timber Harvest

Timber harvest and associated activities occur over a large portion of the ESUs and DPS of the affected species. Timber harvest has caused widespread increases in sediment delivery to channels through both increased landsliding and surface erosion from harvest units and log decks. Much of the riparian vegetation has been removed, reducing future sources of LWD needed to form and maintain stream habitat that salmonids depend on for various life stages. Cumulatively, the increased sediment delivery and reduced woody debris supply have led to widespread impacts to stream habitats and salmonids. These impacts include reduced spawning habitat quality, loss of pool habitat for adult holding and juvenile rearing, loss of velocity refugia, and increases in the levels and duration of turbidity which reduces the ability of juvenile fish to feed, and, in some cases may cause physical harm by abrading the gills of individual fish. These changes in habitat have led to widespread decreases in the carrying capacity of the streams that support salmonids.

2. Road Construction

Road construction, whether associated with timber harvest or other activities, has caused widespread impacts to salmonids (Furniss *et al.* 1991). Where roads cross salmonid-bearing streams, improperly placed culverts have blocked access to many stream reaches. Landsliding and chronic surface erosion from road surfaces are large sources of sediment across the affected species' ranges. Roads also have the potential to increase peak flows with consequent effects on the stability of stream substrates and banks. Roads have led to widespread impacts on salmonids by increasing the sediment loads. The consequent impacts on habitat include reductions in spawning, rearing and holding habitat, and increases in turbidity. These effects are similar to those described for timber harvest above.

3. Hatcheries

Artificial propagation is also a factor in the decline of salmonids due to the genetic impacts on indigenous, naturally-reproducing populations, disease transmission, predation of wild fish, depletion of wild stock to enhance brood stock, and replacement rather than supplementation of wild stocks through competition and the continued annual introduction of hatchery fish.

Artificial propagation and other human activities such as harvest and habitat modification can genetically change natural populations so much that they no longer represent an evolutionarily significant component of the biological species (Waples 1991). NMFS specifically identified the past practices of the Mad River Hatchery as potentially damaging to NC steelhead. CDFG out-planted non-indigenous Mad River Hatchery brood stocks to other streams within the DPS. It also attempted to cultivate a run of non-indigenous summer steelhead within the Mad River. CDFG ended these practices in 1996.

4. Water Diversions

Stream flow diversions are common throughout the species' ranges. Unscreened diversions for agricultural, domestic and industrial uses are a significant factor for salmonid declines in many basins. Reduced streamflows due to diversions reduces the amount of habitat available to salmonids and can degrade existing water quality, particularly where return flows enter the river. Reductions in the quantity of water in a given stream reach will reduce the carrying capacity of the reach. Where warm return flows enter the stream, fish may seek reaches with cooler water, thus increasing competitive pressures in other areas.

5. Predation

Predation was not believed to have been a major cause in the species declines, however, it may have had substantial impacts in local areas. For example, Higgins *et al.* (1992) and CDFG (1994) reported that Sacramento River pikeminnow have been found in the Eel River Basin and are considered a major threat to native salmonids (this is discussed further in the *Environmental Baseline* section). Furthermore, California sea lions and Pacific harbor seals, which occur in most estuaries and rivers where salmonid runs occur on the west coast, are known predators of salmonids. However, salmonids appear to be a minor component of the diet of marine mammals (Scheffer and Sperry 1931, Jameson and Kenyon 1977, Graybill 1981, Brown and Mate 1983, Roffe and Mate 1984, Hanson 1993). NMFS (1997) determined that although pinniped predation did not cause the decline of salmonid populations, in localized areas where they co-occur with salmonids (especially where salmonids concentrate or passage may be constricted), predation may preclude recovery of these populations. Specific areas where predation may preclude recovery cannot be determined without extensive studies.

6. Disease

Infectious disease is one of many factors that can influence adult and juvenile salmonid survival. Salmonids are exposed to numerous bacterial, protozoan, viral, and parasitic organisms in spawning and rearing areas, hatcheries, migratory routes, and the marine environment. Very little current or historical information exists to quantify changes in infection levels and mortality rates attributable to these diseases for salmonids. However, studies suggest that naturally-spawned fish tend to be less susceptible to pathogens than hatchery-reared fish (Sanders *et al.*

1992).

7. Existing Regulatory Mechanisms

Existing regulatory mechanisms, including land management plans (*e.g.*, National Forest Land Management Plans, State Forest Practice Rules), Clean Water Act (CWA) section 404 activities, urban growth management, and harvest and hatchery management all contributed to varying degrees to the decline of salmonids due to lack of protective measures, the inadequacy of existing measures to protect salmonids and/or their habitat, or the failure to carry out established protective measures.

The CWA, enforced in part by the Environmental Protection Agency (EPA), is intended to protect beneficial uses, including fishery resources. To date, implementation has not been effective in adequately protecting fishery resources, particularly with respect to non-point sources of pollution. In addition, section 404 of the CWA does not adequately address the cumulative and additive effects of loss of habitat through continued development of waterfront, riverine, coastal, and wetland properties that also contribute to the degradation and loss of important aquatic ecosystem components necessary to maintain the functional integrity of these habitat features. Sections 303(d)(1)(C) and (D) of the CWA require states to prepare Total Maximum Daily Loads (TMDLs) for all water bodies that do not meet State water quality standards. Development of TMDLs is a method for quantitative assessment of environmental problems in a watershed and identification of pollution reductions needed to protect drinking water, aquatic life, recreation, and other uses of rivers, lakes, and streams. Appropriately protective aquatic life criteria are critical to the TMDL process for affecting the recovery of salmonid populations, as the criteria's exceedence will determine which water bodies will engage in the TMDL process and criteria compliance goals are the impetus for developing mass loading strategies. The ability of these TMDLs to protect salmonids should be significant in the long-term. However, developing them quickly in the short-term will be difficult, and their efficacy in protecting salmonid habitat will be unknown for years to come.

In August 2002, the California Fish and Game Commission (Commission) issued a finding that coho salmon warranted listing as a threatened species in the SONCC ESU under the California Endangered Species Act. The Commission directed CDFG to develop a Recovery Strategy. Subsequently, the Director of CDFG initiated a multi-stakeholder statewide Coho Recovery Team to make recommendations on components of a plan to recover the species. Implementation of the recovery plan and protective regulations will potentially have significant long term benefits to coho salmon. However, we do not know the manner in which additional regulations and recovery actions will be implemented. Therefore, at this time, we cannot estimate how coho salmon have benefited from the State listing.

8. Sport and Commercial Harvest

Over fishing in non-tribal fisheries is believed to have been a significant factor (May 7, 1997, 62 FR 24588) in the decline of salmonids. Further, NMFS also notes that under some circumstances, the impacts of recreational freshwater fishing are of concern - particularly during years of decreased availability of refugia, such as drought years.

Commercial and recreational ocean salmon fisheries result in adult mortality of listed Chinook salmon and coho salmon. Steelhead are rarely caught in the ocean fisheries. Ocean salmon fisheries are managed by NMFS to achieve Federal conservation goals for certain key stocks specified in the fishery management plan for west coast salmon, the Pacific Coast Salmon Fishery Management Plan (FMP). The goals specify numbers of adults that must be allowed to spawn annually, or maximum allowable adult harvest rates. In addition to the FMP goals, salmon fisheries must meet requirements developed through NMFS' intra-agency section 7 consultations. The key stocks of fall-run Chinook salmon in California are the Klamath and Sacramento River. The commercial and recreational take of listed salmon originating from the Eel River is treated as incidental to the harvest of more abundant Chinook salmon stocks from the Central Valley and Klamath River basins. In the past, NMFS has issued Reasonable and Prudent Alternatives (RPAs) in connection with the ocean harvest of several listed salmon populations, including CC Chinook salmon and SONCC coho salmon, both of which occur in the action area.

Estimates of harvest rates based on tagged Chinook salmon originating from the action area are not available. However, reliable harvest rates are available for Klamath River fall-run Chinook salmon, which are not part of the CC Chinook salmon ESU but have a pattern of ocean distribution similar to that of Eel River Chinook salmon, as described in the 2000 FMP Opinion (NMFS 2000). Beginning in 1991, ocean harvest rates on Klamath River fall-run Chinook salmon declined from an average of 0.45 (1981-1990) to an average of 0.12 (1991-2002). Harvest rates are expressed as the proportion of adults in a given year class that are caught. The reduction in ocean harvest was a result of implementing the Federally-reserved fishing rights of the Yurok and Hoopa Valley Indian tribes of the Klamath Basin, quantified in 1993 as 50 percent of the available harvest. NMFS (2000) required that ocean harvest rates on Klamath River fall-run Chinook salmon (used as an indicator for harvest rates on CC Chinook salmon) not exceed 0.16. However, more recent data (Lohn and McInnis 2006) indicate that the actual harvest rate of Klamath River Chinook salmon has ranged up to 50 percent.

NMFS is also concerned with the potential mortality of CC Chinook salmon as a result of catch and release angling that occurs in the action area during the fall. Despite restrictions on the retention of Chinook salmon once they enter freshwater, a catch and release fishery for Chinook salmon remains popular, especially in the action area. No analysis of the effects of this fishery on CC Chinook salmon has been undertaken. However, it is likely that this fishery results in a decrease in the number of adult CC Chinook salmon that survive to spawn once they enter freshwater.

Ocean exploitation rate estimates are available for tagged hatchery coho salmon from the Klamath, Trinity, and Rogue Rivers and serve as an index for the impact rates on SONCC coho salmon. NMFS' (2000) FMP Opinion requires that management measures developed under the FMP achieve an ocean exploitation rate on Rogue/Klamath hatchery coho salmon stocks of no more than 0.13. Retention of all coho salmon is prohibited off California.

C. Status Summary

To summarize the status of the species, we use the concept of viable salmonid populations and the parameters for evaluating populations described by McElhany *et al.* (2000). The parameters for evaluating populations are abundance, population growth rate, spatial structure and population diversity. We briefly summarize the status of SONCC coho salmon, CC Chinook salmon and NC steelhead with regard to each of these parameters. Finally, we provide a summary of the conservation value of the designated critical habitat for each of the three listed species.

1. Abundance

In general, smaller populations face a host of risks intrinsic to their low abundance levels. Our review of the status of the three listed species indicates that populations have declined well below historic levels. A host of factors have been responsible for these declines.

2. Population Growth Rate

The most recent data indicate continued declines in several populations of California populations of SONCC coho salmon and no apparent trends in the other remaining coho salmon populations. Trends in NC steelhead populations show a preponderance of declines. The potential increases in NC steelhead populations are unclear, with introduced hatchery fish and increased monitoring efforts contributing to the uncertainty of the results. Information on CC Chinook salmon suggests mixed trends in populations. Recently improved ocean conditions likely factor into recently observed increases in abundance, but the persistence of this trend is unknown, particularly when ocean conditions shift to less favorable conditions.

3. Population Spatial Structure

Recent information for SONCC coho salmon indicates that their range continues to shrink, as evidenced by an increasing number of previously occupied streams where they are now absent. Despite the declines noted for NC steelhead populations, available information does not indicate a collapsing spatial structure. However, we are concerned that the continuing declines may portend a reduction in spatial structure and the limited monitoring conducted to date is not sufficient to detect this. Data for CC Chinook salmon indicate that many of the populations are small and occur sporadically. This raises concern over the future stability of the spatial structure of this ESU.

4. Diversity

The primary factors affecting the diversity of SONCC coho salmon appear to be the influence of hatcheries and out-of-basin introductions. In addition, some brood years have abnormally low abundance levels or may even be absent in some areas, furthering restricting the diversity present in the ESU. For NC steelhead, low populations of summer steelhead and the influence of hatchery introductions threaten the diversity of this DPS. Little information exists on the current diversity of CC Chinook salmon. Spring-run populations of CC Chinook salmon were likely present in the Mad and Eel Rivers, but have since been extirpated. Trends and abundance information for CC Chinook salmon suggest that the diversity of the ESU is threatened by continued declines in abundance.

5. Designated Critical Habitat Conservation Value

The condition of designated critical habitat for the three listed anadromous salmonid species reflects the legacy of impacts to the respective ESUs and DPS. Land management activities have led to widespread habitat degradation. In particular, habitat elements for access, rearing and reproduction have been impacted due to the combination of roads, timber harvest and alterations in the natural flow regimes of larger rivers. Access has been restricted due to a number of large dams that form a total migration blockage. Excessive sedimentation has led to aggraded stream reaches that dry up sooner and may prevent migration of juveniles. Similarly, excessive sedimentation and lack of woody debris has led to a decline in the quantity and quality of pools and declines in substrate quality necessary for juvenile rearing. Reproductive success has declined due to excessive sediment which has filled spawning gravels and reduced the quantity of suitable spawning habitat. Under these conditions, emergence rates have declined. Where these impacts overlap with the potential effects of the proposed action, they are discussed in more detail in the Environmental Baseline section that follows.

IV. ENVIRONMENTAL BASELINE

During section 7 consultation, NMFS analyzes the effects of past and ongoing human and natural factors which have led to the current status of the species, its habitat (including critical habitat), and ecosystems within the action area. The action area for the LMCRP includes all 28 miles of road segments, adjacent streams, and all downstream aquatic habitat in Lost Man Creek, Prairie Creek and approximately 3.5 miles of Redwood Creek downstream of the Prairie Creek confluence, including the Redwood Creek estuary. In general, the watershed conditions in Prairie Creek and its tributaries, such as Lost Man Creek, appear to be much better than the conditions in Redwood Creek as a whole.

"Effects of the action" refers to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, which will be added to the environmental baseline. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State

or private actions which are contemporaneous with the consultation in process (50 CFR § 402.02).

The discussion below first describes the general environmental setting of the Redwood Creek watershed and the action area in particular. Second, the historic and current impacts that have shaped the current salmonid populations and their designated critical habitats within the Redwood Creek watershed, and the action area, are described. Third, the current watershed conditions that continue to shape current salmonid populations and their designated critical habitats are described. Fourth, the distribution, abundance and trends of the three listed anadromous salmonid species are discussed. Finally, this information is summarized to describe the current condition of the species, in terms of its likelihood of survival and recovery, and the role that the action area plays in the overall conservation of the listed species and their designated critical habitats.

Most of this information is compiled and summarized from the *Redwood Creek Watershed Analysis* (RNSP 1997), the *Total Maximum Daily Load for Sediment: Redwood Creek, California* (EPA 1998), and the LMCPR BA (RNSP 2006). More detailed descriptions and analyses can be found in these documents. With the exception of the flood control levees on lower Redwood Creek, many of the current factors affecting the Redwood Creek baseline conditions occur partially, or entirely, outside of the action area.

1. General Watershed Description

The Redwood Creek watershed is located in the Northern Coast Range of California. Redwood Creek flows into the Pacific Ocean near Orick. The drainage area at the stream mouth is about 285 square miles. The basin is narrow and elongated, with its long axis oriented northwest-southeast. The total length of the basin is about 65 miles, and its width varies from 4 to 7 miles (Janda *et al.* 1975). Total basin relief is about 5,300 feet, with a mean annual basin-wide precipitation of approximately 80 inches (Janda *et al.* 1975).

Lost Man Creek is a sixth order tributary which flows into Prairie Creek, which is itself the largest tributary of Redwood Creek and the last major tributary to join Redwood Creek before it enters the ocean. Located approximately 3 miles (5 km) north of the town of Orick, California in Humboldt County, Lost Man Creek composes one-third of Prairie Creek's total basin area. The Lost Man Creek watershed covers approximately 12 square miles. Originally, the entire Lost Man Creek watershed was forested with redwood, fir, spruce and hemlock, and supported healthy runs of Chinook and coho salmon and steelhead. Similar to most of the former old-growth redwood areas in north coastal California, Lost Man Creek was heavily logged and roaded during the 1950s, 1960s and early 1970s, prior to implementation of the state's forest practice rules in 1975.

Most of the action area is covered by the relatively young, poorly consolidated marine and fluvial sediments of the Prairie Creek Formation. These deposits generally lay as a cap over the underlying more resistant, older graywacke of the Franciscan Assemblage. Rivers in northwestern California, such as Redwood Creek, have naturally high sediment yields because of recent tectonic activity (uplift of the mountains), relatively weak geologic materials, steep slopes, and high precipitation

rates. These conditions, combined with land use activities such as timber harvesting, road construction, and ranching, give the region one of the highest denudation rates in the United States. The rate of erosion for the north coast region ranges from 6.4 to 16 tons per acre per year, 10–100 times the rate for other river basins in the country.

The geomorphic processes acting within the action area are a direct result of the distinctly different physical characteristics of the two bedrock units, high rainfall, and disturbance by intensive logging and road building activities. The topography of the areas underlain by the Prairie Creek Formation is relatively gentle, and the sediment tends to accumulate in relatively broad, meandering stream valleys. The unconsolidated sediments of the Prairie Creek Formation are readily mobilized by surface runoff, especially where the sediments have been cut and sidecast to construct roads and lay-outs, and natural drainage patterns have been obliterated by logging disturbances. These sediments are also susceptible to natural and disturbance-induced mass wasting processes.

The relatively resistant Franciscan bedrock in the northeast and southern portions of the Lost Man Creek watershed generally results in steep slopes, narrow, confined canyons and high-energy streamflow in comparison to the gentler topography and less confined stream reaches of the Prairie Creek Formation. Hummocky earthflow-type terrain is present along the possible southern extension of the Lost Man Creek Fault, possibly a result of more extensive shearing, fracturing and weathering of the Franciscan bedrock along this lineation.

Within the Lost Man Creek watershed, the lower reaches of Larry Damm Creek and North Fork Lost Man Creek have downcut through the Prairie Creek Formation, and into the Franciscan Assemblage below. The Franciscan graywacke has inhibited downcutting, resulting in gentle stream gradients and creating natural sediment traps. The result is a large accumulation of sediment in the broad, middle reaches of these two tributaries. In comparison, the lower reaches of the Middle and South Forks of Lost Man Creek are entirely within the Franciscan, and maintain relatively steep gradients along their entire lengths. The graywacke contains abundant fine volcanic detritus (Harden *et al.* 1982). Volcanic detritus commonly weathers to produce montmorillonite clays in the soil. Given the proximity to the coast, salt carried inland by the fog may bind with these clays, resulting in the clay particles repelling each other, and remaining in suspension almost indefinitely (Spreiter 1979). This may affect the natural turbidity levels of the various tributaries of Lost Man Creek, depending on the proportions of Franciscan graywacke to Prairie Creek Formation in each tributary.

The lower mainstem of Lost Man Creek has a gentle gradient, and meanders within the steep-sided valley, with narrow, intermittent floodplains. Near the junction with Prairie Creek, Lost Man Creek's base level has been artificially raised by a 7-foot high dam at the former Prairie Creek Fish Hatchery, constructed in the 1930s; aggradation has occurred for approximately 800 feet upstream. A second dam associated with the hatchery, 0.8 miles upstream, was removed in 1989. Sediment that had accumulated upstream of the dam was removed, and the natural stream gradient was re-established.

2. Historic and Current Impacts

a. Logging and Roads

Timber harvesting is the most widespread land use in the Redwood Creek Basin. Over 85 percent of the basin upstream of RNSP has been logged, including about 30 percent which was logged between 1978-1992. About three-quarters of this recently-logged area was logged using intensive silvicultural methods which remove all, or almost all, trees from the harvest area. Substantial areas of RNSP were intensively logged prior to their inclusion in RNSP. Harvested areas remain at greater risk of increased erosion (principally through landsliding) several years after harvest. Most of the likely future erosion potential in the basin caused by human activity is associated with logging roads and skid trails, although roads constructed for other purposes also pose significant erosion potential.

Roads can be major sources of accelerated erosion (Kelsey *et al.* 1981a, Hagans and Weaver 1987, Best *et al.* 1995), depending on their location, design, and level of maintenance (Janda *et al.* 1975, Best 1984, Klein 1987). Common erosional problems associated with roads include washouts and stream diversions at stream crossings, mass wasting of unstable fills and over-steepened cutbanks, and interception of surface and subsurface water by cutbanks and inboard ditches.

As the roads have aged, the mechanisms of road failure have evolved. Culverts not washed out in earlier storms are now severely corroded, allowing water to saturate and destabilize road fills. Where logs were placed in stream crossings in lieu of culverts (Humboldt crossings), the logs are decaying, allowing stream crossing fill to collapse into the streams. Sediment and small woody debris are washed downstream, plugging culverts and Humboldt crossings, and allowing streams to be diverted down roads, away from their natural watersheds. The diverted flow is eroding gullies, and saturating and destabilizing slopes that did not evolve under these increased moisture regimes. Woody debris buried beneath sidecast road fill is rotting, creating a zone of weakness, prone to landsliding.

About 1,200 miles of forest roads and 5,400 miles of skid trails were built within the Redwood Creek watershed as of 1978 (Best 1984). About 445 miles of roads and 3,000 miles of skid trails (Steensen and Spreiter 1992) were included within present RNSP boundaries as a result of RNSP expansion in 1978. Roughly 270 miles of logging haul roads remain on RNSP lands. Recent surveys located about 1,200 sites with potential or existing erosional problems along old haul roads in RNSP (RNSP 2002). In addition, about 20 miles of state highway and county roads cross the watershed, including several miles of abandoned state highway.

Most of the upper- and middle-basin road network in the Redwood Creek watershed was built before enactment of current forest practice rules, as amended in 1983, which required new roads to be built without potential to divert streamflow. Of the 1,110 miles of roads upstream of RNSP, about 340 miles were determined to be un-maintained and abandoned as of 1992. Another 180 miles were classified as un-maintained but still driveable. A large proportion of observed erosion is associated with an extensive road network (7.3 mile/square mile) on private lands upstream of RNSP, improperly designed and maintained roads and skid trails, and timber harvest (EPA 1998). An estimated 90 percent of gully erosion within Redwood Creek is road-related (Hagans *et al.* 1986, RNSP 1997). Furthermore, a study of 586 mainstem landslides

revealed that approximately 50 percent of the slides had one or more associated roads (Kelsey *et al.* 1981). However, RNSP has been working with private landowners in the upper Redwood Creek Basin since 1997 to upgrade or decommission deteriorating roads, and significant improvements have already been made in several areas (RNSP 2006). This cooperative approach is projected to continue in the future and should result in a gradual reduction in watershed impacts from existing roads.

By the time logging began in the Lost Man Creek watershed in the 1950s, the majority of the watershed was owned by two timber companies. The property line between these two owners roughly split the watershed along a north-south line: Hill-Davis owned the western portion, and Sage Land and Lumber owned the eastern portion.

Virtually all of the logging within the Lost Man Creek watershed occurred prior to the establishment of the California Forest Practice Rules. Logging south of Geneva road on both ownerships ended with the establishment of Redwood National Park in 1968. North of Geneva Road, logging in the middle and lower portions of Larry Damm Creek and North Fork Lost Man Creek watersheds culminated in the early 1970s just prior to RNSP expansion.

The Sage Land and Lumber Company holdings were logged and tractor-yarded primarily in the 1950s; scattered old growth was left for seed trees. The Hill-Davis holdings were clear-cut logged and tractor-yarded in the 1960s to early 1970s. Much of the Hill-Davis lands suffered extreme ground disturbance. This level of disturbance was due to the combination of: (1) the recently increased power developments in large bulldozers, (2) highly erosion-prone unconsolidated substrate, (3) old-growth logging and tractor-yarding methods of the period, and (4) construction of large haul roads and landings with little regard for preserving the natural drainage network. Imminent RNSP expansion also influenced the rampant logging activities in the watershed.

Old roads in RNSP pose numerous problems because many have inadequate drainage structures and trigger landslides when they wash out (RNSP 2006). The skid roads that bulldozers used to drag logs on steep slopes (tractor yarding) became the new drainage network. These and other former practices drastically altered the topography and hydrology of the Redwood Creek watershed (RNSP 2006).

Storm events in 1955, 1964, 1972 and 1975 in combination with the high level of ground disturbance from recent logging resulted in accelerated erosion and large quantities of sediment being entrained in the stream systems. Aerial photos of the Larry Damm Creek and North Fork Lost Man Creek watersheds taken immediately after the 1972 storm show extensive erosion, with numerous washed out roads and diverted streams; many of the skid roads exhibit dual rills, one per bulldozer track.

A new section of U.S. Highway 101 was constructed partially within the Prairie Creek watershed between 1985 and 1992. This highway section, known as the Redwood Park bypass, has caused substantial sediment delivery to tributaries of Prairie Creek (Meyer 1994). The most notable impacts occurred during a heavy rainstorm in October 1989. Suspended-sediment loads in Prairie Creek and its tributaries increased as a result (Meyer *et al.* 1994), but monitoring efforts within Prairie Creek suggested that these effects were gone from the system by October 1998 (Klein 1999).

The effects of the increased sediment from roads and logging on listed anadromous salmonids and their habitats are discussed in the *Current Watershed Condition* section of this Environmental Baseline section.

b. Mining

Mining within the Redwood Creek watershed has been limited to gravel mining within the channel of Redwood Creek and rock quarries and borrow pits used for road construction. Gravel has been mined between the flood-control levees on Lower Redwood Creek, near the mouth of Prairie Creek, at the mouth of Tom McDonald Creek, and near Highway 299 (Janda *et al.* 1975). In addition, gravel was removed in lower Redwood Creek to improve or maintain channel conveyance capacity during 2004 and 2005. Instream gravel mining simplifies stream habitat for listed salmonids by widening channels, releasing fine sediment from mined surfaces, and reducing riparian vegetation. Channel topography becomes less pronounced, with less topographic change between pools and riffles, in addition to the filling in of pools with fine sediment. Rearing, spawning and migratory habitats are reduced in both quantity and quality for listed anadromous salmonids.

c. Grazing

In other areas of the western United States, livestock grazing has been associated with increased runoff and erosion. Cattle grazing continues on grasslands in the middle and upper Redwood Creek basins and in the Orick Valley, where several dairies are located. However, RNSP considers the sediment-related impacts of grazing in Redwood Creek to be insignificant in comparison to high natural rates of runoff and erosion and the effects of logging and road building (RNSP 1997). Still, cattle may affect water quality in Redwood Creek and its estuary through the introduction of nutrient-rich waste and reduction of riparian shading. A more thorough assessment of the effects of past and present grazing would require additional research.

d. Orick Flood Control Levees

Salmonid habitat in the lower portions of Redwood Creek, including the estuary, has been degraded by the flood control levees, which were built by the U.S. Army Corps of Engineers in 1968 (RNSP 2001). The levee bisects the estuary at the mouth of Redwood Creek and drastically impairs the physical and biological functions of the estuary and adjacent wetlands, confining the Redwood Creek channel to a width of 300 feet for a length of 3.4 miles. Levee construction removed streamside riparian tree cover, reduced adjacent wetlands, altered valley drainage patterns, decreased instream woody debris structures, and reduced pool depths along lower Redwood Creek. The levees also disconnected Redwood Creek from its last downstream meander, reduced circulation into the south and north sloughs, and resulted in an increase in ocean-derived marine sediment for a combined reduction of the lower estuary of approximately 50 percent. Reduced circulation within sloughs and embayments has compromised water quality, thus reducing the estuary's value as suitable rearing habitat for listed salmonids. The degraded condition of the Redwood Creek estuary serves as a bottleneck to fish production in the watershed by affecting subsequent ocean survival and their eventual return as spawning adults (RNSP 2001).

In order to maintain the flood control channel, riparian vegetation and gravel are removed from the section of channel between the levees (RNSP 2001). In recent years, the growth of both riparian vegetation and gravel bars within the levees has provided significant improvements in the habitat's value to salmonids. However, Humboldt County is obligated through an agreement with the U.S. Army Corps of Engineers to maintain channel conveyance capacity through this reach, and NMFS expects that some gravel and riparian vegetation will be removed during 2006-2009.

e. Watershed Restoration

The legislation expanding Redwood National Park in 1978 (PL 95-250) authorized a major watershed restoration effort. Congress directed that this work focus on minimizing erosion from past land uses, re-establishing native vegetation, and protecting aquatic and riparian resources along RNSP streams (Spreiter *et al.* 1995).

Since 1981, former log-haul roads have been the primary focus of the watershed restoration efforts within RNSP. About 175 miles of logging roads have been treated since 1978. The total volume of sediment excavated from roads is approximately 1,300,000 cubic yards. These reductions in risk should provide a long-term benefit to the Redwood Creek watershed conditions, by decreasing the sediment that would be deposited in stream channels in large storm events and by decreasing chronic erosional sources. Expected long-term benefits from watershed restoration to listed salmonids include deeper pools for rearing and holding, and cleaner substrates for spawning. Expected short-term impacts from watershed restoration include increased turbidity the first 2 years after implementation (Klein *et al.* 2006).

Through an analysis of road conditions, erosional threats, and resources at risk, the Lost Man Creek watershed was identified as a high priority watershed for restoration. Within this 12 square mile watershed, approximately 44 miles of abandoned, failing haul roads were identified for removal, and approximately 15 miles of relatively stable road will be kept and maintained. Since restoration work in Lost Man Creek began in 2000, over half of the haul roads have been treated, along with associated skid roads. This work has restored natural runoff patterns to 2,369 acres, or 30 percent of the watershed. Table 3 provides data on recent road removal work in the watershed.

Stream crossing excavations in the Lost Man Creek watershed during 2000-2002 encountered an unusually large amount of fine sediments deposited upstream of the crossings. It appears that stream crossings that did not immediately fail became sediment traps for fine sediment washing off of the skid roads. The damming effect of these crossings has undoubtedly delayed the full impacts of logging from reaching the lower portions of Lost Man Creek, where aquatic habitat is still relatively healthy. However, woody debris incorporated in the sidecast fills and stream crossings is decaying and becoming less stable as time passes. As the woody debris rots, fills are beginning to lose their integrity, and failure is imminent in many locations. As these failures occur, not only will much of the material making up the fills erode and enter the stream transport system, but the accumulated sediment trapped by the crossings will be mobilized.

Table 3. Restoration progress in Lost Man Creek as of winter, 2005.

<i>Sub-basin</i>	<i>2000</i>	<i>2001</i>	<i>2002</i>	<i>2003</i>	<i>2004</i>	<i>Cum. To date</i>
Larry Damm Creek						
Miles Removed	0	0.0	2.9	4.2	6.2	7.3
No. Fk Lost Man Cr						
Miles Removed	6.9	1.6	2.4	0	0	10.9
M. Fk Lost Man Cr						
Miles Removed	2.1	1.5	0	0	0	3.5
S. Fk Lost Man Cr						
Miles Removed	2.0	0.7	0	0	0	2.7
Total Miles Removed:	11.0	3.8	5.2	4.2	0.2	24.4

RNSP has been conducting erosion and turbidity monitoring in the Lost Man Creek watershed from 2002 to the present to evaluate the possible effects of road removal on listed salmonids and their habitats. The objectives of the monitoring program are: (1) to assess the effects of the road removal program on downstream turbidity and suspended sediment concentrations, and (2) to provide adaptive management feedback for refining erosion control methods and application criteria aimed at minimizing downstream effects and maximizing cost-effectiveness. The study has provided valuable information regarding the effectiveness of road removal techniques and erosion control methods. A summary of RNSP's findings from the erosion and turbidity monitoring is provided below:

Finding 1: Post excavation observations revealed that the comparatively higher level of sediment released from restoration sites came the first winter after excavation, with a lesser amount of erosion the second winter, and an imperceptible amount of erosion the third winter after excavation. Moreover, by 3 years after the restoration, the volunteer reestablishment of vegetation had eliminated surface erosion and, in some cases, started to encroach on the line-of-site for photographic documentation. Similarly, the turbidity data (Klein *et al.* 2006) indicate that erosion at new stream crossing excavations was generally most severe in the earliest large storms of the first season and diminished as the winter runoff season progressed.

The turbidity monitoring site on Lost Man Creek is located about 1.5 stream miles downstream of the nearest past-restoration site in Larry Damm Creek. Because the monitoring site on Lost Man Creek is the downstream-most site, RNSP cannot quantify how far downstream turbidity from restoration work might have been detected. However, RNSP acknowledges that turbidity from past restoration work in Lost Man Creek would have affected turbidities in Prairie Creek below the confluence with Lost Man Creek for some distance.

Finding 2: Based on the onsite observations, stream crossing excavation sideslope failures relate primarily to attributes of fill placement, including:

- Inadequate compaction (*i.e.*, compaction performed by an excavator rather than a bulldozer);
- Placement of fill too close to channel;
- Placement of fill on too steep a slope;
- Placement of fill on top of unmapped springs and seeps; and
- Attempting compaction with too high a water content in fill material.

Finding 3: The post-excavation erosion control guidelines used during the 2002-2004 watershed restoration in Lost Man Creek watershed were generally effective at reducing surface erosion, allowing native vegetation to re-establish, and providing near-stream woody debris to bind any liquefied fill that may have been mobilized after treatment.

Finding 4: In certain instances, the locations where sediment delivery occurred were related to the state of mind that the ground crews were in when the excavation treatments were in progress. Situations where the work was behind schedule, or facing impending inclement weather, would generally cause the ground crews (contractors, equipment operators, and on-site RNSP geologists) to go into a “hurry up and get it done” mind set. A majority of the fill failures that occurred in the 2002-2004 seasons can be associated with this type of mind set.

f. Floods

Floods are critical events for the resources of Redwood Creek because they erode hillslopes, reshape channels, and transport large proportions of fluvial sediment loads. Numerous major floods have occurred on Redwood Creek during the past 50 years, including 1953, 1955, 1964, 1972 (2 floods), 1975 and 1997.

The 1964 flood was a regionally significant event that caused major damage to towns, highways, and other structures, as well as significant hillslope erosion and channel changes. Massive amounts of coarse sediment were deposited in tributaries and the upper and middle reaches of mainstem Redwood Creek during the 1964 flood (Janda *et al.* 1975; Iwatsubo *et al.* 1976; Nolan and Janda 1979; Kelsey *et al.* 1981, 1981a; Pitlick 1982; Madej 1984, 1995; Varum 1984; Varum and Ozaki 1986; Nolan and Marron 1995; Madej and Ozaki 1996). During subsequent floods, particularly in 1972 and 1975, coarse sediment was scoured from tributaries and the upper mainstem of Redwood Creek and re-deposited in lower reaches (Varum 1984, Madej 1995, Varum and Ozaki 1986). Analysis of the effects of the 1997 “New Year’s” storm (an approximately 11-year recurrence interval storm) indicated that numerous landslides were triggered or reactivated, with multiple road failures occurring both within and outside of RNSP lands (RNSP 1997). An estimated over 900,000 tons of sediments were discharged into Redwood Creek (RNSP 1997). The landscape’s response to this storm indicates that unaddressed erosion potential remains and additional action is needed to prevent destructive sediment loading in the basin.

3. Current Watershed Condition

a. Pools, Riffles and Substrate

Redwood Creek is prone to storm-induced erosional events, and would probably experience extensive erosion under natural conditions. However, land management activities, such as logging and road building, have accelerated this natural process, overwhelming the stream channel's ability to efficiently move the delivered sediment (EPA 1998). Land management patterns and practices have contributed to increased erosion beyond natural rates through mass wasting (landsliding) and fluvial erosion (gullying and stream bank erosion). The resulting sediment enters the stream, filling deep pools and depositing silt in spawning gravels (EPA 1998).

Cold pools in the lower reaches of Redwood Creek offer potential high quality rearing habitat and holding areas for juvenile salmonids and migrating adult summer steelhead (Keller and Hofstra 1983, Ozaki 1988). Channel deposition has destroyed much of the pool/riffle configuration of Redwood Creek, reducing rearing and holding habitat for salmonids. In addition, fine sediments have filled interstitial spaces in substrate, reducing the quality and quantity of spawning habitat. The reduced number of deep pools following the 1964 flood has possibly made fish more vulnerable to predation (RNSP 1997). In 1977, channel aggradation had filled essentially all pools in sampled reaches of the lower mainstem. By 1986, pools had re-established in all sampled reaches, and average residual pool depths were about 4 feet. Although channel deepening and pool development have been observed in all but the lower few miles of the creek, the mainstem generally lacks an adequate pool-riffle structure and cover (RNSP 1997).

Redwood Creek watershed was listed in the CWA section 303(d) list beginning in 1992 as water quality limited due to sedimentation. The level of sedimentation in Redwood Creek watershed was judged to exceed the existing narrative water quality objectives necessary to protect beneficial uses of the basin, particularly the cold water fishery (EPA 1998).

The 1998 TMDL for sediment includes EPA's estimates of the following: (1) instream numeric targets for various sediment parameters (these interpret and are consistent with the narrative water quality standards and also represent the instream conditions for anadromous salmonids where sediment is not a limiting factor), (2) an assessment of significant sediment sources that have in the past or are presently impacting the stream system, (3) an estimate of the loading capacity of the system for sediment discharges (and associated reductions) necessary to attain the numeric targets, and (4) allocations of loads among different sediment source categories (EPA 1998). NMFS notes that the Redwood Creek TMDL does not set a target for suspended sediment, which represents a parameter with potential impacts to listed salmonids. The following are more detailed descriptions of EPA's numeric targets for fine sediment, and a summary of the current condition with respect to fine sediment in Redwood Creek.

(a) Percent fines less than or equal to 0.85 mm

Fine particles either delivered to the stream or mobilized by storm flow can intrude into the interstitial spaces of salmonid redds, reducing redd permeability and decreasing embryo survival (EPA 1998). The numeric target set by EPA for fines less than or equal to 0.85mm for Redwood Creek is less than or equal to 14 percent (EPA 1998). No bulk sampling data has been published for Redwood Creek; however, the fraction of fine sediments less than or equal to 2 mm commonly exceeds 20 percent (RNSP 2002). Levels of very fine sediments are believed to be relatively higher in lower Redwood Creek than in the middle and upper basin (RNSP 2002).

(b) Percent fines less than or equal to 6.5 mm

The size of fine particles likely to fill the interstices of redds sufficient to block passage of fry are larger than those likely to suffocate embryos (0.85 mm to 9.5 mm) (EPA 1998). The percent of fines is also inversely related to the size of emerging fry (Chapman 1988). Each of these factors may impact the ultimate survivability of embryos and fry. The numeric target set by EPA for fines less than or equal to 6.5 mm is less than or equal to 30 percent for Redwood Creek. Although no specific bulk sampling data have been published for Redwood Creek, the fraction of fine sediments less than or equal to 8 mm commonly exceeds 50 percent (RNSP 2002).

b. Temperature

Although currently improving, the loss of canopy closure in the upper Redwood Creek basin due to removal of streamside trees, past sediment inputs, and the effects of floods have all contributed to high water temperatures in the mainstem of Redwood Creek (RNSP 1997). Anderson (1988) determined that in the mainstem of Redwood Creek during the summers of 1980 and 1981, water temperatures were generally between the upper preferred and upper lethal temperatures for juvenile steelhead. In some reaches, water temperatures exceeded the upper lethal temperature. For example, the U.S. Geological Survey measured a water temperature of 92.3°F at the O'Kane gaging station in 1977 (RNSP 2002). During 1990, mainstem and tributary water temperatures were measured as part of the summer steelhead survey (Anderson 1993). The highest water temperatures, ranging from 68.9°F to 76.1°F, were measured in the mainstem of Redwood Creek. High summer water temperatures are a problem for juvenile steelhead and coho salmon, because these species remain in the stream system for at least 1 year after hatching. Summer water temperatures remain well above the preferred temperature of juvenile salmonids and at times exceed the upper lethal temperatures of steelhead and cutthroat trout (Reiser and Bjorn 1979).

RNSP suspects that the lack of juvenile coho salmon in the middle and upper basin of Redwood Creek may be due to a thermal barrier. Although the mainstem of Redwood Creek is accessible to salmon and steelhead for most of its length, there is a noticeable lack of juvenile coho salmon in the middle and upper part of the basin. In the late 1980s, adult coho salmon spawned in the middle basin of Redwood Creek (RNSP 2006). However, in the last 7 years, no juvenile coho salmon have been caught in the downstream migrant trap located in the middle basin (Sparkman 2006). Recent work by Madej *et al.* (2006) suggests that thermal restriction may have reduced the

historical distribution of juvenile coho salmon by 75 percent in Redwood Creek, suggesting that watershed disturbance can impose a temperature barrier where none existed historically. Stream temperature is important to the health of the aquatic ecosystem and can control the distribution of stream amphibians and fish. Stream temperature has been monitored by RNSP since the mid-1990s and indicates that high water temperatures during the summer may negatively impact juvenile salmon and steelhead.

As part of a temperature study, RNSP fisheries staff conducted a presence-absence snorkel survey in mainstem Redwood Creek from the middle basin near Lacks Creek downstream to the lower river near Hayes Creek (RNSP 2006). Juvenile coho salmon were only observed downstream of Tom McDonald Creek near the Tall Trees Grove, in the lower mainstem of Redwood Creek. Those few coho salmon generally occupied side channels which were cooler than the mainstem.

During the summer of 2003, RNSP contracted for airborne thermal infrared imaging of Redwood Creek. The thermal images were used to measure surface water temperature along the main channel and show the distribution of summer water temperature along the entire length of Redwood Creek. Sixty miles of Redwood Creek were imaged in about 1.5 hours on July 29, 2003. That day turned out to be the hottest day of the summer. Photographs were taken from a helicopter about 1400 feet above the ground and resulted in about 2500 overlapping thermal images. A digital video of the Redwood Creek was also taken simultaneously and provides good coverage of the channel and riparian zones.

Based on the temperature data, the creek can be divided into four main reaches that showed similar temperature characteristics. In general, water temperatures were warmest in the middle to lower mainstem of Redwood Creek, and then water temperature cooled as Redwood Creek approached the ocean. The lowest 3.5 miles of Redwood Creek is within the cooler zone that is influenced by the coastal climate.

c. Large Woody Debris

LWD in streams provide multiple functions which are key to the maintenance of healthy stream habitat, including pool formation, sediment storage and routing, and nutrient loading. In a study by Pitlick (1982), 16 tributaries in Redwood Creek Basin were evaluated for percentage of sediment stored by LWD. Values ranged from a low of 13 percent to a high of 94 percent. On average, greater than 50 percent of the sediment volume stored in Redwood Creek tributaries was stored by LWD in the lower half of the tributaries (Pitlick 1982). However, the sediment stored in Redwood Creek tributaries only accounted for approximately 15 percent of the total sediment in storage within the basin, with the remaining 85 percent stored in the Redwood Creek mainstem (Pitlick 1982).

Limited information is available concerning LWD within the riparian area of Redwood Creek. Due to harvesting of riparian forests along Redwood Creek and its tributaries, along with streambank erosion, recruitment of LWD is well below historic levels, which diminishes the amount of rearing habitat available to juvenile salmonids (RNSP 1997). This condition is likely to persist into the future as deciduous willows and alders take the place of evergreen conifers along much of the mainstem and tributaries.

d. Migration Barriers

Redwood Creek's ability to support fish populations is determined by habitat availability and quality. Habitat availability is limited by, among other things, physical barriers such as boulders, debris jams, dams, culverts, and dewatered stream segments caused by aggradation (rising stream bed elevation). With the exception of Prairie Creek, and Prairie Creek's main tributary, Lost Man Creek, tributary streams are generally short and steep, and provide relatively little habitat for anadromous salmonids. The lower reaches of most major tributaries are accessible to fish, but many tributaries become impassable a short distance upstream due to steep gradients and debris jams (Brown 1988). Pitlick (1982) concluded that 95 percent of the sediment stored in tributaries was deposited in downstream reaches, and as a result, some tributaries were, and may remain, impassable for juvenile salmonids during summer low flows due to aggradation. Streamflows can infiltrate into thick gravel deposits at tributary confluences, leaving insufficient surface flow for migration of juvenile salmonids (EPA 1998). The only engineered structure on a tributary to Redwood Creek is a small dam at the former Prairie Creek fish hatchery on Lost Man Creek, which creates a partial barrier to upstream migration of fish (RNSP 1997).

Known barriers to fish migration along the mainstem of Redwood Creek include the sand bar that forms every summer at the mouth of Redwood Creek and the steep channel gradients in the uppermost 2-3 miles of the Redwood Creek headwaters. Additionally, two summer dams (temporary) are constructed in Redwood Creek nearly every year since the late 1950s (RNSP 2002). Each dam is an earthen berm, commonly known as "push-up dam," and is constructed with heavy equipment that pushes up riverbed gravel material. The dams are generally in place from June 30 until September 20.

As shown in figure 1, two large log jams that RNSP considers to be barriers to fish migration are found on Lost Man Creek and South Fork Lost Man Creek (RNSP 2006).

e. Current Condition of Lost Man Creek

The mainstem of lower Lost Man Creek, which begins at the confluence with Prairie Creek and continues upstream for 1.68 miles (2.7 km), has an average stream gradient of 0.01 feet per mile, cool water temperature, year round streamflow, good riparian cover, no migration barriers, large riffles with a wide variety of gravel sizes for spawning adults of all salmonid species, many deep pools for rearing, and instream cover provided by LWD, boulders and bedrock. The next 1.24 miles (2 km) of mainstem Lost Man Creek has similar characteristics, but is the last reach before fish migration is blocked by a large log jam (RNSP 2006).

In contrast with the mainstem of Redwood Creek, Lost Man Creek contains high quality, intact aquatic habitat that is at risk of damage due to past upslope logging and road building. The mainstem of Lost Man Creek has been noted for its relatively good channel conditions in spite of its headwaters having been essentially clear-cut, compared with other streams in RNSP. While much of the Lost Man Creek watershed has been intensively logged, the lower reaches of Larry Damm Creek and North Fork Lost Man Creek flow through uncut old growth redwood forest,

and Lost Man Creek itself flows through old growth forest from a point about 1 mile upstream of these two tributaries to its confluence with Prairie Creek. The risk of temporarily trapped sediment being released from woody debris dams, sidecast fills and Humboldt crossings is increasing.

Temperature data collected in Lost Man Creek between July 1, 2005, and August 31, 2005, resulted in an average temperature of 57.81°F (14.34°C), a minimum temperature 54.45°F (12.47°C), and a maximum temperature of 62.04°F (16.69°C), which are acceptable ranges for anadromous salmonids (RNSP 2006).

4. Distribution, Abundance and Trends of the Species

The numbers of native salmonid species in Redwood Creek have declined substantially, by perhaps as much as 90 percent by the mid-1970s (EPA 1998), but few data are available to describe past and present salmonid populations in Redwood Creek (RNSP 1997). Furthermore, available data on listed salmonids specific to Prairie Creek and its tributaries (specifically Lost Man Creek) are also rare or not of the type that would facilitate accurate assessments of the population status and trends of listed salmonids in these Redwood Creek tributaries. Therefore, most of the descriptions presented below are general in nature, addressing salmonids in Redwood Creek as a whole, but should be understood to include Prairie Creek and its tributaries, such as Lost Man Creek.

a. Local Population of SONCC Coho Salmon in Redwood Creek

A map of predicted presence of SONCC coho salmon in the Redwood Creek watershed was provided in RNSP (2002). Coho salmon distribution in the Redwood Creek watershed is limited to the mainstem and the larger low gradient tributaries primarily in Prairie Creek and its tributaries, possibly owing to the lower gradient and more pristine nature of that watershed (Anderson and Brown 1983). RNSP conducted general stream surveys of the basin in 1980 and 1981 to describe and characterize the salmonid rearing habitat and distribution of juvenile salmonids (Anderson 1988, Brown 1988). Migration barriers at tributary mouths were identified during these surveys. No coho salmon were found during these early electrofishing surveys above the barriers. However, subsequent surveys in the 1990s detected coho salmon in streams that did not have coho salmon in 1980-81. Whether these barriers still exist, have changed to allow fish passage, or new barriers have been created is unknown.

Downstream migration of coho salmon juveniles to the ocean from rearing areas in upper Redwood Creek occurs from March to June (Sparkman 2006). Past survey data from RNSP indicate coho salmon move directly into the ocean, spending a minimal amount of time in the Redwood Creek estuary (Anderson 1995). Furthermore, Bell (2001) indicates that some juvenile coho salmon in Prairie Creek (a third order tributary of Redwood Creek) choose to rear for a second year in freshwater habitat, out-migrating as 2+ smolts. This behavior is considered fairly common for coho salmon in British Columbia and further north (Sandercock 1991), but had not been previously documented among California coho salmon. Adult coho salmon migration through the Redwood Creek estuary is dependent upon the mouth being open to the ocean. Whether or not the mouth is open depends on a combination of wave action on the sand berm,

the volume of water in the estuary, and the flow of water in the stream. Adult coho salmon typically migrate upstream to spawn from late October to early March depending on access through the estuary (Anderson 1995), with the peak of the spawning run beginning in late November (Anderson 1998a).

Current coho salmon runs are far below those that occurred 70-80 years ago. News accounts and recollections of longtime residents of the Redwood Creek watershed suggest that both the size and numbers of salmonids have declined in recent decades (Van Kirk 1994). The Prairie Creek Hatchery propagated coho salmon in the basin from 1926 through 1992, planting non-indigenous coho salmon taken from outside the Redwood Creek Basin (RNSP 2002). A total of 9,610 coho salmon juveniles were seined from Prairie Creek and its tributaries in 1951 (Hallock *et al.* 1952). The total population of SONCC coho salmon in Redwood Creek may have conservatively numbered more than 2,000 adults at the time the hatchery closed, but the current adult population of SONCC coho salmon in Prairie Creek is almost certainly well below that number (Anderson 2003). Documented escapement numbers of adult coho salmon in Prairie Creek for the years 1999-2002 were 69, 53, 252, and 363 individuals for each year respectively (Duffy 2003). RNSP has been conducting winter spawning adult and carcass counts of coho salmon in Lost Man Creek since 1999, which range from a high of 46 live spawning adults and 11 carcasses in 2001-2002, to a low of 1 live spawning adult and 3 carcasses in 1999-2000. These numbers indicate low numbers of returning adult coho salmon (RNSP 2006).

Recent information from Sparkman (2006) further documents the current low numbers of coho salmon in the Redwood Creek basin. From year 2000 to year 2006, no coho salmon have been captured migrating downstream from the upper Redwood Creek basin, suggesting that for the past 7 years, coho salmon have not successfully spawned in the middle to upper basin of Redwood Creek (Sparkman 2006).

Recent information about the historical population structure of coho salmon within the SONCC ESU (Williams *et al.* 2006) provides insight into the importance of the coho salmon population within Redwood Creek. Williams *et al.* (2006) classified the historical coho salmon population within Redwood Creek as Functionally Independent. Functionally Independent populations were defined by Williams *et al.* (2006) as “populations with a high likelihood of persisting over 100-year time scales, and that conform to the definition of independence offered by McElhany *et al.* (2000) that an independent population is one whose population dynamics or extinction risk over a 100-year time period is not substantially altered by exchanges of individuals with other populations.” Functionally Independent populations are those that are viable-in-isolation, and were determined to have minimal demographic influence from adjacent populations. The classification of Functionally Independent populations can help determine watersheds of potential population strength within a larger geographical area, such as an ESU. In addition, independent populations have high levels of self-recruitment, and provide more individuals to other populations than they receive, making independent populations a source of individuals that can “seed” nearby watersheds during times of watershed disturbance. Thus, although the current population of coho salmon in the Redwood Creek watershed is well below historic levels, the potential Redwood Creek population is important for eventual recovery of the SONCC coho salmon ESU. In addition, given that Prairie Creek and Lost Man Creek represent some of the

best habitat in the Redwood Creek watershed, the action area is vital to Redwood Creek populations.

b. Local Population of CC Chinook Salmon in Redwood Creek

A map of predicted presence of CC Chinook salmon in the Redwood Creek watershed was provided in RNSP (2002). In 1965, CDFG estimated spawning escapement of 5,000 Chinook salmon in Redwood Creek (EPA 1998). However, these estimates were derived using data from the Eel River, and cannot be considered as reliable as field data from Redwood Creek. The 1979 Chinook salmon spawning run was estimated to be 1,850 fish (Ridenhour and Hofstra 1994) based on that summer's estuarine juvenile population.

Most of the CC Chinook salmon within Redwood Creek watershed begin their upstream migration around November, if access through the Redwood Creek estuary is possible, and have spawned and died by January. Adult spring-run Chinook salmon were observed in only one season since 1981, when RNSP began summer steelhead surveys, but are not typically considered to use the Redwood Creek watershed. Stream barriers may impede Chinook salmon spawning in RNSP tributaries, but they may be able to surmount some barriers that may impede the smaller coho salmon.

Sparkman (2005) found that juvenile Chinook salmon rear in the upper, middle and lower sections of Redwood Creek for up to several months before migrating to the estuary. Sparkman (2005) also indicates that juvenile Chinook salmon may rear in river sections for a longer period of time compared to their residency in the estuary. RNSP (2002) also shows that if given the opportunity, juvenile Chinook salmon will spend an extended period (to late summer) rearing in the estuary before entering the ocean. Thus, both Redwood Creek itself and its estuary are important rearing habitat for Chinook salmon.

Winter spawning/carcass counts in RNSP continue to indicate low numbers (Anderson 2002). The highest number of live, adult Chinook salmon observed in Prairie Creek in any year since 1983 was 101 (RNSP 1997). In Bridge Creek, the highest number of adult Chinook salmon observed was 272 fish in 1986 (RNSP 1997). Chinook salmon continue to decline in some tributaries, but estuary numbers remain as high as those in the early 1980s (Meyer 1994). Mainstem Redwood Creek provides important Chinook salmon spawning and rearing habitat, and slow improvements in the mainstem condition may be offsetting declines elsewhere in the basin.

CDFG has trapped outmigrant juvenile Chinook salmon leaving upper Redwood Creek since March 2000, using a rotary screw trap located approximately 5.6 miles downstream of the Chezum summer dam site (Sparkman 2005). Based upon mark and recapture efficiency rates, CDFG estimated the number of 0+ Chinook salmon leaving upper Redwood Creek to range from 987 - 629,847 individuals per season, with an average of 390,926 emigrants, which Sparkman (2005) describes as a "fairly large number." The low number (987) of Chinook salmon emigrating in year 2003 indicated a year class failure, and 84 percent of the variation in population emigration over the 5-year period was explained by high winter flows during the egg incubation period (Sparkman 2005). Sparkman (2006) described that between the years 2000

through 2006, there has been a negative trend in production of juvenile smolt production for Chinook salmon. However statistical significance has not currently been found (Sparkman 2006). Additional years of monitoring will be required to detect statistically significant trends due to the observed variability in population abundance between years, and low sample size.

RNSP has conducted seine net surveys of juvenile Chinook salmon populations in the Redwood Creek estuary every summer from 1997 to 2001 (Anderson 1998, 1999, 2000, 2001, 2002). Sampling dates vary, but population sampling efforts are conducted for 3 days in each of the months of June, July, and September. The largest monthly population estimates of juvenile Chinook salmon in the Redwood Creek estuary have ranged from a low of 12,030 in July 1998 (Anderson 1999), to a high of 58,630 in June 2001 (Anderson 2002). Unfortunately, the number of adult Chinook salmon expected to return to spawn in Redwood Creek cannot be extrapolated from these data; thus, no reliable estimate of the current adult population size of Chinook salmon in Redwood Creek is available. However, RNSP has been conducting winter spawning adult and carcass counts of Chinook salmon in Lost Man Creek since 1999, which range from a high of 38 live spawning adults and 8 carcasses in 2000-2001, to a low of 8 live spawning adults and 5 carcasses in 1999-2000. These numbers indicate low numbers of returning adult Chinook salmon (RNSP 2006).

Recent information about the historical population structure of Chinook salmon within the ESU (Bjorkstedt *et al.* 2005) provides insight into the importance of the Chinook salmon population within Redwood Creek. Bjorkstedt *et al.* (2005) classified the historical Chinook salmon population within Redwood Creek as Functionally Independent. Functionally Independent populations are those that are viable-in-isolation, and were determined to have minimal demographic influence from adjacent populations. The classification of Functionally Independent populations can help determine watersheds of potential population strength within a larger geographical area, such as an ESU. In addition, independent populations have high levels of self-recruitment, and provide more individuals to other populations than they receive, making independent populations a source of individuals that can “seed” nearby watersheds during times of watershed disturbance. Thus, although the current population of Chinook salmon in the Redwood Creek watershed is well below historic levels, the potential Redwood Creek population is important for eventual recovery of the CC Chinook salmon ESU. In addition, given that Prairie Creek and Lost Man Creek represent some of the best habitat in the Redwood Creek watershed, the action area is vital to Redwood Creek populations.

c. Local Population of NC Steelhead in Redwood Creek

A map of predicted presence of NC steelhead in the Redwood Creek watershed was provided in RNSP (2002). Steelhead are the last of the anadromous salmonid species to return to Redwood Creek in the annual cycle, generally between January and April. Steelhead are found in most small order, high gradient tributaries to Redwood Creek. They are able to leap above barriers that might impede coho salmon. Whether logjams are barriers to movement depends upon stream dynamics, such as the size of the logjam and the stream discharge, as well as the timing and duration of the steelhead migration. These events change from year to year. The majority of juvenile steelhead in Redwood Creek spend their second year of life in the estuary and lower part of Redwood Creek (Anderson 1988).

In 1965, CDFG roughly estimated spawning escapement of 10,000 winter steelhead from Redwood Creek (EPA 1998). RNSP began summer steelhead surveys in a Redwood Creek index reach (Lacks Creek to Tom McDonald Creek) in 1981, and survey data indicate a continuous decline (Anderson 2003). The 44 adult steelhead observed in both 1984 and 1985 represent the highest counts within this reach from 1981-2002 (Anderson 2003). No adult steelhead were seen in 1989 or 2001, and only 3 were observed in 2002 (Anderson 2003). Winter steelhead numbers are much higher than summer steelhead numbers. Factors which may limit the number of adult summer steelhead in Redwood Creek include: (1) access to Redwood Creek if the sandbar blocks the mouth in late June, July, and August; (2) high summer water temperatures; and (3) the lack of deep holding pools (Sparkman 2006).

Juvenile steelhead are the most common and widely distributed fish in the Redwood Creek basin. During sampling efforts in the summers of 1980 and 1981, steelhead occurred in 57 of the 111 tributaries surveyed. Over the past 14 years, adult summer steelhead surveys in a 16-mile index reach determined a high of 44 summer steelhead in Prairie Creek; however, in some years, no summer steelhead were observed (Anderson 1993, 1995). On Bridge Creek, the highest number of live steelhead and carcasses was 126 in 1985 (RNSP 1997). A 1994 analysis found that summer steelhead continued to decline, most likely because of the lack of adequate holding pool habitat (Meyer 1994). The same analysis found that fall and winter steelhead outnumbered coho salmon and Chinook salmon in Redwood Creek, potentially due to a higher tolerance to elevated sediment and disturbance regimes.

CDFG has trapped outmigrant juvenile steelhead leaving upper Redwood Creek since March 2000, using the same rotary screw trap as described above (Sparkman 2005). Based upon mark and recapture efficiency rates, CDFG estimated the number of 1+ steelhead trout population emigration to range from 28,501 – 68,030, with an average of 43,762, which Sparkman describes as a “large number.” CDFG also estimated 2+ steelhead population emigration ranging from 2,846 – 12,668, with an average of 6,667. Each season, CDFG found that large numbers of 0+ steelhead trout emigrated from upper Redwood Creek, as evidenced by trap catches ranging from 55,126 – 128,885 individuals, average of 102,760 (Sparkman 2005). The large proportion of young-of-year steelhead emigration compared to 1+ and 2+ steelhead population emigration suggests that rearing conditions, in combination with passive out-migration and an innate/genetic predisposition to out-migrate, may be limiting the abundance of older, juvenile steelhead age-class production from upper Redwood Creek. Sparkman (2006) described that between the years 2000 through 2006, there has been a negative trend in production of juvenile smolt production for steelhead. Statistical significance has currently been found for 1+ steelhead smolts (Sparkman 2006). Additional years of monitoring will be required to detect additional statistically significant trends due to the observed variability in population abundance between years, and low sample size.

RNSP has conducted seine net surveys of juvenile steelhead populations in the Redwood Creek estuary every summer from 1997 to 2001 (Anderson 1998, 1999, 2000, 2001, 2002). Sampling dates vary, but populations sampling efforts are conducted for 3 days in each of the months of June, July, and September. The largest monthly population estimates of juvenile steelhead in the Redwood Creek estuary have ranged from a low of 7,990 in July 1998 (Anderson 1999), to a high of 38,460 in June 2001 (Anderson 2002). Unfortunately, the number of adult steelhead

expected to return to spawn in Redwood Creek cannot be extrapolated from these data; thus, no reliable estimate of the current adult population size of steelhead in Redwood Creek is available. However, RNSP has been conducting winter spawning adult and carcass counts of steelhead in Lost Man Creek since 1999, which range from a high of 8 live spawning adults and 0 carcasses in 2003-2004 to a low of 0 live spawning adults and 0 carcasses in 1999-2000. These numbers indicate low numbers of returning adult steelhead (RNSP 2006).

Recent information about the historical population structure of NC steelhead within the DPS (Bjorkstedt *et al.* 2005) provides insight into the importance of the steelhead population within Redwood Creek. Bjorkstedt *et al.* (2005) classified the historical steelhead population within Redwood Creek as Functionally Independent. Functionally Independent populations are those that are viable-in-isolation, and were determined to have minimal demographic influence from adjacent populations. The classification of Functionally Independent populations can help determine watersheds of potential population strength within a larger geographical area. In addition, independent populations have high levels of self-recruitment, and provide more individuals to other populations than they receive, making independent populations a source of individuals that can “seed” nearby watersheds during times of watershed disturbance. Thus, although the current population of steelhead in the Redwood Creek watershed is well below historic levels, the potential Redwood Creek population is important for eventual recovery of the NC steelhead DPS. In addition, given that Prairie Creek and Lost Man Creek represent some of the best habitat in the Redwood Creek watershed, the action area is vital to Redwood Creek populations.

4. Summary

Populations of SONCC coho salmon, CC Chinook salmon, and NC steelhead in Redwood Creek are much reduced compared to historic accounts. However, a great deal of uncertainty remains with respect to the actual adult population sizes and population trends of ESA-listed salmonids returning to spawn in Redwood Creek and its tributaries. Spawning surveys and dive surveys do not provide data suitable for population size estimates, but can give an indication of the numbers of individuals returning to use specific stream reaches over time. Lacking more complete data sets, spawning surveys and dive surveys represent the best measure of adult population trends, keeping in mind that conditions such as transient variations in habitat quality within survey reaches, as well as the water visibility at the time of surveys, can also produce variations in survey results that are not necessarily reflective of changes in total adult escapements. With these caveats in mind, available adult survey data from Redwood Creek and its tributaries suggest that yearly adult population numbers for both SONCC coho salmon and CC Chinook salmon number in the hundreds to perhaps a few thousand, and are well below historic estimates. Surveys of NC steelhead suggest that their yearly adult population numbers fall within the range of hundreds of individuals, at best, considering that dive surveys in Prairie Creek have failed to confirm the presence of a single individual in some years. No data exist to support conclusions that populations of any of the three ESA-listed anadromous salmonids in the Redwood Creek watershed are viable, as described in McElhany *et al.* (2000).

Habitat conditions, including the condition of designated critical habitats, are still quite degraded relative to pristine conditions. Although channel deepening and pool development has been observed in all but the lower few miles of the creek, the mainstem of Redwood Creek generally

lacks an adequate pool-riffle structure and cover. Coarse sediment deposited in the mainstem allows a large proportion of summer base flows to infiltrate and flow subsurface, thereby limiting the surface water available to fish and increasing surface water temperatures. Large deltas block some tributary mouths and prevent migration of fish. The lack of suitable rearing habitat in the mainstem and tributaries has forced juvenile fish to the estuary. Canopy closure along the upper reaches of Redwood Creek is increasing, but is still far less than it was in the early 1900s. Tributary water temperatures are generally suitable for salmonids, but water temperatures are suboptimal, or lethal, for fish along much of the mainstem of Redwood Creek. Recruitment of LWD and nutrients are probably well below historic levels. This condition is likely to persist into the future as deciduous willows and alders take the place of evergreen conifers along much of the mainstem and tributaries, and as large conifers along watercourses in the upper basin are harvested.

In designating critical habitat, NMFS described the conservation value (December 10, 2004, 69 FR 71880) of watersheds and sub-watersheds within the CC Chinook salmon ESU and the NC steelhead DPS. The Redwood Creek watershed is located in the northern portion of the ESU and DPS, encompasses approximately 294 square miles (758 square km) and includes three occupied sub-watersheds. Fish distribution and habitat use data compiled by NMFS biologists identified approximately 107 miles (171 km) of occupied riverine and estuarine habitat (December 10, 2004, 69 FR 71880) for CC Chinook salmon and 138 miles (220 km) of occupied riverine and estuarine habitat for NC steelhead. NMFS concluded that all occupied areas contain one or more PCEs (*i.e.*, spawning, rearing, or migratory habitat) for both the CC Chinook salmon ESU and the NC steelhead DPS. NMFS identified several management activities that may affect the PCEs, including forestry, sand and gravel mining, agricultural water withdrawals and impoundments, grazing, and stream channelization. Of the three occupied sub-watersheds within Redwood Creek, two were rated as having high conservation value and one as having medium conservation value to the ESU and DPS (December 10, 2004, 69 FR 71880). NMFS did not identify any unoccupied areas in the Redwood Creek watershed that may be essential for the conservation of the ESU or DPS. As previously described, spawning, rearing and migratory habitat within Redwood Creek and its tributaries have all been reduced in both quality and quantity, primarily through excess sedimentation from land management activities. However, Lost Man Creek and Prairie Creek are generally in much better condition than the mainstem of Redwood Creek.

Based upon the relationships between habitat quality and the health of salmonid populations, NMFS expects the population numbers of ESA-listed anadromous salmonids to remain depressed relative to historic estimates in the foreseeable future. However, improvements in local habitat and salmonid populations may develop more rapidly within the portion of Redwood Creek under RNSP control, particularly within tributaries that lie completely within RNSP ownership, such as Lost Man Creek. RNSP's watershed restoration program should, in the long-term, result in the accelerated recovery of salmonid habitat within the RNSP boundaries. For this reason, NMFS expects the portions of the Redwood Creek watershed within RNSP to serve as an important stronghold for the eventual recovery of ESA-listed salmonids in the watershed.

V. EFFECTS OF THE ACTION

This Opinion addresses RNSP's implementation of the LMCRRP in the Lost Man Creek watershed. NMFS provided an overview of the LMCRRP in the *Description of the Proposed Action* section of this Opinion. In the *Status of the Species* section of this Opinion, NMFS provided an overview, at the ESU and DPS scale, of the status and trends of SONCC coho salmon, CC Chinook salmon, NC steelhead and designated critical habitat for these three species. In the *Environmental Baseline* section of this Opinion, NMFS summarized the effects of past and present Federal, State, local and private activities on SONCC coho salmon, CC Chinook salmon, NC steelhead, and designated critical habitat, within the Redwood Creek watershed, and the action area. The *Status of the Species* and *Environmental Baseline* sections established that numerous human activities within the ESU and DPS and upstream of, within, and downstream from the action area have negatively affected SONCC coho salmon, CC Chinook salmon and NC steelhead, and their designated critical habitats, and the distribution and abundance of these species in the ESU and DPS, as well as within the Redwood Creek watershed, and the action area.

Pursuant to section 7(a)(2) of the ESA (16 U.S.C. §1536), Federal agencies are directed to ensure that their activities are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of designated critical habitat. In this section of the Opinion, as required by the ESA and its implementing regulations (50 CFR §402), NMFS assesses the direct and indirect effects of the proposed action, and any interrelated and interdependent actions on SONCC coho salmon, CC Chinook salmon, NC steelhead, and their designated critical habitats. As defined by 50 CFR §402.02, "indirect effects" are caused by or result from the proposed action, are later in time, and are reasonably certain to occur. The purposes of this assessment are to determine if the proposed action: (1) is likely to have effects on SONCC coho salmon, CC Chinook salmon, or NC steelhead that appreciably reduce their likelihood of both survival and recovery in the wild by reducing their numbers, reproduction, or distribution (the jeopardy standard identified in 50 CFR §402.02); or (2) is likely to appreciably diminish the value of designated critical habitat for the conservation of SONCC coho salmon, CC Chinook salmon, and NC steelhead in the wild.

The assessment of effects is largely habitat-based. The *Environmental Baseline* section described the past and ongoing impacts to habitat. Many of these impacts were related to past timber harvest and road construction. The *Environmental Baseline* section also established the pathways of these hillslope disturbances to stream habitat and salmonids. For example, extensive road construction in the Lost Man Creek watershed contributed large quantities of sediment to the stream channel network. Consequently, habitat lacks complexity due to channel aggradation, with loss of pool depth, size and quantity, resulting in loss of adult holding habitat and juvenile rearing habitat.

RNSP and NMFS identified the following activities related to the LMCRRP that could adversely affect listed salmonids or their habitat:

- Addition of sediment to Lost Man Creek, Prairie Creek and Redwood Creek within the action area due to ground disturbance from road removal and slope reconfiguration, stream crossing removal and channel excavation, and fill disposal;
- Removal of riparian vegetation; and

- Delivery of toxic fuels and lubricants from equipment into Lost Man Creek, Prairie Creek and Redwood Creek within the action area.

A. Sediment

Implementation of the LMCRP will result in disturbance to the bed and banks of streams during crossing removal, riparian vegetation disturbance and removal, and soil compaction leading to higher runoff and sedimentation. Sedimentation from decommissioned roads and fill disposal sites may also occur, especially where decommissioned segments lie within riparian areas, or where direct connections exist between the project and surface water. On the other hand, reduction of potential future sediment inputs from roads and related stream crossings represents one of the primary goals of the LMCRP. Unstable road fill slopes, undersized culverts, and Humboldt crossings all represent nearly certain sources of large sediment inputs. NMFS believes that removal of these features from the landscape provide a long-term benefit by reducing both potential future sediment inputs and the risks of catastrophic debris torrents.

An increase in fine sediment deposited in spawning gravel can reduce interstitial water flow, leading to depressed dissolved oxygen concentrations, and can physically trap emerging fry in the gravel (Hicks *et al.* 1991). Excess fine sediments can also reduce habitat structure and quality by reducing pool volumes or filling in pools, thereby reducing juvenile habitat and adult holding habitat, and by elevating and widening the channel bed. These changes, if of a large enough magnitude, can cascade into further structural changes of the channel. Excess sedimentation that leads to a series of channel and habitat responses may also reduce the prey base for salmonids by causing direct mortality to prey species, and by reducing the value of this habitat for prey species.

Studies on adult and juvenile salmon have shown that salmon, when exposed to short-term pulses of suspended sediments, dispersed from or avoided the area (Bisson and Bilby 1982, Whitman *et al.* 1982, Berg and Northcote 1985). Large increases in suspended sediments, usually measured as turbidity, may damage sensitive gill membranes in juvenile salmon or affect their ability to perform vital functions. Cedarholm and Reid (1987) observed evidence of stress in juvenile coho salmon exposed to suspended sediment levels from 1,000 to 12,000 mg/L. Temporary visual impairment, caused by the suspended sediments, reduced the salmon's ability to capture prey (Berg 1982). Redding *et al.* (1987) reported physiological changes indicative of stress in coho salmon and steelhead exposed to sublethal levels of suspended sediments.

1. Anticipated Sediment Contributions from the LMCRP

RNSP has conducted erosion and turbidity monitoring in the Lost Man Creek watershed from 2003 to the present. This monitoring program was designed to monitor increases in turbidity from road and stream crossing removal. Results from the turbidity monitoring provide information useful in predicting the increase in sediment yields and downstream turbidity levels from the proposed LMCRP. In general, Klein *et al.* (2006) found that turbidity at the mouth of Lost Man Creek (treatment site) was elevated by about 2.5 times the level at the control site during peak and recession streamflows the first year after road and stream crossing removal. However, elevated turbidity levels rapidly decreased the second year after implementation, and

little difference in turbidity levels between control and treatment sites remained the third year after project implementation. In addition, Klein *et al.* (2006) showed that during the third year after project implementation, the turbidity levels in South Fork Lost Man Creek (control site) were greater than turbidity levels in Larry Damm Creek and North Fork Lost Man Creek (treatment sites), indicating that erosion from abandoned roads, or natural sources, can outweigh the turbidity generated as a result of road and stream crossing removal. Much of the future road and stream crossing removal proposed in the LMCRRP is located in South Fork Lost Man Creek.

Klein *et al.* (2006) also documented observed estimates of the erosion response from previously excavated stream crossings in Lost Man Creek to average 24 cubic yards of sediment, ranging from a low of zero to a high of 140 cubic yards during the years 2002-2005. Most of the stream crossing excavations showed a moderate amount of erosion, with some stream crossing excavations showing little or no erosion, and a few experiencing large volumes of erosion. Using the average of 24 cubic yards of post-excavation erosion per stream crossing, and a value of 165 stream crossings proposed for excavation during implementation of the LMCRRP, we predict that approximately 3,960 cubic yards of sediment (408 cubic yards in 2006, 1248 cubic yards in 2007, 1872 cubic yards in 2008, and 432 cubic yards in 2009) will be eroded and delivered to Lost Man Creek and Redwood Creek as a result of stream crossing removals over the next 4 years.

2. Anticipated Sediment Savings from the LMCRRP

RNSP (2006) anticipates that implementation of the LMCRRP will save approximately 344,000 cubic yards of sediment from entering Lost Man Creek and Redwood Creek. Most of this risk reduction comes from the elimination of stream crossings and unstable fill slopes (RNSP 2006).

3. Analysis

Klein *et al.* (2006) found that during the first winter following road and stream crossing removal in the Lost Man Creek watershed the highest turbidity concentrations peaked at approximately 1,900 nephelometric turbidity units (NTU) at a treatment site, compared with a peak of approximately 800 NTUs at the control site. However, these high turbidity levels lasted approximately 1 hour, during the peak of a large storm event. Peak turbidities during the more frequent smaller storms and the recession limbs of larger storms were also elevated the first year following road removal (800 NTUs at a treatment site) compared to approximately 200 NTUs at the control site.

However, during the second year following road removal, peak turbidity levels at both treatment and control sites were approximately 1,400 NTUs during a peak storm event, while peak turbidity levels during the more frequent smaller storms and recession limbs of larger storms were approximately 150 NTUs at the control site and ranged between 150-250 NTUs at the treatment sites. By the third year post-implementation, turbidity levels were measured at approximately 150 NTUs at the control site, and between 100-150 NTUs at the treatment sites during the more frequent smaller storms. Klein *et al.* (2006) speculated that the higher turbidity value found at the control site, versus the treatment sites, was due to either natural erosion, or erosion from abandoned logging roads.

Klein *et al.* (2006) shows that during the first year following road and stream crossing removal, the turbidity levels of the treatment versus control sites diverge at approximately 40 NTUs, thus road and stream crossing removal in Lost Man Creek has not affected turbidity levels during winter base streamflow. However, during the first year after road and stream crossing removal, turbidity measured at the treatment site during smaller storms, and during receding winter peak streamflow, was elevated for 33 days, versus 18 days for the control site. In addition, turbidity was elevated during large winter storms for 26 days at the treatment site, versus 10 days for the control site. The differences in the number of days of elevated turbidity between treatment versus control sites during both small and large storms the second year post-implementation were extremely small.

The storm events when turbidity was the most elevated occurred anywhere from December to April during the 2003-2006 study period. Klein *et al.* (2006) stated that they cannot generalize about the timing and magnitude of increased turbidity following road and stream crossing removal, except to say that the increase in turbidity decreases rapidly with time and increases with storm severity.

As shown in Klein *et al.* (2006), most of the estimated post-implementation sediment delivery occurs during heavy rainfall and high flows, which occur sporadically. NMFS also recognizes that the relationship between sediment volumes delivered to stream channels and magnitude of negative effects to listed salmonids and their habitat may not be linear.

The fact that much of the sediment delivery from road and stream crossing removal requires heavy rains and high flows further complicates NMFS' effects analysis, as background delivery of sediment and background levels of turbidity are also high during large storm events. In addition, all of the roads and stream crossings proposed for removal are upstream of two large log jams that RNSP (2006) considers to be fish migration barriers (figure 1), so that sediment inputs will not be delivered directly into occupied habitat, but rather to downstream anadromous salmonid habitat in Lost Man Creek, Prairie Creek, and Redwood Creek. The effects of this increased sediment to downstream habitat will be diluted by distance, and spreading the implementation over a 4-year time period. Sediment will also be metered out over time by sediment routing and storage within stream channels.

NMFS expects most of the negative effects to ESA-listed salmonids and their habitat from LMCRRP implementation to occur in Lost Man Creek downstream of the lower log jam, to its confluence with Prairie Creek, because this area contains known spawning, rearing and migratory habitat commonly used by all three listed species, and is the habitat that lies in closest proximity to the project area. The increased sediment and turbidity from the LMCRRP will also ultimately route through the lower portion of Prairie Creek below the Lost Man Creek confluence, and the lower portion of the Redwood Creek mainstem, below the mouth of Prairie Creek. However, the intensity of effects to these reaches will be diminished because the volume of water and sediment flowing in these larger watercourses will exceed those in Lost Man Creek by orders of magnitude. Therefore, the following analysis focuses on the negative effects likely to occur to ESA-listed salmonids and their habitats from increased sediment and turbidity to Lost Man Creek below the lower log jam to Lost Man Creek's confluence with Prairie Creek,

recognizing that similar negative effects may also occur to ESA-listed salmonids and their habitats within the action area further downstream, but to a lesser extent.

NMFS anticipates that the implementation of the LMCRRP will result in negative effects to listed salmonids and their habitat by short-term increases in sediment delivery and turbidity within the action area. NMFS anticipates injury or death to all three ESA-listed anadromous salmonid species adults, juveniles, fry, and eggs will occur primarily in Lost Man Creek, as described above. However, adult salmonids choosing to spawn in this reach, along with the redds they create, will receive the bulk of the impacts from elevated sediment and turbidity. Effects expected to these life history stages include behavioral modification and respiratory distress of adults due to elevated turbidity, and the smothering or trapping of salmonid eggs and fry due to increased sediment deposition. NMFS also expects some effects to ESA-listed juvenile salmonids to result from pool filling and other habitat simplification that may result from sediment deposition in juvenile rearing habitats, and through modification of juvenile feeding behavior due to increased turbidity. NMFS cannot estimate the extent of the negative effects with precision, as the ultimate level of effect will depend on unknowable factors such as the timing and quantity of sediment delivery, and the instream flow rates at the time of sediment delivery. However, as discussed above, Klein *et al.* (2006) demonstrate that the increases in turbidity from road and stream crossing removal during most of the first two winter storm seasons following implementation are of small magnitude and short duration. In addition, Klein *et al.* (2006) show that through time, erosion and sediment delivery from natural sources, or abandoned logging roads, is greater than the erosion caused by road and stream crossing removal. Thus, during each subsequent year of implementation, the chronic and potential erosion from abandoned logging roads is reduced, resulting in a decrease in additive, or combined, effects with each subsequent year.

Given the estimated range of fine sediment transport rates for Redwood Creek, and that the effects from increased turbidity will be most pronounced the first year following implementation, NMFS anticipates that the increase in sediment produced by the LMCRRP, as well as the corresponding negative effects to listed salmonids and their designated critical habitats, will persist for approximately 5-6 years due to the project being implemented over a 4-year timeframe. However, a precise estimate of the time necessary for complete routing of sediment through the action area is not possible because sediment transport rates for Lost Man Creek have not been estimated, and because such rates will also vary with flow regimes.

In summary, due to the limited magnitude, and short duration of negative effects to all three ESA-listed anadromous salmonid species from elevated sediment and turbidity resulting from LMCRRP implementation, NMFS concludes that the resulting negative effects to ESA-listed anadromous salmonids and their habitats will not threaten the long-term persistence or recovery of their populations in Redwood Creek, and as such, will not diminish the likelihood of survival or recovery of their respective ESUs or DPS. Ultimately, the anticipated short-term negative effects should give way to long-term benefits to all three populations and their habitats resulting from the removal of chronic sources of sediment, and the return of Lost Man Creek to properly functioning ecological conditions.

B. Riparian Vegetation

The LMCRP will remove riparian vegetation growing along the sides of road segments proposed for removal, as well as riparian vegetation growing on the streambanks adjacent to stream crossing removal sites. The removal of streambank vegetation adjacent to excavated stream crossings may include the removal of plants and trees shading tributaries to Lost Man Creek. The cumulative watershed effects of past riparian vegetation removal has contributed to the decline of the listed salmonids covered in this Opinion. Aside from increased sedimentation, if the removal of riparian vegetation decreases stream shading, elevated stream temperatures may result, ultimately decreasing salmonid survival and fitness within the stream. Loss of riparian vegetation may also decrease allochthonous nutrient input, thereby decreasing the productivity in the creek and limiting the amount of food available for salmonids.

As described in the *Environmental Baseline* section of this Opinion and RNSP (2006), Prairie Creek and Lost Man Creek have water temperatures within the suitable range for salmonids, as does lower Redwood Creek. The riparian vegetation removal proposed in the LMCRP will not result in significant or measurable differences in water temperatures in Lost Man Creek, Prairie Creek or lower Redwood Creek because the riparian vegetation in question does not lie immediately adjacent to Lost Man Creek, and therefore, contributes only minimally to downstream water temperatures through stream shading. The shade-contributing riparian vegetation that will be removed as a result of LMCRP implementation is associated with stream crossing excavations, or with the excavation of landings that were constructed in streamcourses. Shade-contributing riparian vegetation will be left in tact whenever feasible (RNSP 2006). Furthermore, exposed soil in Lost Man Creek typically regenerates vegetation within a year or 2, and can be expected to provide significant shading shortly thereafter given the typically narrow channel widths within the project area. Because the amount of streamside riparian vegetation that will be removed under the LMCRP will be small, and occurs in tributaries to Lost Man Creek, rather than the mainstem channels within the action area, NMFS does not anticipate appreciable increases in stream temperatures to occur within the action area.

Similarly, NMFS does not anticipate appreciable decreases in allochthonous nutrient input in the action area due to LMCRP implementation, due to the following: (1) small amounts of riparian vegetation will be removed; (2) riparian vegetation that must be removed prior to road decommissioning will be stored on site and placed on top of finished surfaces as mulch, and so will continue to contribute allochthonous materials immediately following project completion, and (3) exposed soil in Lost Man Creek watershed typically regenerates vegetation within a year or 2, and can be expected to contribute to nutrient input almost immediately. Therefore, NMFS anticipates that the impacts to stream temperature and allochthonous nutrient input from riparian vegetation removal in the LMCRP is insignificant or discountable to the listed salmonids or their designated critical habitats.

C. Toxics

Release of toxic substances, such as oil, fuel, grease or other substances in or near a watercourse during construction activities could degrade water quality and harm or kill aquatic species, including young salmonids and their macro-invertebrate prey base. NMFS does not anticipate negative effects to listed salmonids or their designated critical habitats due to the delivery of

fuel, lubricants, and other potentially toxic substances related to the operation of heavy machinery because: (1) RNSP's minimization measures prohibit fuel trucks and refueling activities within the riparian zone, (2) the materials necessary to implement a spill plan will be available on site, and (3) all machinery failing to pass daily leak inspections will not be used until repaired. In the event that a piece of machinery develops a leak during operation in the riparian zone, NMFS does not anticipate that toxic substances would be delivered to Lost Man Creek below the fish migration barriers due to the distance from the worksites to the log jams on South Fork Lost Man Creek and Lost Man Creek. NMFS anticipates that impacts from toxic inputs to water quality are insignificant and discountable to the listed salmonids or their designated critical habitats.

D. Interrelated and Interdependent Actions

Based upon the information provided in the LMCRRP BA, NMFS does not anticipate interrelated or interdependent actions.

VI. CUMULATIVE EFFECTS

Cumulative effects as defined in 50 CFR §402.02 are those effects of future State or private activities not involving Federal activities that are reasonably certain to occur within 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 ESA.

The entire Lost Man Creek watershed lies within RNSP ownership, as does the vast majority of Prairie Creek. Therefore, cumulative effects will originate in areas of the Redwood Creek watershed above the RNSP boundary, and will impact only the portion of the LMCRRP action area in lower Redwood Creek, below the confluence with Prairie Creek.

In general, NMFS believes that conditions and activities occurring on non-Federal lands within the Redwood Creek watershed will exert a greater influence on watershed condition parameters for habitat of SONCC coho salmon, CC Chinook salmon, and NC steelhead than will those actions occurring on Federal lands. The upper 60 percent of the Redwood Creek watershed is in private ownership. Recovery of SONCC coho salmon, CC Chinook salmon, and NC steelhead habitat on non-Federal lands remains unlikely without changes in forestry, agricultural, and other practices occurring within non-Federal riparian areas.

Under the current California Forest Practice Rules (FPRs), logging haul roads are likely to remain a significant source of sediment during future large storms because the FPRs cease to apply once logging has been completed and the logged area has met conifer stocking requirements. The current maintenance period for roads and erosion-control structures is based primarily on the time required to complete the harvest operation. Typically, road maintenance is required for a period of 2 to 4 years: 1 to 3 years during the harvest operation plus 1 year following harvest for stocking. As a result, long-term maintenance of roads, culverts and erosion-control structures has been rare. Unless planned road abandonment and construction of

temporary roads (that is, the intentional construction of roads that will be treated to reduce erosion after timber harvests are completed) are encouraged or required by the FPRs, perhaps through a more rigorous assessment of cumulative watershed impacts, roads will remain a significant source of sediment during future large storms.

Until improvements in non-Federal land management practices are actually implemented, NMFS assumes that future private and State actions will continue at similar intensities as in recent years, and that habitat for listed salmonids will continue to be degraded. Agriculture, timber harvest, road building, and livestock grazing have resulted in loss of riparian vegetation, migration barriers, increased water temperatures, increased nutrient loading, loss of pool habitat, and increased fine sediment. In the past, these impacts have substantially reduced survival of listed salmonids in Redwood Creek.

VII. INTEGRATION AND SYNTHESIS OF THE EFFECTS ON THE LISTED SALMONID SPECIES AND THEIR CRITICAL HABITAT

The preceding analyses focused on the expected short-term effects from implementation of the LMCRP on listed anadromous salmonids and their designated critical habitats in the action area. This portion of the effects analysis summarizes this information for each species and considers the overall effects on the populations in the context of other activities occurring within the action area or influencing conditions within the action area (*Environmental Baseline* and *Cumulative Effects* sections).

A. Effects on SONCC Coho Salmon, CC Chinook Salmon, and NC Steelhead

The proposed action will primarily influence adults and incubating eggs, and will also influence, although to a lesser degree, juvenile coho salmon and steelhead rearing in the action area. Since coho salmon utilize freshwater habitat for more than 1 year, and juvenile steelhead are present year-round in the action area, they are exposed to changes in habitat conditions for a longer period of time, potentially increasing the impacts of degraded habitat on individuals. Our effects analysis suggests that the minimization measures provided for in the LMCRP are sufficient to maintain habitat in the existing state, or may result in slight, short-term decreases in habitat quality and quantity. Given the use and distribution of coho salmon, Chinook salmon, and steelhead in the action area, we expect that negative effects to individuals would be primarily in the form of behavioral modification and respiratory distress of adults due to elevated turbidity, and the smothering or trapping of eggs and fry due to increased sediment deposition. We also expect that juvenile coho salmon and steelhead will be affected by short-term increases in turbidity, and that negative effects to individual juvenile coho salmon and steelhead will occur due to changes in feeding behavior, and slight changes in the quality and quantity of pool habitat. We do not expect that the numbers of fish to be affected will reduce the ability of the population to survive and recover. In turn, we do not expect a reduction in the numbers, reproduction, or distribution of SONCC coho salmon and CC Chinook salmon at the ESU scale, and NC steelhead at the DPS scale, that appreciably reduces their likelihood of both survival and recovery in the wild.

B. Effects on SONCC Coho Salmon, CC Chinook Salmon, and NC Steelhead Critical Habitat

Implementation of the LMCRP will result in small, short-term negative effects to coho salmon, Chinook salmon, and steelhead habitat. Primarily, spawning and rearing habitat will either be maintained in the existing state, or may experience slight, short-term decreases in the quality of spawning substrate, and quality and quantity of pool habitat for rearing. Since we do not expect more than a slight decline in habitat quantity or quality, and since we expect this slight decline to be of short duration, with longer-term benefits to the habitat realized by implementation of the LMCRP, the conservation value of the three listed species critical habitat will not be appreciably diminished. Therefore, NMFS has determined that implementation of the LMCRP is not likely to appreciably diminish the value of designated critical habitat for the conservation of SONCC coho salmon CC Chinook salmon, and NC steelhead in the wild.

VIII. CONCLUSION

After reviewing the best available scientific and commercial information, current status of SONCC coho salmon, CC Chinook salmon, NC steelhead, and their designated critical habitats, the environmental baseline for the action area, the anticipated effects of the LMCRP, and the cumulative effects, it is NMFS' biological opinion that the implementation of the LMCRP, as proposed, is not likely to jeopardize the continued existence of SONCC coho salmon, CC Chinook salmon, or NC steelhead, and is not likely to destroy or adversely modify designated critical habitat of SONCC coho salmon, CC Chinook salmon or NC steelhead.

IX. INCIDENTAL TAKE STATEMENT

Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS as an act which kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering. 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) of the ESA, taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA 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 RNSP so that they become binding conditions of any grant, permit or contract issued for LMCPR implementation, as appropriate, for the exemption in section 7(o)(2) to apply. RNSP has a continuing duty to regulate the activity covered by this Incidental Take Statement. If RNSP (1) fails to assume and implement the terms and conditions; or (2) fails to require contractors, grantees, or permittees 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, RNSP must report the progress of the action and its impact on the species to NMFS as specified in the Incidental Take Statement [50 CFR § 402.14(i)(3)].

A. Amount or Extent of Take Anticipated

NMFS anticipates that some LMCPR actions may have more than a negligible likelihood to result in incidental take of listed SONCC coho salmon, CC Chinook salmon and NC steelhead. This includes actions considered to be beneficial to the species (*e.g.*, in-stream habitat enhancement and restoration projects, stream crossing removals, and road decommissioning projects). NMFS expects incidental take associated with these types of projects due to detrimental effects on aquatic habitat parameters including substrate quality, turbidity and suspended sediment levels, all of which may directly affect the life history of these fish.

Most of the anticipated incidental take associated with the LMCPR would be in the form of “harm” due to a short-term delivery of fine sediment and elevated turbidity during project implementation and after completion of the project during the first few storm events that are sufficient in size to mobilize and transport the project-related sediment. NMFS expects incidental take to occur through multiple pathways and mechanisms, including the smothering or trapping of salmonid eggs and fry due to fine sediment deposition in spawning gravels, reductions in juvenile rearing and adult holding habitat quality and quantity from the filling of pools and widening of channel beds, reduced food availability due to fine sediment deposition, and altered feeding behavior due to elevated turbidities. NMFS cannot, with the current best available science, quantify anticipated take of individual fish associated with road removal and stream crossing removal and the subsequent transport of sediment downstream. In instances where NMFS cannot quantify the number of individuals that may be taken, a surrogate such as

the amount of habitat modification that may result in harm or the duration of a project impact can be used to describe the extent of incidental take. Most of the adverse effects or anticipated incidental take from road or stream crossing removal would occur during the first several storms of sufficient duration and intensity to mobilize and transport project-related sediment to downstream anadromous salmonid habitat.

As indicated in the *Effects of the Action* section of this Opinion, NMFS expects the implementation of the LMCRP to result in increased delivery of sediment to Lost Man Creek, Prairie Creek, and ultimately to Redwood Creek, including the Redwood Creek estuary. Sediment contribution associated with the LMCRP would be metered out over many years due to the nature of sediment routing. NMFS anticipates that the sediment produced by the LMCRP, as well as the corresponding adverse effects to listed salmonids and their designated critical habitats, will persist for 5-6 years, due to the 4-year implementation timeframe of the LMCRP, and that most of the sediment generated due to implementation of the LMCRP will occur the first 1-2 years after implementation.

B. Effect of the Take

In the accompanying Opinion, NMFS determined that the level of anticipated take from the LMCRP is not likely to jeopardize the continued existence of SONCC coho salmon, CC Chinook salmon, or NC steelhead.

C. Reasonable and Prudent Measures

NMFS believes that the following reasonable and prudent measure (RPM) is necessary and appropriate to monitor the impact of the proposed action on the habitat of listed salmonid species analyzed in this Opinion and to report this information to NMFS.

RNSP shall:

1. Ensure that monitoring information is provided to NMFS annually in order to track changes in salmonid habitat quality and quantity downstream of the proposed action.

D. Terms and Conditions

RNSP must comply with the following term and condition, which implements the RPM described above. This term and condition is non-discretionary.

1. In addition to the on-site and turbidity monitoring described in RNSP (2006), RNSP shall include in its monitoring an erosional response assessment of every excavated stream crossing, with photopoints documenting the condition of the stream crossing post-treatment, but prior to the onset of the winter storm season, and photopoints during the two winter storm seasons following treatment.

X. REINITIATION OF CONSULTATION

This concludes formal consultation on the LMCPR. As provided in 50 CFR § 402.16, re-initiation 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 on 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 of incidental take is exceeded, formal consultation shall be reinitiated immediately.

XI. LITERATURE CITED

Section 7(a)(2) of the ESA requires biological opinions to be based on “the best scientific and commercial data available.” This section of the Opinion identifies the data, information, and references used in developing this Opinion.

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MAGNUSON-STEVENSON FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT CONSERVATION RECOMMENDATIONS

I. INTRODUCTION

The Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267, 16 U.S.C. 1801 *et seq.*), established new requirements for "Essential Fish Habitat" (EFH) descriptions in Federal fishery management plans and require Federal agencies to consult with NOAA's National Marine Fisheries Service (NMFS) on activities that may adversely affect EFH. EFH for Pacific Coast salmon has been described in Appendix A, Amendment 14 to the Pacific Coast Salmon Fishery Management Plan. The Lost Man Creek Watershed Restoration Program (LMCRP) affects the Redwood Creek watershed and its tributary, Prairie Creek, both of which have been designated EFH for salmon.

Only species managed under a Federal fishery management plan are covered under the MSFCMA. Coho salmon and Chinook salmon are managed under Federal fishery management plans, whereas steelhead are not managed. Therefore, these EFH Conservation Recommendations address only coho salmon and Chinook salmon and do not address steelhead.

II. LIFE HISTORY AND HABITAT REQUIREMENTS

General life history information and Evolutionarily Significant Unit (ESU) status for Southern Oregon/Northern California Coast (SONCC) coho salmon and California Coast (CC) Chinook salmon are discussed in the associated biological opinion (enclosure 1). Further detailed information on coho salmon ESUs is available in the NMFS status review for coho salmon from Washington, Oregon, and California (Weitkamp *et al.* 1995), status review update (NMFS 2001), the recent coho salmon status review done by the California Department of Fish and Game (CDFG 2002), as well as the presence and absence update for the northern California portion of the SONCC coho salmon ESU (Brownell *et al.* 1999). Detailed information on Chinook salmon ESUs is available in the NMFS status review for Chinook salmon from Washington, Idaho, Oregon, and California (Myers *et al.* 1998).

III. PROPOSED ACTION

The Redwood National and State Parks (RNSP) proposes to remove 28 miles of abandoned logging roads and 165 stream crossings as part of the Lost Man Creek Erosion Control and Disturbed Land Restoration Plan (LMCRP) in the Lost Man Creek watershed, which is a tributary of Prairie Creek, Humboldt County, CA. Project implementation will occur over a 4-year period, from 2006-2009. The LMCRP is more fully described in the associated biological opinion (enclosure 1).

IV. EFFECTS OF THE PROPOSED ACTION

Effects of the LMCPR on coho and Chinook salmon EFH are described in the *Effects of the Action* section of the associated biological opinion. In the action area, EFH is adversely affected by habitat degradation resulting from increased sedimentation.

V. CONCLUSION

After reviewing the effects of the LMCPR, NMFS has determined that the LMCPR may adversely affect coho salmon and Chinook salmon EFH.

VI. EFH CONSERVATION RECOMMENDATIONS

Pursuant to section 305(b)(4)(A) of the MSFCMA, NMFS recommends that term and condition 1 of the biological opinion's incidental take statement be adopted as the EFH Conservation Recommendation for coho salmon and Chinook salmon.

VII. FEDERAL AGENCY STATUTORY REQUIREMENTS

The MSFCMA [section 305(b)(4)(B)] and Federal regulations [50 CFR Section 600.920(j)] to implement the EFH provisions of the MSFCMA require Federal action agencies to provide a written response to EFH Conservation Recommendations within 30 days of its receipt. A preliminary response is acceptable if final action cannot be completed within 30 days. The final response must include a description of measures proposed to avoid, mitigate, or offset the adverse impacts of the activity on EFH. If your response is inconsistent with our EFH Conservation Recommendations, you must provide an explanation for not implementing those recommendations.

VIII. LITERATURE CITED

Brownell, N. F., M. K. Kier, and M. L. Reber. 1999. Historical and Current Presence and Absence of Coho Salmon, *Oncorhynchus kisutch*, in the Northern California Portion of the Southern Oregon-Northern California Evolutionary Significant Unit. Prepared for NMFS by Kier and Associates, Sausalito, CA.

California Department of Fish and Game. 2002. Status Review of California Coho Salmon North of San Francisco: Report to the California Fish and Game Commission. April.

Myers, J. M., R. G. Kope, G. J. Bryant, D. Teel, L. J. Lierheimer, T. C. Wainwright, W. S. Grant, F. W. Waknitz, K. Neely, S. T. Lindley, and R. S. Waples. 1998. Status review of Chinook salmon from Washington, Idaho, Oregon, and California. United States Department of Commerce, National Oceanic and Atmospheric Administration Technical Memorandum NOAA Fisheries-NWFSC-35.

National Marine Fisheries Service. 2001. Status Review Update for Coho Salmon (*Oncorhynchus kisutch*) from the Central California Coast and the California portion of the Southern Oregon/Northern California Coasts Evolutionarily Significant Unit. April. Southwest Fisheries Science Center, Santa Cruz, CA.

Weitkamp, L. A., T. C. Wainwright, G. J. Bryant, G. B. Milner, D. J. Teel, R. G. Kope, and R. S. Waples. 1995. Status review of coho salmon from Washington, Oregon and California. United States Department of Commerce, National Oceanic and Atmospheric Administration Technical Memorandum NOAA Fisheries-NWFSC-24.