

**LOST MAN CREEK WATERSHED RESTORATION PLAN
ENVIRONMENTAL ASSESSMENT**

**REDWOOD NATIONAL AND STATE PARKS
HUMBOLDT COUNTY, CALIFORNIA**

June 27, 2006

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Introduction

Redwood National Park was established by Congress in 1968 to "preserve significant examples of the coastal redwood ... forests and the streams and seashores with which they are associated for purposes of public inspiration, enjoyment, and scientific study." (Public Law 90-545).

In 1978, Congress expanded the national park, in part "to provide a land base sufficient to insure preservation of significant examples of the coastal redwood in accordance with the original intent of Congress, and to establish a more meaningful Redwood National Park for the use and enjoyment of visitors." (Public Law 95-250).

The expanded park area included approximately 50,000 acres of privately owned timber lands that had been logged. A road network had been constructed to provide access to timber cutting areas and to move the cut logs to landings where the logs could be loaded onto trucks and hauled to a mill. The expansion area included many miles of roads that were abandoned when the timber companies vacated the land.

Roads that are cut into and across steep slopes with unstable soils may contribute to massive slope failures that cause the soils to erode from their original position on a slope and be delivered as sediment directly into intermittent and perennial stream channels. Rainwater running off the ground surface is intercepted and concentrated by inboard ditches along the roads. If there is more water than the ditch can hold, the runoff often empties onto slopes that have no natural drainage channels, accelerating natural levels of erosion and resulting in severe gullying. During major storms, culverts and inboard ditches often become blocked with debris, and water is diverted onto road surfaces, causing new gullies and saturating road fills, which in turn leads to hillslope failures. Logging roads and the removal of the vegetation result in altered drainage patterns, loss of topsoil, soil compaction, destruction of ground cover and subsequent decreased evapotranspiration, increased runoff rates, increased soil temperature, and decreased soil moisture.

Erosion and sedimentation are naturally occurring processes that are accelerated by human activities that disturb soil and vegetation. Erosion is often described as the detachment of soil particles by some force, such as rainfall, wind, or gravity. Once detachment occurs, the particles are transported, most often by water action. Sedimentation is the process of deposition of soil particles. An influx of sediment causes streams to become shallower and wider, which destabilizes streambanks and results in increased landsliding and loss of riparian vegetation and old growth trees.

Clearcuts and logging roads have led to general degradation of downstream and downslope portions of park watersheds, and damaged the aquatic and riparian environments of the Redwood Creek corridor and its tributaries. Erosion and sedimentation from the extensive road network associated with logging prior to park establishment and expansion pose risks to water quality of streams and aquatic resources including threatened salmon and steelhead trout. The 1978 park expansion legislation directed the National Park Service (NPS) to develop and implement "a program for the rehabilitation of areas within and upstream from the park contributing significant sedimentation because of past logging disturbances and road conditions..." to protect the existing irreplaceable park resources, including redwood forests and streams.

In 1981, the NPS prepared a Watershed Rehabilitation Plan to guide development and implementation of erosion control and watershed restoration treatments for over 300 miles of abandoned logging haul roads within the national park. The goal of watershed restoration is to

establish a hydrologically and geomorphologically stable landform that can sustain a self-functioning ecosystem. Abandoned roads are targeted for treatment because they often represent a disproportionate source of accelerated erosion and sediment delivery, and because they can be effectively treated to eliminate most sources of episodic and chronic sediment delivery (Weaver and Hagans 1994).

The 1981 Watershed Rehabilitation Plan prioritized the roads needing immediate treatment and listed other park areas to be reviewed for restoration in the future. The number of roads needing treatment, improved understanding and development of restoration techniques, new requirements to protect water quality and endangered species, and declining budgets have contributed to a decreased rate of treatment of the roads since 1981. As the roads continued to deteriorate, many roads once thought to be relatively stable are actively failing, or showing increasing evidence of instability, and are now in critical need of treatment.

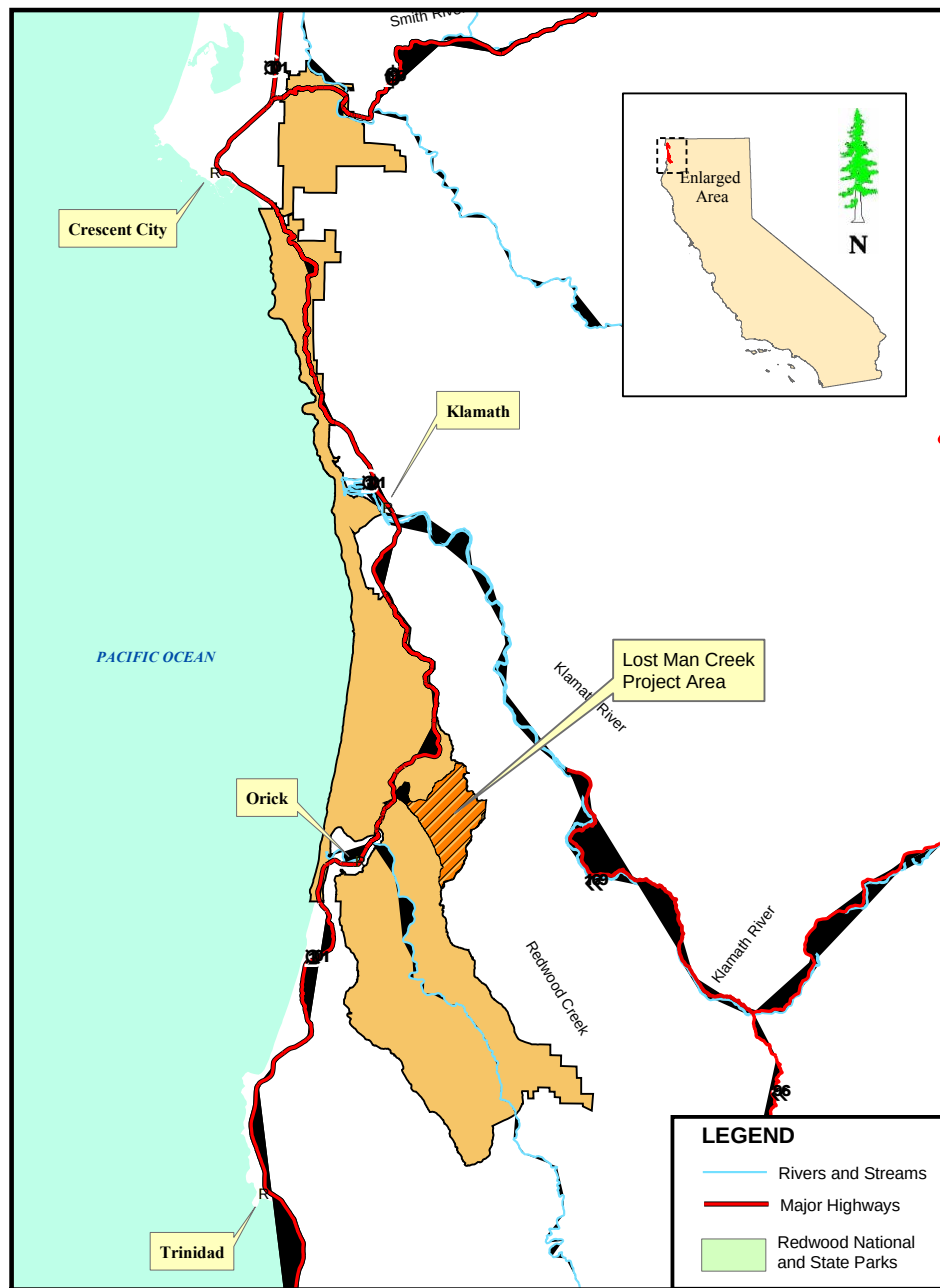
The 1981 plan guided restoration work in the parks through 1995 when a series of meetings was held to reevaluate the parks' road network. Collectively referred to as the "Road Summit," the meetings resulted in an outline of a road network needed for long-term recreational and administrative access in the parks and a road classification based on erosional threat from individual roads, resources-at-risk (e.g. salmonids, old-growth redwoods), and levels of use. The sub-watershed level (tributaries of Redwood Creek) was determined to be the most appropriate scale to evaluate aquatic and riparian resource degradation in the parks related to logging and roads. Road treatment priorities were established by sub-watershed based on protecting the best remaining aquatic and riparian habitats that are subject to the greatest threat from failing roads.

In 1997, a park interdisciplinary team refined the original analyses of road conditions, erosional threats, and resources at risk in the Redwood Creek sub-watersheds in the parks. The Lost Man Creek watershed was identified as the highest priority of the Redwood Creek tributaries for restoration because the lower portion of Lost Man Creek retains relatively good conditions, including intact redwood groves and anadromous fish, compared to other heavily logged watersheds in the parks.

In 2003 in response to changes in funding and resource management needs, additional survey and monitoring data from restoration work begun in 2000, and advances in technology since the original Road Summit, park resource managers reanalyzed and updated the road classification network and sub-watershed treatment prioritization. The prioritization identified Lost Man Creek as the highest priority sub-watershed for restoration treatments within park lands in Redwood Creek. The *ROAD STRATEGY: Access and Treatment Priorities for Parkland in the Redwood Creek Watershed* (NPS 2005) describes in detail the Road Summit and sub-watershed prioritization methods, results, and recommendations.

Lost Man Creek has a drainage area of about 7,729 acres (12.1 square miles) and is a major tributary of Prairie Creek, which itself is the largest tributary of Redwood Creek, which flows directly into the Pacific Ocean (see General Location Map). The upper portion of the Lost Man Creek watershed contains approximately 44 miles of abandoned logging haul roads and about 200 miles of skid roads. Haul roads are larger roads used by logging trucks to transport logs from the cutting site to mills. Skid roads are smaller roads used by bulldozers to drag logs to locations where they could be loaded onto trucks to be hauled to mills.

Redwood National and State Parks Project Location



About 24 miles of haul roads and associated skid roads in Lost Man Creek were treated between 2000 and 2004. About 15 miles of roads located on ridges far enough away from streams to pose less of a threat to aquatic resources and needed for administrative and recreational access will be maintained as park roads.

The project area encompasses 5,804 acres in the upper portion of the Lost Man Creek watershed. This plan describes three alternatives for erosion control and treatments to restore lands disturbed by logging and roads in Lost Man Creek over the next 6-10 years. The “no action” alternative includes a description of previous road removal work in the watershed. Two action alternatives for erosion control and restoration in the watershed through treatment of the remaining roads are presented.

Purpose of and Need for Action

The NPS proposes to remove all or part of about 28 miles of abandoned logging roads in the Lost Man Creek watershed (see Lost Man Creek Roads to Treat graphic.) This action is needed to control erosion, restore watershed functions, and protect park resources damaged by past land use and threatened by erosion associated with logging roads, especially high quality anadromous fish habitat.

Three-quarters of the Lost Man Creek watershed was intensively logged and roaded between the 1950s and the 1970s. Prior to implementation of regulations under the California Forest Practice Act in 1973, large clearcuts were common and road construction was largely unregulated. During major floods in 1955, 1964, and later, widespread erosion related to logging and associated roads occurred in the Lost Man Creek watershed. Uncontrolled erosion has caused road failures and sedimentation of streams.

Erosion problems associated with roads in Lost Man Creek watershed include streamflow diversion, stream crossing failures, road-fill failures, and gully formation. Streamflow diversions occur when unmaintained or poorly constructed roads or skid roads intercept surface and subsurface water and direct the flow away from natural watercourses. Diversions typically occur at stream crossings where there is no drainage structure, or when the drainage structure plugs or storm runoff exceeds the capacity of a drainage structure. The flow diverts from its natural course, runs down the road or inboard ditch, and can discharge onto hillslopes that lack natural drainage channels, resulting in gullying and landsliding in excess of the natural rate of these processes in unlogged watersheds. Diverted flow from failing roads and crossings is creating gullies on slopes, and saturating and destabilizing slopes that did not form under these concentrated flows and increased moisture regimes. The sediment released into the stream from failing roads damages the spawning and rearing habitat of coho and chinook salmon and steelhead trout.

Stream crossings are places where roads or skid roads cross streams or drainage channels. Stream crossings are composed of road fill and a drainage structure, although many smaller 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 fill, or when the fill becomes saturated and slumps. Many of the crossings in Lost Man Creek have acted as dams, trapping a large wedge of sediment upstream of the crossing. When crossings 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 out of its original channel and run down the road or local hillslopes, creating gullies or initiating landslides. The majority of sediment eroded from failed stream crossings ends up in the stream system.

There are generally not enough culverts along the older roads. Almost all the original culverts are smaller than current logging regulations require and are too small to carry high flows. Current state Forest Practice Rules require culverts with a 50-year-storm-event capacity. To protect anadromous salmonid species that are listed as threatened or endangered, the National Marine Fisheries Service (NMFS) requires NPS roads to have culverts capable of accommodating a 100-year storm event. Existing culverts are corroded, allowing rainfall and runoff to saturate and destabilize road fills. Culverts do not function properly when they become plugged with debris, when they deteriorate because of rust, or when they are crushed or bent. In some crossings, two culverts are joined together with a metal band that may break, causing the two culverts to separate and leak at the separation. Water coming vertically from the culvert outflow is essentially a waterfall that further erodes the soil at the downstream culvert outlet.

Humboldt crossings (logs placed parallel to the stream flow and buried in the road fill in place of a culvert) are common in the Lost Man Creek watershed. The logs placed in streams in lieu of culverts are decaying, allowing road fill to collapse into the streams at the stream crossings. Woody debris buried beneath road fill is rotting, creating zones of weakness that make roads prone to landsliding.

Road failures outside stream crossings occur simply when road fills become saturated during heavy rains and slide down a slope. Many sections of road in RNSP are built on a layer of early logging road 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.

During the last major storm in the parks in January 1997 (a 12-year return interval storm), park staff documented 77 landslides along haul roads throughout the Redwood Creek basin within the park that mobilized an estimated 150,000 cubic yards (cy) of sediment and debris. (A large dump truck holds 10 cubic yards.) Of the 77 slides, 28 were in the Lost Man Creek watershed. Sixty percent of those landslides occurred along haul roads in locations previously identified as stable, and contributed 70% of the total landslide volume that eroded during this storm. These unpredicted landslides triggered some of the largest and most damaging debris flows observed to date in the park. Coupled with the fact that decayed buried organic debris is commonly encountered beneath sidecast fills, the number of unexpected landslides along roads emphasized the need to thoroughly excavate all sidecast fills if erosion is to be successfully reduced to near natural background levels.

The primary focus of watershed restoration work within the park is to remove unneeded roads that pose sedimentation risks to downstream resources. The goal of this work is to reduce erosion and sedimentation risks from abandoned logging roads and to accelerate recovery of stream channels and dependent aquatic ecosystems. Although it is impossible to completely prevent erosion following road removal, minimizing erosion and its effects on downstream turbidity and suspended sediment concentrations is an important goal of restoration work.

The purpose of watershed restoration is to reduce adverse effects on park resources from erosion related to abandoned logging roads and from sedimentation of streams through rehabilitation of watersheds and restoration of watershed functions damaged by past logging and poorly constructed roads.

Applicable Park Legislation and NPS Policies

Legislation

- Minimize human-induced erosional threats and impacts to terrestrial and aquatic resources within the park. Public Law 90-245, Section 3(e)
- Minimize human-caused sediment entering Redwood Creek and its tributaries. Public Law 95-250, Section 101(a)(6)
- Public Law 105-18, the Natural Disaster Relief Bill (June 1997), provided supplemental appropriations to repair damage from major storms on January 1-3, 1997 that caused significant damage to Redwood National Park and other parks throughout California, notably in Yosemite Valley.

Management Policies

Erosion control and watershed restoration on park lands disturbed by logging and road construction is consistent with the following National Park Service Management Policies (NPS 2001a):

- re-establish natural functions and processes in human-disturbed components of natural systems in parks.
- return human-disturbed areas to the natural conditions and processes characteristic of the ecological zone in which the damaged resources are situated.
- use 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.
- manipulate landscape and vegetation conditions altered by human activity where the park management plan provides for restoring the land to a natural condition.
- restore human-altered landscapes by removing constructed features, restoring natural topographic gradients ...
- seek to understand and preserve the soil resources of parks and to prevent, to the extent possible, the unnatural erosion, the soil....

NPS Natural Resource Management Guidelines

The long-term goals of the RNSP watershed restoration program have been developed in accord with NPS policies and guidelines for restoration of disturbed lands outlined below.

The Servicewide objectives for restoring disturbed areas are as follows:

- restoration of soil-geomorphic, chemical, and biologic characteristics and processes that were or are affected by modern human activities, so that the site will eventually reintegrate with the surrounding natural ecosystem functions and processes;
- elimination of threats to human safety and health that may be associated with disturbed areas;
- prevention of new and limitation of the effects of existing sources of disturbance.

NPS Reference Manual 77 for implementing Director's Order 77: Natural Resource Protection defines *disturbed lands* as areas where the integrity of the natural setting and natural system processes has been directly or indirectly affected by human activities such as resource extraction, visitor use, development or maintenance, or invasion of nonnative species.

Natural system restoration is defined as the long-term process of assisting the recovery of disturbed areas and reintegrating the site into the surrounding natural system so that the area reaches a planned condition and, ultimately, returns to its former unimpaired condition. Restoration involves active management (purposeful manipulations) of the disturbed habitat, such as biological (re-introduction of species), structural (removal of invasive woody or nonnative species), physical (restoration of natural topography), or chemical (mineral waste mitigation). Active management may also include removal of the anthropogenic (human-caused) disturbances that are causing resource degradation or that are preventing natural recovery of a site.

Lands are considered to be *restored* at the point in the project where disturbed land areas no longer require active management, i.e., the site has reached a planned condition, but not necessarily the former or unimpaired condition. Restored conditions and processes should replicate those of the ecological zone in which the disturbance occurs, including the biological and physical components of the ecosystem, such as the geomorphology, hydrology, soils, biodiversity, and natural process linkages.

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 end point in a restoration project is reached when the landforms resemble the pre-disturbance landforms to the greatest extent practicable.

Watershed Restoration under the RNSP General Management Plan

The Lost Man Creek Watershed Restoration plan and environmental assessment are tiered off the Redwood National and State Parks 1999 *Final General Management Plan/General Plan, Environmental Impact Statement / Environmental Impact Report* (GMP/EIS). The GMP directed that watershed restoration work within the parks should emphasize partial landform restoration, with complete removal of all major logging roads and limited removal of minor roads that pose the greatest threat to the parks' resources.

The GMP outlined the following management goals that are relevant to watershed restoration in Lost Man Creek:

- Protect and preserve the natural resources of the parks.
- Restore lands, ecosystems, and processes that have been altered by modern human activities.

Natural resource management and protection strategies from the GMP that guide watershed restoration include:

- Support the perpetuation of ecosystem processes and components, including the redwood forest ecosystem as the prime RNSP resource.
- Restore and maintain RNSP ecosystems as they would have evolved without human influences since 1850.

Restoration of logged forests in the Lost Man Creek area is being planned through a separate process to guide restoration on about 1700 acres of second growth forests that were logged and regrew without thinning, which is typically done following logging to encourage newly planted trees to grow larger in a shorter time.

Redwood Creek TMDL

Lost Man Creek is a major tributary of Prairie Creek. Prairie Creek is one of the largest, and the last major, tributary of Redwood Creek, which it joins about four miles before Redwood Creek meets the Pacific Ocean. Redwood Creek has been identified as a sediment-impaired stream by the U.S. Environmental Protection Agency (EPA). In 1998, EPA Region 9 established a Total Maximum Daily Load (TMDL) for sediment for Redwood Creek under Section 303(d)(1)(A) of the Clean Water Act, which requires that "Each State shall identify those waters within its boundaries for which the effluent limitations...are not stringent enough to implement any water quality standard applicable to such waters." The North Coast Regional Water Quality Control Board (RWQCB) identified Redwood Creek in California's 1996 and 1998 list submittals as water-quality limited due to clean sediment loading and designated the watershed as a high priority for TMDL development.

The Redwood Creek TMDL is used as a reference to ensure that watershed restoration in Lost Man Creek is consistent with the recommendations of the TMDL to protect the beneficial uses of Redwood Creek, particularly the cold water fishery. The Redwood Creek TMDL is primarily concerned with the conditions on the mainstem of Redwood Creek that result from the effects of land use and natural conditions on the mainstem and all the tributaries. The positions of Lost Man Creek and Prairie Creek low in the watersheds relative to the entire mainstem of Redwood Creek means that restoration in Lost Man Creek contributes less to the restoration of the mainstem of Redwood Creek than if other tributaries higher in the drainage were being restored. However, Lost Man Creek is proportionately more valuable than some other tributaries because Lost Man Creek still contains streamside old growth redwoods, important fish spawning habitat, and viable fish populations.

The TMDL includes a problem assessment that assesses existing instream and hillslope conditions; instream numeric targets that interpret and are consistent with narrative water quality standards and also represent instream conditions for cold water fish where sediment is not a limiting factor; an assessment of significant sediment sources that have in the past or are presently impacting the stream system; an estimate of the loading capacity of the system for sediment discharges and associated reductions necessary to attain the numeric targets; and allocations of loads among different sediment source categories. The proposed restoration work in Lost Man Creek is fully consistent with the recommendations in the Redwood Creek TMDL.

Public Involvement

The NPS sent letters to 141 agencies, organizations, and individuals in April 2004, soliciting comments on the proposal to restore the disturbed lands of the Lost Man Creek watershed. Seven people attended a public field trip on September 25, 2004. A presentation about the project was made on October 5, 2004 to the Strategic Partnership Coalition, a group of council members from local Tribes and representatives of state and federal agencies who meet to share information on environmental issues and concerns. NPS and CDPR sent letters on November 3, 2004 to Yurok Tribe representatives, Trinidad Rancheria representatives, Big Lagoon Rancheria representatives, Resighini Rancheria representatives and the California State Office of Historic Preservation (SHPO) requesting comments, issues or concerns regarding the project. The NPS met regularly with the USFWS and NOAA Fisheries (also known as National Marine Fisheries Service [NMFS]) to incorporate threatened and endangered species protection measures as the project was developed.

The Redwood Creek TMDL also received public review. A public hearing was held on November 19, 1998 on a draft TMDL proposed by the EPA on October 19, 1998. The final TMDL included changes to the draft as a result of written comments and oral testimony.

Issues Raised During Internal Scoping

The following issues were identified by NPS staff during project development.

- Widths of disturbance corridor along treated roads should be minimized.
- Some areas with high sediment threat also have high quality habitat for threatened birds that might be adversely affected by removal of vegetation.
- The high density of skid roads along the A130 road on the west side of the South Fork should be addressed.
- Risks and benefits of removal versus natural recovery for South Fork log stringer bridge crossings.
- Vegetation recolonization on work sites near old growth increases chance of attracting nest predators of threatened bird species.
- Short-term turbidity impacts on fish.
- Access for second growth management should be retained.
- Access for fire suppression on “beign” ridgetop roads should be retained.

Issues Raised During Public Scoping

The following issues were raised in letters received in response to the scoping letters sent and meetings with agencies, researchers, organizations, and the general public.

- The project should fulfill the national park’s legislative directive to control erosion and restore the disturbed parklands.
- The project should improve chances of survival for the threatened species that inhabit the redwood forest ecosystems.
- The project should minimize the flooding potential of Redwood Creek downstream of the project area.
- This project should improve the water quality of Redwood Creek.
- Restoration is needed to prevent further resource damage.
- Restoration is needed to improve the long-term health of park ecosystems.
- Aesthetics and other intangible park values, as well as erosion and sedimentation issues, should be considered in restoration decisions
- Restoration projects are needed to create jobs and demand for services in the local community.
- Restoration projects should improve visitor experiences.
- Some roads, e.g. Geneva Road, should remain for a variety of means of visitor access (handicapped, hike, bike, horse).
- Redisturbing areas after more than 40 years may result in
 - Loss of vegetation that has regrown
 - Loss of habitat that has developed
 - Increased erosion
 - Sedimentation downstream of project area.
- Wildland fire suppression may be hampered by road removal.
- Cumulative impacts of historic, current and proposed road removal on recreational access should be considered.
- Managing roads for recreational access should be considered as an alternative.
- Restoration funds could be better spent on improved visitor/recreational services.
- Park lands and resources should be allowed to evolve without additional disturbance by humans.

Consultation with Other Agencies

Endangered Species

Informal consultation on this project began during an Interagency Consultation Team (ICT) field trip to South Fork Lost Man Creek on July 14, 2004 to view the A130 road, its stream crossings, and the various problems associated with erosion at this site. The ICT includes representatives from the National Park Service, the U.S. Fish and Wildlife Service Arcata Fish and Wildlife Office (USFWS AFWO) and the Arcata office of NMFS who meet to discuss proposed projects and determine whether the projects require informal or formal consultation under requirements of Section 7 of the Endangered Species Act. Based on discussions of potential impacts of the proposal to listed terrestrial and aquatic species, formal consultations were conducted with both USFWS and NMFS.

At three ICT meetings held in February and March 2005, NPS watershed restoration program 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. Marbled murrelet survey data and residual habitat also were reviewed and discussed in the context of removal activities. There also was discussion regarding the risks associated with treatment activities, including sediment production and marbled murrelet habitat degradation, versus the long term benefits of treatment.

A second field trip to the A130 with USFWS staff took place on March 30, 2005. The purpose of this trip was to view the treatment site in terms of potential impacts on residual habitat and to assess the condition of the habitat at a location where mapping indicated residual trees occurred close to the area that could potentially be affected by treatment. A skid road off the A100 was also investigated as a proposed access route to the project site in the vicinity of the A130 road on the west side of South Fork Lost Man Creek.

A third field trip to Manning Creek with park biologists and NMFS staff took place on April 27, 2005 to view and discuss effects of treatment alternatives for the A140 and the skid roads running up either side of the tributary.

The NPS submitted a final biological assessment to the USFWS on March 10, 2006 that described the project, potential effects of the project on northern spotted owls and marbled murrelets, and measures to minimize adverse effects on these two species. The USFWS issued a Biological Opinion file number 8-14-2006-2836, dated May 30, 2006, which concurred with the NPS determination that the project may affect but is not likely to adversely affect the northern spotted owl and that the project may affect and is likely to adversely affect the marbled murrelet. The NPS requested, and the USFWS authorized, incidental take of marbled murrelets expected from harassment of nesting birds due to operation of heavy equipment in 2 acres of occupied nesting habitat during the breeding season; harm of murrelets due with an increased risk of corvid predation on 66 acres of nesting habitat; and harm of murrelets associated with 7 acres of nesting habitat due to habitat degradation. The biological opinion concluded that the level of anticipated take from this project is not likely to result in jeopardy to the marbled murrelet, or destruction or adverse modification of critical habitat for the marbled murrelet.

The NPS submitted a biological assessment to NMFS in April 2006 that described the project, potential effects of the project on Southern Oregon/Northern California Coast (SONCC) coho salmon, California Coastal (CC) chinook salmon, and Northern California (NC) steelhead trout; and measures to avoid or minimize adverse effects on these species, and designated critical habitat for these species. Mitigation measures associated with the species and their habitat would

also serve to protect Essential Fish Habitat (ESH). NMFS is expected to issue a Biological Opinion prior to project implementation that will contain terms and conditions that will be incorporated into project specifications to minimize adverse effects on listed species and their designated critical habitat.

Cultural Resource Consultations

The National Historic Preservation Act of 1966 requires federal agencies to consult with the state historic preservation officer (SHPO) if an undertaking would have the potential to affect properties listed or eligible for listing on the National Register of Historic Places. The NPS notified the SHPO in November 2004 that an environmental assessment was being prepared and outlined the project. The NPS sent a subsequent letter to the SHPO in March 2006 seeking concurrence with the preliminary findings and recommendations for protecting historic properties in the project area, including two sites on Holter Ridge. The SHPO responded in April 2006 with concurrence that a finding of No Adverse Effect with conditions outlined in the NPS recommendations was appropriate for this project.

NPS policies require consultation with affected American Indian groups. Ethnographic interviews that were conducted in 2000 provided information about the project area being used for resource procurement and fishing along the lower reaches of the Lost Man Creek watershed. Consultation with the Yurok Tribe Culture Committee occurred on August 26, 2005 and November 18, 2005 in the Klamath tribal office. Notes from these meetings are on file at the Yurok Culture Department. The initial consultation with the Yurok Tribe Culture Committee resulted in the recommendation to speak in detail with a Yurok elder who has knowledge of the history of trails and logging history of the area and a traditional Yurok basket maker with resource knowledge of the area, particularly a bear grass area close to the coast used by Yurok basket makers.

A post-survey consultation on the survey findings was conducted with the Yurok Tribe Culture Committee on November 18, 2005. The location of the bear grass site on Holter Ridge Road was shared with the committee and recommendations were sought for future management. The Yurok Tribe Culture Committee recommended that the bear grass site be protected from impact by the project, and for future management to enhance and improve the health of this site.

Alternatives

Three alternatives are being considered for watershed restoration in the Lost Man Creek area: Alternative 1: No Action; Alternative 2: Partial Restoration (the proposed action and the environmentally preferred alternative); and Alternative 3: Full Restoration.

The no action alternative is required under NPS guidelines for compliance with the National Environmental Policy Act (NEPA) and is used to compare the existing conditions with the other alternatives. No action means either a continuation of existing management practices or —no project”. In this case, no action includes road maintenance (existing management practice) but no removal of roads or restoration of landforms or stream channels (proposed project).

An erosion control alternative presented in GMP was not selected as an overall restoration strategy in Lost Man Creek because it would not provide the level of resource protection needed to meet the purpose and need for the project, which is long-term protection of the timber, soils, and streams in the watershed (Public Law 90-545) and rehabilitation of areas contributing significant sedimentation because of past logging disturbances and road conditions (Public Law 95-250). Some aspects of erosion control techniques are presented here to provide more detailed

site-specific comparison among partial restoration (the proposed action) and more extensive restoration. These comparisons were not possible for the conceptual level of GMP analyses on the scale of the entire park over a period of 15-20 years.

Road mileages, estimates of the excavation volumes, and the numbers of stream crossings given in the alternatives are for the entire project. Appendix 1 lists all roads that would be either treated or used for access for the entire project. Although the project is planned for completion by 2009, the total duration of the project depends on weather-related accessibility of the project areas and could take as long as six years if there is an early onset of the rainy season in a given year.

Under all alternatives including no action, approximately 12 miles of road that are relatively stable and pose a low risk of failure will be kept for administrative uses and will receive regular maintenance.

The graphic “Lost Man Creek Roads to Treat” shows which roads would be removed each year under the proposed action. In addition to the 12 miles of administrative roads that will be retained, 15 miles of roads, primarily along ridges, would be upgraded for access during the project and removed at the end of the project under both action alternatives. After roads are removed, there is no access for heavy equipment for any future restoration work on untreated road segments beyond treatment sites. Project planning included a schedule of road removal that would allow access to rehabilitation sites as the project proceeds, with no access remaining when the project is completed.

Alternative 1: No Action

Under the No Action alternative, no additional work to restore watershed damage from logging roads would be undertaken in the Lost Man Creek watershed. Existing abandoned logging roads would remain in place. The total mileage of roads removed in the Lost Man Creek watershed would remain at about 25 miles. Roads that are passable by vehicles and that have been identified as needed for administrative or fire access would be maintained under the regular park road maintenance program by occasional brushing, grading, and culvert replacement as funding permits. Table 1 shows the miles of roads that have been removed in the Lost Man Creek watershed to date.

Table 1—Miles of Road Removed in Lost Man Creek

Sub-basin	1987	2000	2001	2002	2003	2004	Total
Larry Damm Creek	0.4			2.9	4.2	0.2	7.7
North Fork		6.9	1.6	2.4			10.9
Middle Fork		2.1	1.5				3.6
South Fork		2.0	0.7				2.7
Total Miles Removed	0.4	11.0	3.8	5.3	4.2	0.2	24.9

Hydrologic and geologic monitoring in Redwood Creek and in previously treated areas in Lost Man Creek would continue. On-going hydrologic and geologic monitoring in Redwood Creek includes sediment transport, high flow suspended sediment and bedload sampling, and USGS streamflow gaging at O’Kane Bridge on State Highway 299 and at U.S. Highway 101 in Orick.

In areas that have been treated in Lost Man Creek, monitoring of surface erosion, mass wasting erosion, channel erosion, stream temperature, and presence/absence for fish and birds would continue. In offsite areas downstream but outside the treated areas, monitoring would continue

on hydrological stage (streamflow) and turbidity, measured both with automated equipment and with water grab samples.

Five recording streamflow and turbidity monitoring stations with automated gages were installed in 2002. Results of completed rehabilitation work will be compared to pre- and post-project data. Treatment effects were already occurring when monitoring was begun three years into the initial Lost Man Creek restoration project.

Actions Common to Restoration Alternatives

The following project goals and techniques developed in the watershed restoration program over the past 25 years would be common to both action alternatives.

- Use heavy equipment for intensive treatments instead of more superficial work done by hand labor.
- Treat the causes of erosion (poor drainage, etc) rather than the symptoms (fill failure, slides and slumps).
- Focus on roads because they are the primary source of erosion.
- Prevent future erosion by treating sites with a high potential for erosion instead of treating only currently active erosion sites.
- Excavate only the unstable skid road sidecast fills to reduce costs and damage to recovering second growth forests instead of fully recontouring all skid roads.
- Excavate sidecast haul road fill completely to prevent future landslides and debris flows instead of partially excavating sidecast fills or constructing waterbars.
- Restore natural stream channel configurations at all stream crossings through complete excavation of road fill, culverts, and Humboldt crossing logs instead of partially excavating only obviously unstable crossings.
- Re-expose the buried original streambed armor to reduce post-treatment erosion instead of placing imported riprap to protect newly excavated stream channels.
- Recover and replace topsoil to allow natural revegetation and use existing on-site biomass supplemented by shredded redwood bark to reduce erosion, retain moisture, and provide ground cover instead of transplanting trees or importing revegetation materials and straw mulch that might contain unwanted non-native plants.

Watershed restoration in RNSP primarily involves road removal and restoration of the original landform, which reverses the process of road building and uses many of the same pieces of heavy equipment. In areas needing treatment, the goal is to re-create landforms that existed prior to road construction to the maximum extent feasible and safely at a reasonable cost. There are two basic types of restoration work: excavation of sidecast fill along lengths of road, and stream channel excavation.

Road Construction—Roads in hilly terrain are typically built by using large earthmoving equipment to cut into a hillslope to create a level bench. The soil is cut from a slope and placed in low spots to create a road surface along a reasonable grade (steepness). The excess cut material is pushed off the side below the road (sidecast fill).

Where a road intersects a stream or low spots in hilly terrain, the road either follows the ground surface by dipping down into the low spot, crosses the low spot or stream channel on fill placed to raise the surface of the ground to maintain the grade of the road, or crosses the stream or low spot on a bridge. A stream or a low spot must have some type of drainage structure to allow water to drain downslope. Filling in a low spot or a stream without adding a drainage structure

creates a dam. A dip in the road surface allows water to drain but becomes impassable to vehicles if enough water flows through it. Bridges or culverts are installed in low spots or streams to allow water to flow and vehicles to cross in wet conditions without creating a dam.

Project Access—Holter Ridge Road and the B-Line would provide the primary access from the south and north, respectively, and would be used daily because they are the main access roads to the entire project area. All access roads would typically be traveled almost exclusively by restoration staff during the work planning phase, which would require that several vehicles be driven to and from a site each day. Once heavy equipment operations begin, vehicle use on access roads is likely to increase.

Heavy equipment would be transported to the project area on a low boy trailer driven as close as possible to a work site and then “walked” (driven at 2-6 mph without any earthmoving) to the site. Depending on the location of individual projects, equipment may need to be walked up to four miles to a work site.

Some access roads in the project area would require upgrading to make them accessible again by pickup trucks and other vehicles. Upgrading would involve removing vegetation that has grown in the road corridor, brushing the edges to widen the corridor enough to accommodate the equipment, grading the surface to make it drivable, and replacing culverts where necessary. The anticipated scale of disturbance would be the width of the bulldozer blade, generally about 15 ft wide. Where stream crossings are in need of reconstruction the area cleared of vegetation may be slightly larger. About 15 miles of roads that are upgraded for access during the project would be removed at the end of the project. About 11.7 miles of roads [Geneva (2.4 mi), Holter Ridge (6.7 mi), B-Line North (1.6 mi), and the A121 (1 mi)] would remain after all associated roads are treated.

Typical Restoration Process—Restoration work is performed by contractors selected through the federal contracting process. Contractors determine the best approach, such as the size and number of pieces of equipment, for accomplishing the work within the contract specifications. A typical restoration project is described below.

Equipment used in watershed restoration ranges from chainsaws to heavy earthmoving equipment. Chainsaws are used to remove brush and some small trees. Fuel trucks transport fuel for the equipment to the project site, and fuel is stored on site. Water trucks would be used for dust abatement. Pickup trucks transport equipment operators and park staff to work sites.

Excavators and bulldozers are the primary types of heavy equipment used in restoration work. Loaders and dump trucks may also be used if fill must be moved more than 800 feet. Tracked vehicles are used in wet areas. Winches attached to the bulldozer are used to pull large pieces of woody debris from work sites, and to pull equipment out of mud.

Excavators are used for lifting or retrieving fill material from steep or muddy slopes, for locating and defining the original stream channel, for final shaping of channel bottoms, and for working in tight locations such as between trees.

Bulldozers remove the bulk of the fill at a treatment site until the area becomes either too wet or too steep for them to work safely or cost-effectively. Bulldozers are used to move large quantities of fill quickly, to recontour rock pits, and for the final shaping of outsloped roads, landings, and fill sites. The material is pushed to stable locations along the road adjacent to the crossing or endhailed (transported away from the immediate work site) to a more distant fill site.

if there are no stable locations within about 800 feet. Along unstable road corridors, loaders or excavators and dump trucks are used to endhaul the material to a stable site rather than pushing the material with a bulldozer.

The size of the bulldozer needed depends on the width of the road. A bulldozer used in park restoration projects is generally equivalent in size to a Caterpillar D-8. U-blades are generally used because of greater blade capacity and minimal sidecast. A tracked vehicle the size of a D-8 generally uses 28" wide tracks.

Ripping to loosen the surface is an option for treating roads that have been surfaced with rock. Ripping is done with a large bulldozer with rear-mounted teeth 24-36 inches long to decompact road and landing surfaces to a minimum depth of 24 inches and furrows a maximum of 24 inches apart. Locations where excavated fill is to be placed are ripped to increase water filtration into soils. Ripping also aids in revegetation by exposing soils where plants can take root. Ripping decreases the chance of having an impermeable surface beneath the fill where water could form ponds and eventually saturate the fill.

Stream crossings in the project area might have a functioning culvert; a non-functioning culvert that no longer conveys water because it is plugged, crushed, leaking, or buried; a culvert that conveys water at some flows but is too small at high flows; or no culvert at all. Culverts that are removed are typically buried on site at least three feet deep. Other metal logging debris such as cables would also be buried.

Stream channels would be completely excavated to the original streambed to eliminate the need for check dams or rock armor. 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 initial excavation work does not disturb the bottom of the stream channel and the bulldozer does not work near flowing water at this stage. 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 end of the fill and moving in the upstream direction.

To protect listed fish species and their designated critical habitat, streams with surface flow sufficient to transport sediment off-site are diverted around excavation areas using best management practices (BMPs) listed in the terms and conditions in the biological opinions issued by NMFS and included in the contract technical specifications. 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 generally flows along the old channel bottom gravels that are 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.

All stream crossings would be reconfigured or completely excavated down to the original stream channel to eliminate the diversion potential. The original stream channel is generally armored with a combination of rock and woody debris. The goal of stream channel excavation is to uncover the buried natural channel armor without disturbing it. Large woody debris encountered

during the excavation would be placed in the channel to augment the natural channel armor. If the original stream channel cannot be exposed, the channel might be armored with rock. Rock might have to be purchased if none is available at or close to the treatment site.

Unstable road fill and landing sidecasts would be excavated to restore the surface runoff patterns and reduce the volume of road fill that might fail as a mass movement. All fill material removed would be stored in a stable area along the road and shaped to resemble natural drainage patterns. Excavated spoils would be placed where they would not enter a water course. There would be no excess material that would require disposal outside the project area.

In sidecast excavation, 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. On steeper ground a bulldozer is assisted by an excavator that lifts more fill up toward the cutbank. On the steeper slopes, all of the work may be done with the excavator. On extreme slopes where the finished slope would exceed the natural angle of repose, the uppermost portion of the cutbank may remain exposed. Similarly, if there are springs present in the cutbank, they might be left exposed.

Road reaches between the treatment sites and any remaining skid trails receive minimum treatment to ensure that drainage on the remaining road bench mimics natural hydrology. Drainage is dispersed through outsloping or creating cross road drains.

Excavated areas would be recontoured to blend in with the original undisturbed channel or hillslope topography and the original ground surface. The original surface and topography are determined by noting where the uncut slope intersects the road bench and by partially buried trees or stumps.

During road construction, topsoil is generally the first material cut and pushed over the edge of the road bench. The topsoil is often capped by the subsoil that was pushed over the edge as the road cut was flattened and widened. The original layer of topsoil may be encountered beneath the subsoil fill. One goal of sidecast excavation is to locate the topsoil on the lower edge of the original slope that was buried under subsoil fill. The topsoil layer defines the lower limits of excavation and would be left essentially undisturbed as the finished surface on the lower portions of a recontoured slope. This layer of organic material indicates the original ground configuration, which represents the most stable configuration of an area following road removal. Repositioning the sidecast topsoil along with its seedbank onto the surface of the road cut improves the process of revegetation by increasing the depth of soil on the cut bench.

Vegetation removed during restoration would be stockpiled and placed or scattered on the slopes for mulching at the end of the heavy equipment work. No old-growth or mature trees larger than 24" dbh would be removed. Trees larger than 18" but less than 24" dbh would be removed only to accomplish the restoration objectives at a specific site. The vegetation that must be disturbed to get to the fill that needs to be excavated is generally abundant and 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. Under the proposed action, vegetation debris would be collected and concentrated on finished slopes leading directly to streams and on recontoured slopes where the downslope buffer is inadequate to catch mobilized fine sediments.

The site geologist would estimate the finished slope steepness and length along road segments with potential to contribute surface erosion to streams, and use the guidelines from the Post-excavation Erosion Control Guidelines found in the biological assessment submitted to NMFS (NPS 2006b) to determine appropriate ground cover rates. Mulch would be concentrated where there is the greatest risk of exposed soils eroding and entering a stream. The heaviest concentration of mulch would be applied closest to streams, where slopes encourage flow convergence and lead directly to a stream. Where flow is expected to cross the finished slopes, ground cover would be increased to reduce erosion and trap sediment. Small swales that might not exhibit signs of surface runoff would also be covered with vegetative debris to reduce erosion and sediment delivery. Ground cover in both cases would be done to ~~—moderate~~ specifications defined in the BMPs and referenced in the contract technical specifications. As excavations proceed and slopes are finished, final adjustments to ground cover rates would be made to insure the intent of reducing downstream turbidity and suspended sediment is achieved.

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

Large woody debris would be placed in the streams when completing crossing excavations to provide storage locations for trapping sediment that moves through the channel from natural upstream and post-excavation erosion, and to provide immediate cover for aquatic/riparian species. The distribution of woody debris and rock in the excavated channel might be rearranged during post-excavation monitoring to ensure effectiveness of restoration, using hand tools to minimize post-excavation erosion and because heavy equipment generally cannot access a site following removal of the road.

Previous monitoring studies show that surface erosion from bare areas is greatest the first winter following earthmoving, and 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 over excavation areas.

Documentation and Post Excavation Monitoring

Road removal work would be documented before and after the heavy equipment work. Road segment to be removed would be surveyed, mapped, and monumented for planning and contracting purposes. Surveys are used to estimate the volume of material to be excavated and the volume of storage areas available for placing fill.

Completed projects would be visited a number of times during the first winter. Sites would be visited more often if there are numerous storms, especially heavy rainfall events, or the site is considered to be less stable. Photo-points that were established during the original surveys prior to excavation would be re-photographed. Excavations would be re-surveyed following restoration work to determine actual volumes of material moved during the project. Information gathered by project geologists during the excavations includes equipment hours, ground conditions, and anything unusual encountered during the excavations. Final excavation costs and volumes for each treatment would be compiled. The project geologists will establish and mark photo points to document conditions before, during and after excavation as a baseline for

monitoring restoration effectiveness and recovery in treated areas. An annual project summary report for each site would describe site conditions and logging history prior to restoration, restoration work accomplished, costs, preliminary monitoring results, and any recommendations for future work at other sites. Monitoring is described in more detail in the Post-excavation Erosion Control Plan which is included in this environmental assessment by reference.

Five recording streamflow and turbidity monitoring stations with automated gages were installed in 2002 (see graphic “Lost Man Creek Roads to Treat”). Results of completed rehabilitation work would continue to be compared to pre- and post-project data. Treatment effects from initial restoration work were already occurring when monitoring was begun three years into the Lost Man Creek project. Treated tributaries would serve as control sites for the current proposed work in the South Fork and future work planned for the Middle Fork Lost Man Creek.

Sensitive species surveys, best management practices, and mitigation measures

BMPs for work around flowing streams and fish-bearing streams, and mitigation measures to reduce or avoid adverse effects to water quality, riparian wetlands and riparian vegetation, threatened species, and cultural resources described for the proposed action would be the same for both action alternatives. BMPs to protect water quality also protect aquatic species, including anadromous fish.

BMPs to Protect Aquatic Resources, Including Listed Fish—Erosion control measures such as straw bales, silt fences, and check dams would be in place down slope of project sites within riparian areas at all times during restoration activities. Erosion control structures would be maintained throughout, and possibly after, restoration activities. Any disturbed ground would receive appropriate erosion control treatment prior to the beginning of the wet season. Work sites would be winterized at the end of each day when significant rains are forecast that may cause unfinished excavations to erode. Winterization could include the following: smoothing unfinished surfaces to allow water to freely drain across them, compacting unfinished surfaces with an excavator bucket where concentrated runoff may flow, 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. Adequate erosion control supplies (gravel, straw bales, shovels, etc.) would be kept at all restoration sites to ensure loose excavated material is kept out of water bodies.

Equipment, both hand tools and heavy equipment, would be inspected daily to check for leaks of petroleum products or other pollutants. Leaks from equipment would be repaired before use in areas where leaks would enter a stream. All equipment would be stored, serviced and fueled outside of riparian areas and away from stream crossings. Heavy equipment would be cleaned (e.g., power washed, steam cleaned) prior to use below the ordinary high water mark.

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

Threatened Bird Mitigation Measures—Two basic mitigation measures are used to minimize adverse effects from the project on northern spotted owls and marbled murrelets from noise and disturbance during the breeding season (NPS 2006a). Project areas are surveyed to determine presence of owls or murrelets using survey protocols established by the USFWS and the Pacific Seabird Group. If birds are determined to be present in a work area or would possibly be affected by work in an area, work that would generate noise greater than ambient noise would be

prohibited between certain dates (seasonal restrictions) or limited to certain hours of the day (daily limited operating periods—DLOPs). A distance of 0.25 miles around owl activity centers or where murrelets are detected is used to provide an additional buffer against noise and disturbance.

Spotted owl surveys would be conducted prior to work in all suitable habitat that may be affected directly or indirectly by the project. Should surveys detect one or more new activity centers within the project area, and if owls are nesting or reproductive status cannot be determined, seasonal restrictions would be implemented between February 1 and September 15 on all roads occurring within the activity center stand or a 70-acre core area surrounding the activity center. A similar restriction would be imposed between February 1 and July 9 for all roads outside an activity center core area but within 0.25 miles of an activity center with known or undetermined nesting status. Surveys to document occupancy of the project area by northern spotted owls were completed in the South Fork sub-basin in 2003-04 and within 0.25 miles of Geneva and Holter Ridge Roads. Surveys would be continued or conducted as needed under the survey protocols and would be completed in all suitable habitat prior to project work.

Surveys were done in 1999-2001 and 2003-04 throughout much of the project area to document marbled murrelet presence and occupancy in project areas that are in or near residual old growth redwood stands that could provide nesting opportunities and in intervening second growth habitat. Surveys would continue in the South Fork as needed to satisfy protocols. Habitat found to be unoccupied during surveys in the Middle and North Fork sub-basins in 2000 and 2001 would be resurveyed in 2006-2007, and all remaining unsurveyed portions of the project area would be surveyed prior to work.

If murrelets are found to occupy sites within 0.25 miles of roads proposed for treatment, seasonal restrictions would be implemented between March 24 and September 15. Work might be allowed between March 24 and September 15 in or within 0.25 miles of sites where murrelet presence was detected (as opposed to occupied) depending on the number and the nature of detections but a DLOP would be imposed in which operation of heavy equipment and power tools would be allowed only between two hours after sunrise and two hours before sunset. Heavy equipment access to a site would also be subject to the seasonal or daily restrictions. There would be no restrictions on passenger vehicle access to a work site.

The roads with a DLOP include those segments of A100 South outside the old-growth or murrelet occupied site buffers, A110, the A120 inside the occupied site buffer, segments of the A140 near sites with presence, A142, A300, B200, B200/B500 Connector, North Branch North Fork, Shangri La, the southern half of the Upper B500, and heavy equipment access through the contiguous old growth forest along Geneva Road. Other roads including the A111, A121, A131, A350, and A400 might require a DLOP if future surveys indicate murrelet presence.

Three different start dates for project work each year would be used to reduce adverse effects to threatened birds. All work would be completed by October 15 to protect listed fish species unless NMFS grants extensions due to dry weather.

- June 15 (earliest project start-up date): Although no actual road removal work is scheduled before July 10, brushing and clearing along access roads might occur as early as June 15 on roads more than 0.25 miles away from old growth, marbled murrelet occupied site buffers, or spotted owl activity centers, and only within areas with current spotted owl and marbled murrelet surveys completed.

- July 10 through October 15: July 10 is the anticipated start date for actual road removal work on roads that are outside old growth and marbled murrelet occupied site buffers, with three exceptions noted below. The July 10 start date applies to roads in areas needing surveys for marbled murrelets and/or spotted owls unless survey results indicate a more restrictive limited operating period is necessary. There are three exceptions to the July 10 start date. In the A120 and A300, the first 0.1- 0.2 miles of road to be removed are within 0.25 miles of occupied murrelet sites. The A140 Manning Creek segment is not in an occupied site but a more restrictive start date would be used due to murrelet presence in the area and the extent of habitat degradation that might occur at this site.
- September 16 through October 15: All roads and associated skid roads and stream crossings within old growth, the old growth buffer, or occupied marbled murrelet site buffers with the exceptions of the A120 and A300 mentioned above would be removed during this time period unless an extension was granted for dry conditions by NMFS.

For both marbled murrelets and spotted owls, habitat degradation or removal would be minimized by limiting vegetation removal to fill sites, leaving all old growth trees at the toe of the fill slope, and by removing trees 18" or greater in diameter at breast height (dbh) in the fill slope only when necessary.

In addition to potential adverse effects from noise, disturbance, and degradation of habitat, northern spotted owls and marbled murrelets are also subject to nest predation, especially by avian predators, primarily Steller's jays and ravens (corvids). Contractors and RNSP staff working in the project area would remove all food scraps and trash to avoid attracting corvids to work sites in the vicinity of suitable habitat during the breeding season. Vegetation removal along project roads within 0.25 miles of the contiguous old growth, or high quality residual habitat, would be minimized to avoid the creation of flight corridors and food sources for avian predators.

Table 2: Comparison of Action Alternatives

Estimated erosion and excavation volumes are rounded to the nearest hundred. All volumes are in cubic yards (cy).

Comparison of Alternatives 2 and 3	Alt 2:	Alt 3:
	Partial Restoration (Proposed Action)	Complete Restoration
Total Miles of Road Treated	27.9	32.06
Ground Disturbance (acres)	216	291
Total Volume of Sediment Excavated (cy)	545,000	999,000
Total Erosion Prevented (erosion potential in cy)	574,700	624,500
Stream Crossings		
Number of Stream Crossings Removed	163	174
Miles of Road at Stream Crossings Fully Removed and Recontoured	4.21	4.63
Volume of Road Fill Excavated	146,900	149,300
Volume of Sediment Prevented from Eroding	140,300	154,200
Volume of Sediment Prevented from Delivering to a Stream	131,600	145,600

Comparison of Alternatives 2 and 3	Alt 2:	Alt 3:
	Partial Restoration (Proposed Action)	Complete Restoration
Roads Between Stream Crossings		
Miles of Road Fully Removed and Recontoured	12.55	27.43
Miles of Road Partially Recontoured	11.14	0
Volume of Road Fill Excavated	398,200	849,700
Volume of Sediment Prevented from Eroding that would Damage Aquatic Habitat	287,600	309,000
Volume of Sediment Prevented from Eroding that would Damage Terrestrial Habitat	15,100	15,700

Alternative 2: Partial Restoration in Lost Man Creek Watershed (Proposed Action and Environmentally Preferred Alternative)

Under the proposed action, 27.9 miles of abandoned roads dispersed throughout 5,804 acres in the South Fork (including Manning Creek), Middle Fork, and North Fork (including Larry Damm Creek) sub-basins of Lost Man Creek would be treated to prevent or reduce erosion. After roads are removed, any segments that are untreated would not be accessible by heavy equipment for any future restoration work. Park geologists have determined that these untreated segments that would be cut off have a low risk of failure or do not pose a threat to significant park resources if the untreated segments fail in the future.

The proposed restoration in Lost Man Creek would focus on removing fill from stream channels and headwater swales, placing excavated material in stable locations, retrieving and stabilizing material that was sidecast during road construction, and shaping all repositioned material to blend with the surrounding hillslope topography and drainage patterns. Road reaches would be recontoured, with excavated material placed against the cutbank or moved to stable locations if the cutbank is potentially unstable. Side slopes would generally match original contours above and below the road.

All locations along haul roads and most locations along skid road with the potential to erode and deliver sediment to the stream system would be fully excavated and restored to their pre-disturbance topography as closely as possible to restore pre-disturbance hydrological function and patterns. Those sites where the erosion and sediment would damage high value terrestrial habitat down slope would also be fully excavated. Of the almost 28 miles of roads that would be treated, approximately 4.21 miles at stream crossings and 12.6 miles between stream crossings would be fully removed and the road corridor recontoured to resemble original topography.

About 11 miles of roads would be partially removed and recontoured between stream crossings where road failures would not result in severe damage to either streams or high value terrestrial habitat. Some sections of haul roads and skid roads that have the potential to erode, but where the sediment would be unlikely to reach (or be delivered to) the stream system would not be fully excavated. Those sites where full excavation would remove advanced second growth would receive a reduced level of treatment to reduce adverse effects on marbled murrelets and northern spotted owls from removal of forest vegetation.

Approximately 398,200 cy of road fill would be excavated for full and partial removal of the 23.7 miles of roads between stream crossings. Excavated areas would be recontoured to resemble original topography.

Approximately 146,900 cy of fill would be excavated to remove 163 stream crossings along 4.2 miles. Stream crossings would be excavated to near original width, depth and slope to expose natural channel armor. Material excavated from the channels would be placed in stable locations away from streams.

A few locations that have the potential to erode and deliver sediment to the stream system but that cannot be accessed safely due to erosion that has already occurred or because of excessively steep slopes would not be treated. Some isolated sites on skid roads that have low potential to erode and deliver sediment to the stream system would not be treated if gaining access to, or excavating the isolated site, would remove advanced second growth stands surrounding residual old growth trees.

Trees, shrubs, and other surface vegetation removed during excavation would be stockpiled for mulch and spread over the finished surface with higher amounts placed on steeper slopes and near streams to trap eroded sediment as it moves downslope before it reaches the stream. This native, on-site material would be supplemented with mulching material such as shredded redwood bark and wood chips obtained from local lumber mills, and by other surface erosion control measures if needed.

Alternative 3: Full Restoration of Lost Man Creek Watershed

Under the full restoration alternative, 32.1 miles of abandoned and failing roads dispersed throughout 5,804 acres in the South Fork (including Manning Creek), Middle Fork, and North Fork (including Larry Damm Creek) sub-basins of Lost Man Creek would be treated.

Under a full restoration alternative, all locations along all haul and skid roads that have the potential to erode and deliver sediment to both aquatic and terrestrial sites would be fully excavated and recontoured to restore pre-disturbance drainage patterns. All sections of road between the fully excavated sites with potential to erode would also be fully excavated. Natural hillslope topography along all treated road corridors restored to the maximum extent reasonably and safely feasible. All sections of road between stream crossings would be fully excavated and the natural hillslope topography restored to the maximum extent reasonably and safely feasible. Only locations that cannot be safely accessed due to erosion that has already occurred or because of excessively steep slopes would not be treated.

Of the 32 miles of roads that would be fully removed and recontoured, 4.63 miles would be at stream crossings. Approximately 149,300 cy of fill would be excavated to remove 174 stream crossings. Between stream crossings, approximately 27.4 miles of road would be fully removed and recontoured. Approximately 849,700 cy of road fill would be excavated for full removal and recontouring of the 27.4 miles of roads between stream crossings.

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 repositioned to speed re-establishment of vegetation.

Skid roads used to access and excavate sites with erosion potential would be fully recontoured to the maximum extent reasonably and safely feasible. Skid roads that are not used for access to other work sites would not be treated.

Environmentally Preferred Alternative

The environmentally preferred alternative is the one that best meets the criteria identified in Section 101 of the National Environmental Policy Act (NEPA) as outlined below.

- Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations.
- Attain the widest range of beneficial uses of the environment without degradation, risk of health or safety, or other undesirable and unintended consequences.
- Preserve important historic, cultural and natural aspects of our national heritage.
- Enhance the quality of renewable resources.

The NPS has determined that Alternative 2: Partial Restoration (the Proposed Action) is the environmentally preferred alternative. This alternative would reduce the erosion into streams while minimizing the adverse effects on threatened bird species caused by removing vegetation that has regrown on and adjacent to abandoned roads between stream crossings. Although Alternative 3: Full Restoration would reduce potential erosion to a greater extent (about 625,000 cy of soil prevented from eroding under Alternative 3 versus about 575,000 cy in Alternative 2), almost twice the volume of soil would be excavated under Alternative 3 (999,000 cy) than under Alternative 2 (545,000 cy). Excavating twice the volume of soil would disturb approximately twice the area of vegetation, including second growth forest, which would increase the adverse effects on northern spotted owls and marbled murrelets from habitat degradation.

Although this vegetation has grown back after logging and is not the original forest cover, the areas from which vegetation is removed are susceptible once again to invasion by exotic species because a greater amount of light is available when the forest canopy is removed. Openings in the forest canopy are also susceptible to colonization by both native and non-native berry-producing plants that are food sources for corvid birds and other nest predators that are a major factor affecting marbled murrelet nesting success. The areas from which vegetation is removed also require several decades for trees to regrow into suitable habitat for many birds. Full restoration also requires more time to accomplish the work, increasing the risk that a large storm will occur with a corresponding increased risk of road failures in areas that have not yet been restored. Full excavation also results in a larger area of newly exposed soils at restoration sites that have a greater short-term risk from erosion in a major storm. The risk of failure of road segments between excavated areas under the Proposed Action has been judged to be acceptable in comparison to the higher cost associated with more complete restoration. Doubling the excavation volume under the Full Restoration alternative would also almost double the cost of the project. Because full restoration costs more, less restoration can be done in a single area for a given cost, increasing the overall time needed to complete watershed restoration in the park as a whole, which exposes other areas to road-related erosion and continuing resource damage.

The majority of road fill excavated under the Full Restoration alternative would be between stream crossings (850,000 cy under Alternative 3 versus 398,000 cy under Alternative 2). Areas between stream crossings would not have as great a potential for damaging aquatic habitat by direct delivery into streams as excavating stream crossings (174 crossings with 146,000 cy prevented from eroding into streams under Alternative 3 versus 163 crossings with 132,000 cy

prevented from eroding into streams under Alternative 2). Thus, while Alternative 3: Full Restoration would result in a greater reduction in erosion over the long term, it has greater short-term impacts on threatened birds from removal of more vegetation, which reduces cover for these birds, and increases the area of exposed soils susceptible to invasive exotic plants that are food sources for avian nest predators. The greater area of newly exposed soils under a Full Restoration alternative also results in an increased risk of erosion if a major storm occurs in the first season following restoration. The short- and long-term risks to fish from erosion into streams can be mitigated more effectively than the short-term risks to birds from noise and removal and degradation of habitat.

The NPS has determined that Alternative 2: Partial Restoration would result in fewer short-term adverse effects on threatened bird species while still eliminating erosion in the stream channels and protecting the most sensitive terrestrial habitat areas from landslides, with the greatest long-term benefits over a larger area of the parks over the long-term. The USFWS concurred with the NPS determination that the project may affect but is not likely to adversely affect northern spotted owls, and may affect and is likely to adversely affect marbled murrelets in 66 acres of occupied or potentially occupied nesting habitat from increased threat of corvid predation, habitat degradation on 7 acres, and noise disturbance in 2 acres. However, the USFWS determined that the project is not likely to jeopardize the continued existence of marbled murrelets, or result in destruction or modification of critical habitat. NMFS is expected to issue a Biological Opinion and Letter of Concurrence with the NPS determination that the project may affect and is likely to adversely affect Southern Oregon/Northern California Coast coho salmon, Coastal California Chinook salmon, and Northern California steelhead trout, their habitat, and Essential Fish Habitat but that the adverse effects would be short-term and would be outweighed by the long-term benefits to the species and their habitats.

Actions Considered but Dismissed from Full Analysis

A variety of different approaches and techniques for rehabilitating damaged watersheds, reducing erosion, and restoring watershed functions in the Lost Man Creek project area were considered. Those alternatives that best meet the purpose and need as described above and are consistent with NPS plans, policies, guidelines, and regulations have been analyzed as the proposed action and alternatives. Several other approaches were considered but eliminated from detailed study because they do not meet the purpose and need for the project or are inconsistent with the 1999 GMP.

Erosion Control

Although erosion control is a reasonable alternative because it is technically feasible and consistent with an unpredictable level of funding, erosion control as the primary restoration approach within the parks is not consistent with the decision for level of restoration outlined in the 1999 GMP/EIS and does not meet the purpose and need for rehabilitating the watershed outlined in the national park expansion legislation. Erosion control might be required in portions of the Lost Man Creek watershed as an emergency measure if widespread damage from a major storm requires immediate action and restoration has not been completed.

Erosion control focuses on treating stream crossings while allowing road benches and landings to remain. The objectives of erosion control are to reduce sediment loads into streams, reduce landslide frequency, and reduce but not eliminate adverse effects from roads on hydrological patterns. Under an erosion control alternative, diversion potential and drainage would be corrected by installing ditches and cross road drains; road drainage ditches and culverts would receive increased maintenance for proper functioning; some road sections would be outsloped to drain water off the edge rather than allowing it to run down the road surface where it could create

gullies; undersized and failed culverts would be replaced with culverts capable of accommodating a 100-year storm event; and Humboldt crossings would be replaced with culverts.

Erosion control uses the same heavy equipment and techniques as partial or full landform restoration, but treatments are done at fewer locations that are prioritized according to the potential for sediment and road fills to fail and enter streams.

Under an erosion control alternative, the primary treatment would correct or prevent stream diversions at stream channels. If roads do not need to be accessible to vehicles, drainage structures would be removed and fill would be excavated from stream crossings to prevent the road washouts. However, once a stream channel has been excavated to the original channel bed, restoration or decommissioning of the road segment beyond the crossing is no longer an option because the crossing is not accessible to vehicles or equipment. If a road must remain drivable, rolling dips are constructed to allow water to drain off the road surface through a shallow depression on the road surface that is passable to high-clearance or four-wheel-drive vehicles.

Under an erosion control alternative, roads in steep headwater swales and inner gorges of streams would be treated to prevent debris flow-type road failures. Road fill failures that would potentially damage streams would be treated by removing sidecast road fill, especially in unstable areas that are indicated by ponded water on road surfaces or along inboard ditches, and restoring natural drainage patterns to the extent possible.

Under an erosion control alternative, some reaches of road that have been surfaced with drain rock would be ripped to loosen the surface to increase infiltration and encourage revegetation. Ripping has a high erosion rate before a sufficient layer of vegetation regrows on the newly redisturbed road surface. Some ripped roads would require active revegetation with plant materials imported from other areas of the parks or purchased. The sidecast fill that remains after ripping would continue to erode and segments on slopes would be susceptible to eventual failure as the fill becomes saturated.

Abandon Roads in Place

Under this alternative, roads would be abandoned in place and would not be maintained. This would accelerate the rate of failure of road fills and stream crossings resulting in damage to resources over both the short- and long-term. Abandoning the former logging roads in Redwood National Park would not be consistent with the legislation establishing and expanding the park, or with NPS laws, regulations, policies, and guidelines, and the 2000 GMP.

Affected Environment

Setting

Redwood National and State Parks lie along the Pacific coast on the western edge of the Coast Ranges of northwestern California. The parks include submerged coastal lands, beaches, estuaries, rivers, ancient redwood groves and spruce and fir forests, prairies and oak woodlands, and second growth coniferous forests.

U.S. Highway 101, a major north-south transportation route along the Pacific Coast, runs through the parks and serves as the primary highway access to the Lost Man Creek area. Lost Man Creek Road, a paved former major logging haul road now used for park access, leaves the highway about four miles north of the town of Orick and follows Lost Man Creek for about one mile, ending at the Lost Man Creek Picnic Area. From the picnic area, a network of former logging roads now provides administrative and recreational access into the Lost Man Creek watershed.

Lost Man Creek is a major tributary of Prairie Creek, which is itself the largest and the last major tributary to join Redwood Creek before it runs into the ocean (see Location map). Redwood Creek, the Klamath, and the Smith are the three major rivers in the parks. Redwood Creek flows northwesterly for 55 miles through a 280-square-mile watershed from an elevation of 5,000 feet to the Pacific Ocean near Orick. The Redwood Creek watershed is characterized by high relief, steep unstable slopes, and narrow valley bottoms.

Table 3—Characteristics of Lost Man Creek Watershed and Sub-basins

<i>Sub-basin</i>	<i>Drainage Area (mi²)</i>	<i>Drainage Area (acres)</i>	<i>Mean Basin Slope (%)</i>	<i>Elevation Range (ft)</i>	<i>Area in Prairie Creek Fm. (acres [%])</i>	<i>Area in Old Growth (acres)</i>
Larry Damm Creek	1.9	1181	27.6	1600	853 [72%]	245
North Fork Lost Man Creek	2.4	1422	35.6	1440	742 [52%]	135
Middle Fork Lost Man Creek	2.4	1444	37.0	1600	583 [40%]	35
South Fork Lost Man Creek	4.3	2522	39.3	1920	177 [7%]	304
Other Areas (Interfluves)	1.1	1160	---	---	106 [9%]	1116
Basin Totals	12.1	7,729	34.9	-----	2461 [36%]	1835

The Lost Man Creek watershed covers approximately 12 square miles and makes up about one-third of the entire Prairie Creek watershed. The lower mainstem of Lost Man Creek has a gentle gradient and meanders within the steep-sided valley with narrow intermittent floodplains. Near the confluence with Prairie Creek, the base level of Lost Man Creek has been artificially raised by a dam constructed in 1936 to supply water to the Prairie Creek Fish Hatchery, about 2.5 miles downstream of the project area. The dam caused the channel to aggrade (widen and raise due to infilling with sediment) for several hundred feet upstream. A second dam built in 1969-1971 below the original upper dam to try to maintain a source of water after silt filled in behind the upper dam. The second dam was removed in 1989. Accumulated sediment upstream of the dam was removed, and the natural stream gradient was re-established.

The lower part of Lost Man Creek retains relatively good channel conditions and stream health compared with other streams in heavily logged watersheds in the parks. This condition may be partly due to the larger logging roads acting as dams to trap large quantities of fine sediment washing off the skid roads, delaying the sediment from reaching the lower portions of Lost Man Creek.

Overview of Logging Effects in the Redwood Creek Watershed and Project Area

Rivers in northwestern California, especially 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 annual precipitation. These conditions combined with land use activities such as timber harvesting, road construction,

and ranching give the region one of the highest erosion 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.

Redwood Creek and its tributaries are frequently flooded by winter storms. Local soils are naturally unstable and highly erodible. Landslides and earthflows are widespread, and even under natural conditions, streams swelled by winter rains transport large volumes of sediment.

Mass failures can be caused by either natural or human-caused disturbances. Mass failures within the Lost Man Creek are a result of the geology, soils, and historic timber harvesting and associated road activities. Areas near fault zones and steep slopes underlain by mudstone, where subsurface drainage has been altered are especially susceptible. Soil materials of the Prairie Creek Formation that underlies about one-third of the project area are weakly consolidated and are highly unstable due to the low amounts of clay and high amounts of sand and gravel.

Altered drainage patterns, loss of topsoil, soil compaction, destruction of ground cover and subsequent decreased evapotranspiration, increased runoff rates, increased soil temperature, and decreased soil moisture are among the results of the logging activities. Disturbances such as roads can cause mass failures if road drainage has significantly altered natural drainage routes or is concentrated enough to saturate soils.

Surface runoff, intercepted and concentrated by inboard ditches along these roads, often empties onto slopes that have no natural drainage channels, resulting in severe gully erosion as the runoff cuts a channel into soft soils. During major storms, culverts and inboard ditches often become blocked, and water is diverted onto road surfaces, causing new gullies and saturating road fills, which in turn leads to hillslope failures. Logging roads cut into steep slopes have often resulted in massive slope failures, causing sediment to be delivered directly into perennial and intermittent stream channels.

Three-quarters of the Lost Man Creek watershed has been logged and over 50 miles of major haul roads constructed, along with several hundred miles of skid roads used to drag the logs to the truck roads. Almost all the logging occurred prior to the enactment of the California Forest Practice Act in 1973, which now requires protection of streams through various techniques, including improved road construction and maintenance.

Logging in the southern part of the project area south of Geneva Road and in the upper portions of Larry Damm and the North Fork began in the 1940s and ended with park establishment in 1968. The NPS acquired the Middle and South Forks and the remaining old growth along the lower main stem of Lost Man Creek in 1968. North of Geneva Road, logging in the middle and lower portions of Larry Damm and the North Fork watersheds began in the late 1950s and culminated in the 1970s with severe ground disturbance during the final phase of logging as park acquisition in 1978 was imminent.

By the time major logging began after World War II, two companies owned most of the Lost Man Creek watershed with their holdings more or less divided along a north-south line. One operation was in the relatively steep, fault exposed Franciscan graywacke slopes and the gentle “~~ap~~” terrane of the Prairie Creek Formation along Holter Ridge. These holdings were logged and tractor-yarded in the late 1950s, leaving scattered old growth for seed trees.

Another company operated in a different part of the watershed where underlying soils are primarily composed of the fine to medium grained sediments of the Gold Bluffs Unit of the

Prairie Creek Formation. These lands were clear-cut and tractor-yarded in the 1960s to early 1970s, with more extreme ground disturbance resulting from the combination of larger more powerful bulldozers, the tractor-yarding methods of the period, removal of all old growth trees, and construction of large haul roads and landings with little consideration of the natural drainage network or the soft and unstable soils of the Prairie Creek Formation. The Prairie Creek Formation is more prone to erosion than the more stable Coherent Unit of Lacks Creek (Franciscan Assemblage) that underlies most of the watershed.

Storm events in 1955, 1964, 1972, and 1975 combined with the high level of ground disturbance accelerated the erosional processes and large quantities of sediment were delivered into the stream systems. Aerial photos in Larry Damm Creek 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 the Prairie Creek Formation and on the intensively logged lands in Larry Damm Creek and the North Fork.

Following park establishment and expansion, little activity occurred in the Lost Man Creek watershed until emergency restoration efforts were initiated in 2000 to reduce erosion from roads that had failed in a major storm in January 1997. Stream crossing excavations in Larry Damm and the lower North Fork watersheds in the last two years encountered an unusually large amount of fine sediments deposited upstream of the crossings. In areas where the easily eroded Prairie Creek Formation is present upstream, it appears that those stream crossings that did not fail immediately acted as sediment traps for the massive quantities of fine sediment washing off the skid roads. The damming effect of these crossings has probably delayed the sediment load from reaching the lower portions of Lost Man Creek, where aquatic habitat is still relatively healthy. As the woody debris incorporated in the sidecast fills and stream crossings continues to decay and become less stable, the road fills are losing their integrity, and failure is imminent in many locations. As these failures occur, much of the material making up the fills will erode and enter the stream transport system, and the accumulated sediment trapped by the crossings will begin to mobilize and enter the stream.

Climate

The Pacific Ocean is a moderating influence on the climate of the parks, producing wet, mild winters and relatively dry summers with frequent coastal fog.

The northwestern Coast Range receives the heaviest rainfall of any area in California. Annual rainfall averages 70 inches but can vary erratically between locations. Inland areas along the Smith River may have more than 100 inches of annual precipitation. Although it can rain any time, most precipitation falls between November and March. Winter storms from the Pacific Ocean bring intense rainfall over several hours or days, particularly warmer storms from lower latitudes. These storms may cause both small streams and larger rivers to flood. Rainfall generally increases with altitude within the parks, but rainfall is also affected by distance from the ocean and variations in slope aspect. Snow falls infrequently at elevations above 1,600 feet and rarely at lower elevations but usually does not last long even at higher elevations inland.

Mean daytime temperatures at Prairie Creek Redwoods State Park are 47°F in January and 59°F in June. Along the coast, temperatures vary only slightly from summer to winter. Temperatures above 90°F or below freezing are rare. Areas inland such as Lost Man Creek have a greater annual temperature fluctuation, with summer high temperatures commonly reaching 90°F and winter temperatures around freezing.

Prevailing winds are northwesterly, bringing cool, moist air and frequently fog to the coastal areas and lower Redwood Creek basin and Lost Man Creek watershed. Intense winter storms may be accompanied by damaging winds. Occasionally in the fall, a warm dry wind from the east produces a rapid drying effect, intensifying fire hazards in the normally moist redwood forests.

Air Quality

Redwood National Park is designated as a class I airshed pursuant to Part C of the Clean Air Act, as amended (42 U.S.C. 7401 et al.). Class I designations are given to areas where air quality is cleaner than the national ambient air quality standards. Class I areas have the most stringent regulations for the protection of air quality, permitting the lowest increments of air quality degradation. The California Air Resources Board assigns the park to the North Coast Air Basin, under the jurisdiction of the North Coast Unified Air Quality Management District.

Air quality in RNSP is considered good to excellent because of the low population, scarcity of pollutant sources, and prevailing westerly ocean winds. Local views and scenes are often obscured by fog, rain, low clouds, salt spray haze, and natural forest haze inversion. All federal standards for regulated air pollutants are consistently achieved, including those for ozone, carbon monoxide, particulate matter, nitrogen dioxide, sulfur dioxide, and lead. The most significant air pollutant in the parks is PM₁₀ (particulate matter less than 10 micrometers in diameter), which is primarily from widespread non-industrial burning including prescribed fire for resource benefits in the parks and the industrial burning of timber harvest slash piles. In the past, total suspended particulates exceeded air quality standards, but improved technology, better use of materials, and fewer sawmills (and especially tepee burners) in the region have resulted in a reduction in suspended particulates.

Topography, Geology, and Soils

Overview—Redwood National and State Parks are near the junction of three active tectonic plates of the earth's crust. Steep, highly erodible landscapes and frequent earthquakes characterize the region and are all related to the geologic forces generated at plate boundaries. Soils are naturally unstable and highly erodible. Landslides and earthflows are widespread, and even under natural conditions, streams swelled by winter rains transport large volumes of sediment.

Topography—Topography refers to the shape and relief of the surface of land, ranging from flat to rolling to mountainous. Landforms result from physical and chemical weathering of surficial materials and rock, subaerial erosion, mass movement, sediment transport, and deposition. Rapid tectonic uplift; abundant, intense rainfall; and sheared bedrock make much of the parks highly erodible, deeply incised, and generally rugged.

Two distinctive physiographic provinces, the coast and the mountains, typify the parks. Inland lie the north-northwest trending mountains of the Coast Ranges. Elevations within RNSP range from below sea level in the offshore areas of the parks, to 3,262 feet at an unnamed peak in the Coyote Creek watershed in the Redwood Creek basin. Slopes range from near level in the alluvial valleys and on flood plains to near vertical along the coastal bluffs and within the inner gorge of stream canyons. Overall, slopes average 40% - 70%.

Elevations in the Lost Man Creek watershed range from about 200 feet above sea level at the confluence with Prairie Creek to about 2,250 feet along Holter Ridge. Slopes range near level in the alluvial valley bottoms of lower Lost Man Creek to near vertical within the inner gorges of

the upper Lost Man Creek tributaries. Overall, slopes average about 27% in Larry Damm Creek and 35-40% in the three other major forks.

Geology—The parks are underlain primarily by Jurassic-Cretaceous aged rocks of the Franciscan assemblage, a collection of sandstones, siltstones, schist and minor amounts of conglomerates with isolated exposures of chert and volcanic greenstones. There are also Plio-Pleistocene coastal plain sediments of the Prairie Creek Formation, Tertiary marine deposits of the Wimer Formation and Mesozoic serpentine rocks in the Little Bald Hills area and Quaternary alluvial and marine deposits in stream valleys and coastal areas.

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.

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. It consists of sandstone, siltstones, schist, and minor amounts of conglomerates. 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.

Most of the Prairie Creek watershed, which includes Lost Man Creek, is underlain by the Plio-Pleistocene aged Prairie Creek Formation. More than one-third of the project area is underlain by the 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.

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.

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 turbidities. 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. The graywacke contains abundant fine volcanic detritus. 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. 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, all 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, 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. Two geologic sections have been described 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.

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 in that the basal deposits are coarser and of fluvial origin. In a section in Larry Dam Creek near the 560 and 540 roads, 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.

Tectonics—The California coast is tectonically very active, and its complex geology and topography are controlled by movement along faults and crustal plates. The topography of the region is controlled by tectonics of the nearby triple junction and by the Cascadia Subduction Zone. Most of the land encompassed by the parks has experienced recent tectonic uplift. This uplift has been manifested in steep "inner-gorge" topography along major streams.

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. The South Fork Mountain fault runs east of the Redwood Creek basin and the parks except in the northeast corner, in the Little Bald Hills area, where the fault comes through the parks. Geologic structure in the parks is governed by several parallel north-northwest trending faults. These faults range from low-angle thrust faults to vertical faults and form the boundaries between the major lithologic units in the parks.

Two important faults cut through Prairie Creek Redwoods State Park — 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. The channel of Redwood Creek closely follows the Grogan Fault. Several faults trending ENE-WSW and E-W also occur within the watershed. These faults, oriented normal to the regional north-northwesterly trend, are expressed in the trellis-like drainage pattern of the tributary channels.

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.

Other faults that are perpendicular to the primary north-northwest fault orientation create the trellis-like drainage found in the parks. Late Cenozoic uplift and stream erosion are particularly evident in the steep inner gorges of Redwood Creek basin. Geologic structure in the Lost Man Creek watershed is governed by several parallel north-northwest trending faults. These faults range from low-angle thrust faults to vertical faults and form some of the boundaries between the major lithologic units in the northern portion of the watershed.

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, and is west of the any roads to be removed in this project area. 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. 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.

As with Redwood Creek, geologic structure in the Lost Man Creek watershed is governed by several parallel north-northwest trending faults. 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.

Geomorphology and Geological Processes—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. If these areas have been impacted by logging and road construction, they become prone to mass wasting. During periods of high precipitation, slope failures commonly occur in watersheds impacted by logging activities and along steep terrain throughout the parks, including roads through steep terrain such as Highway 101 along the ocean bluffs north of the Klamath River and the Prairie Creek bypass.

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 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 (areas prepared for large old growth trees to fall when cut to avoid breaking the tree and losing valuable wood), 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 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.

The depositional contact between the Prairie Creek Formation and the Franciscan is a probable hydrologic boundary and a potential zone of instability; groundwater that infiltrates through the porous Prairie Creek “~~ap~~-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. 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 Assemblage, and maintain relatively steep gradients along their entire length.

Gully erosion is apparent in both natural and disturbed settings (Janda et al., 1975). On unlogged forested hillslopes, gully erosion is related to subsurface piping through root channels. On logged hillslopes, extensive networks of rills and gullies have developed from streamflow diversions at road and skid road stream crossings, from ditches, and from interception of subsurface flow along roads and trails. Surface erosion of logged areas may also have increased as a result of decreased interception of rainfall by the forest canopy following harvest.

Previous studies have documented large increases in gully erosion on lands where timber has been harvested or where roads have been constructed (Janda et al., 1975; Nolan et al., 1976; Walter, 1985; Hagans and Weaver, 1987).

Many hillslopes in the Lost Man Creek watershed are inherently unstable as a result of steep gradients imposed by recent uplift and subsequent fluvial erosion, low shear strength resulting from pervasive shearing and fracturing of bedrock, and seasonal saturation of soils and regolith. Several mass-movement processes are active, including soil creep, slow persistent landslides, and rapid episodic landslides. The distribution of these processes is related to lithology (Harden et al., 1978), faults, hydrology, and land use. The most extensive mass movement features in the watershed are block slides.

Debris slides are shallow, translational mass movements that involve intact slope-parallel layers of soil and colluvium. Most debris slides in the Redwood Creek watershed are adjacent to major channels or are located along roads.

Streamside landslides are a major source of sediment in the watersheds of Redwood National and State Parks, including Lost Man Creek, both because of their number and volume and because they deliver sediment directly to high-order channels and steep, low-order channels capable of transporting most sediment downstream. Increased sediment from eroding hillslopes leads to stream aggradation, which in turn increases the rate of streamside landsliding.

Soils—Soil development proceeds farthest on landforms stable for a long time. Surface horizons reach a steady state within centuries and subsurface horizons develop for millennia. In most of the national and state parks, the soils have strongly developed surface horizons, rich in organic matter and nutrients. There are particularly high levels of organic matter and nutrients in the surface horizons of soils developed under the parks' coniferous forests, oak woodlands and prairies. This high organic matter content contributes to the high natural growth rate of the vegetation in these plant communities.

Soil development occurs in response to the weathering of the parent materials (rocks and alluvial deposits) and input from surface materials (vegetation), and varies depending on the topography (slope, aspect, and hydrologic features), underlying rock composition, and time. For the most part, the soils in the parks are well developed because the mild wet climate has caused a high degree of weathering of the underlying materials. Most of the soils have strongly developed surface horizons that are rich in organic matter and nutrients, particularly in areas that have coniferous forests, oak woodlands, and prairies; are moderately coarse textured; and have infiltration capacities but possess little cohesion and very low shear strength. The steep terrain, rainy climate, and deep, medium-textured soils make the area very susceptible to erosion.

The soils in the parks have developed primarily from rocks of the Franciscan complex. Underlying geologic units strongly influence the nature of the soils, depending on their mineralogical and chemical composition and susceptibility to weathering and erosion. Residual soils are found in isolated areas on sloping ridge crests, and alluvial soils have formed in alluvial valleys, on floodplains, and on stream terraces.

Soils found in Lost Man Creek Watershed can be grouped into six generalized map units (see Table 3). Soil development is strongly influenced by the distance from and elevation above the ocean, underlying rock type, and vegetation. Upland soils in the watershed are well drained (seasonal high water table is at a depth greater than 100 centimeters), and very deep (greater than 152 centimeters to bedrock). In general the surface layer is a brown to very dark brown gravelly to very gravelly loam. Surface layer organic matter is greater (very dark brown) in vegetation communities dominated by a deciduous shrub or fern dominated understory, as compared to an evergreen shrub dominated understory. As a result, available waterholding capacity and nutrient storage and availability are greater. The subsurface layer is a yellowish brown to pale yellow clay loam to very gravelly loam dominated by low amounts of organic matter and non-expanding, low activity clays, hence nutrient storage and availability is low.

Most of the soils classified as Paleohumults and Haplohumults. Humults are well-drained ultisols that have high organic matter content. Ultisols are strongly leached, acid forest soils with relatively low native fertility. They are found primarily in humid temperate and tropical areas of the world, typically on older, stable landscapes. Intense weathering of primary minerals has occurred, and much calcium, magnesium, and potassium has been leached from these soils. Ultisols have a subsurface horizon in which clays have accumulated, often with strong yellowish or reddish colors resulting from the presence of iron oxides. Because of the favorable climate regimes in which they are typically found, ultisols often support productive forests.

Table 3. Generalized Soil Map Units for Lost Man Creek Watershed.

Map unit name	Lithology	Watershed (%)
Coppercreek-Slidecreek-Lacks creek, 15 to 75 percent slopes	Sandstone & Mudstone	35
Sasquatch-Sisterrocks-Ladybird, moist, 15 to 75 percent slopes	Sandstone & Mudstone	20
Ossagon-Squashan-Goldbluffs, moist, 15 to 50 percent slopes	Prairie Creek Frm	15
Ossagon-Squashan, 15 to 50 percent slopes	Prairie Creek Frm	10
Ladybird-Stonehill, moist, 15 to 50 percent slopes*	Redwood Creek Schist	10
Surpur-Mettah, dry, 15 to 30 percent slopes	Prairie Creek Frm	5
Endoaquepts-Dystrudepts, 0 to 15 percent slopes*	Alluvium	5

* These map units are not within the project area.

Approximately 70 percent of the watershed is underlain by sandstone and mudstone of the Lacks Creek Unit of the Franciscan Assemblage. The Coppercreek-Slidecreek-Lacks creek map unit is found mainly along the southeast and east margins of the project area on steep to very steep highly dissected mountain slopes. The vegetation is mainly redwood, Douglas-fir overstory, with an evergreen shrub dominated understory. The main limitations are slope steepness, seasonally saturated soil conditions (at a depth greater than 100 centimeters), and mass wasting potential, which is high near fault zones and where mudstone bedrock predominates and/or subsurface drainage is impaired.

The Sasquatch-Sisterrocks-Ladybird map unit is on steep to very steep highly dissected mountain slopes. The vegetation is mainly redwood, Sitka spruce, alder and western hemlock overstory, with a deciduous shrub or fern dominated understory. The main limitations are slope, seasonally saturated soil conditions (at a depth greater than 100 centimeters), and mass wasting potential, which is high near fault zones and where mudstone bedrock predominates and/or subsurface drainage is impaired.

Weakly consolidated fluvial sediments, nearshore marine, beach, and estuarine deposits of the Prairie Creek Formation underlie the remaining 30 percent of the watershed. The Goldbluffs, Mettah, Ossagon, Squashan, and Surpur suite of soils are mapped on the Prairie Creek Formation. The Goldbluffs and Squashan soils developed in weakly consolidated gravelly to very gravelly fluvial deposits. The surface layer is a gravelly loam to very gravelly sandy loam. The subsurface layer is a very gravelly sandy clay loam to extremely gravelly sand. The Mettah soils form is estuarine deposits. The surface layer is a clay loam. The subsurface layer is a clay or silty clay. The Ossagon and Surpur soils developed in weakly consolidated fluvial overbank, nearshore marine and beach deposits. The surface layer is a loam to very fine sandy loam. The subsurface is a fine sandy loam to clay loam. The vegetation of the Ossagon-Squashan and Surpur-Mettah map units is mainly redwood, Douglas-fir overstory, with an evergreen shrub dominated understory. The vegetation of the Ossagon-Squashan-Goldbluffs map unit is mainly redwood, Sitka spruce, alder and western hemlock overstory, with a deciduous shrub or fern dominated understory. These soils are on unstable, rounded hillslopes and mountain slopes. Soil strength and slope stability are low.

Schist of the Redwood Creek Unit of the Franciscan Assemblage and recent alluvium underlies approximately 15 percent of the watershed, primarily in the southwest margin, but the two map units do not occur in the project area.

The components of the soil resource that could be affected by the proposed activities are soil productivity, soil erosion, and soil stability.

Soil productivity is the ability of the soil to supply water and nutrients to sustain plant growth. Factors, which strongly influence soil productivity, include physical properties such as soil depth, pore space, and soil density. Changes in these characteristics occur when ground-based equipment makes repeated passes over the soil. These activities compact soils, reducing the amount of pore space and increasing soil density. As a result, water and air movement and root growth is affected. Water and nutrients may become unavailable for plant growth.

The surface layer in soils within the Lost Man Creek Watershed contains three to eight percent organic matter. Organic matter in its various forms improves soil productivity. Organic matter within the soil increases nutrient availability and storage, and increases pore space, which in turns allows the soil to store more water available for plant growth. Organisms within the surface layer, including fungi and bacteria, drive nutrient cycling by decomposing organic matter, which releases nutrients for plant growth.

Soil erosion is the movement of soil particles by water or wind. Soil erosion is most strongly dependent on rainfall, topography, and vegetative cover. On steep, highly dissected slopes, water is the most common cause of soil erosion. Erosion in undisturbed forest communities is infrequent. Thick organic layers and soil layer with abundant pore space allow rainwater to infiltrate into the soil. Soil erosion can occur when the organic and mineral surface layers are removed or compacted. Compaction, rutting, and puddling reduce the movement of water into soil, and tend to channel water.

Water Resources

Hydrology—Streamflow in the parks, including Lost Man Creek watershed, is highly variable from year to year as a result of annual rainfall variations. Streamflow also varies seasonally, owing to the highly seasonal distribution of rainfall. Winter flood flows can be as much as four orders of magnitude higher than summer low flows. Tributaries with drainage basins smaller than about 1 square mile are commonly dry during summer months (Janda et al., 1975).

Regular stream discharge measurements have been taken on Redwood Creek in Orick since 1953. Peak annual flows ranged from a low of 2,300 in February 2001 to the highest flow on record of 50,500 in December 1964. Between 1953 and the present, there have been five years with a peak annual flow at or near 50,000 cfs, and three years with flows at or around 40,000 cfs. The most recent flow above 40,000 cfs occurred on January 1, 1997 (40,300 cfs).

The only significant storm since 1975 (when logging was still occurring in what is now the park before park expansion in 1978) was the January 1997 storm. This storm is considered to be a 12-year return interval storm (a storm with a chance of occurring 12 times in 100 years or a 12% chance in any given year). This flood initiated debris torrents of whole trees, boulders, and mud directly into Redwood Creek adjacent to the Tall Trees Grove, about nine miles upstream of the confluence of Prairie Creek and Redwood Creek. The effects of a major storm (a 25 year or greater return interval) would be more severe. Within the period of 1975 to 2015, there is an 80% chance of a 25-year flood. The last 25-year event in Redwood Creek was in 1975 and the last 50-year event was the 1964 flood. The erosion potential in the Redwood Creek basin from a 50-year storm event is estimated to be 5 million cy from all human-caused and natural erosion sources (fluvial, bank erosion, mass wasting, etc.) The January 1997 storm is estimated to have delivered 167,000 cy in the Redwood Creek basin in the park with an erosion potential for another 411,000 cy.

Water Quality—Redwood Creek is particularly prone to storm-induced erosional events and would probably experience extensive erosion under natural conditions. However, land management activities have accelerated this natural process and have overwhelmed the stream channel's ability to efficiently move delivered sediment. 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 resultant erosion caused sediment to enter the stream, filling deep pools and depositing silt in spawning gravels.

Redwood Creek was identified as having impaired water quality due to sedimentation in the state of California's 1996 and 1998 303(d) list submittal by the North Coast Regional Water Quality Control Board. The 303(d) list was developed in response to Section 303(d)(1)(A) of the Clean Water Act, which requires that —Each State shall identify those waters within its boundaries for which effluent limitations . . . are not stringent enough to implement any water quality standard applicable to such waters.” The Clean Water Act also requires states to establish a priority ranking for waters on the 303(d) list of impaired waters and establish total maximum daily loads (TMDLs) for such waters. A total maximum daily load is defined as —the sum of the individual waste load allocations for point sources and load allocations for nonpoint sources and natural background” such that the capacity of the waterbody to assimilate pollutant loadings is not exceeded.

The Environmental Protection Agency adopted a TMDL for sediment in Redwood Creek on December 30, 1998. Beginning in 1998 in conjunction with the EPA, the North Coast Regional Water Quality Control Board formulated a —Water Quality Attainment Strategy and Implementation Plan” to achieve the water quality objectives for the Redwood Creek watershed. Redwood National Park staff and researchers are actively participating in the development and implementation of the total maximum daily load both for parklands and with private landowners who request assistance from park staff.

Quantifying sediment sources involves determining the volume of sediment delivered to stream channels by the variety of erosional processes operating within the watershed. For the Redwood Creek watershed, there are two general processes of sediment delivery: mass movement, with landslides being most important; and fluvial erosion from road and skid trail crossing failures, gullies, and surface or sheetwash erosion, and stream bank erosion. Streamside landsliding and fluvial hillslope erosion may be the most important processes delivering sediment to Redwood Creek. Erosional processes range from removal of individual soil particles by raindrops to extensive landslides that cover entire hillslopes. Erosion caused by large-scale earth movement has been better documented than erosion caused by dispersed small-scale processes. Small-scale processes may be important in generating sediment because they are widespread through the basin. Streamside landslides are an important source of sediment for Redwood Creek watershed because of the number and volume, and because they deliver sediment directly to stream channels. Debris slides account for most of the streamside landslide volume. Fluvial hillslope erosion on logged hillslopes, extensive networks of rills and gullies have developed from streamflow diversions and washouts at road and skid trail stream crossings, from ditches and cutbanks, and from interception of subsurface flow along roads and trails. Surface erosion of logged areas may also have increased as a result of decreased interception of rainfall by the forest canopy following harvest.

The TMDL identified ten sources of sediment delivery for the Redwood Creek watershed. Two sources of naturally occurring sediment delivery are earthflows/block slides and tributary landslides. The other eight are controllable to some extent: 1) erosion associated with roads, skid

trails, and landings; 2) gully erosion; 3) bare ground erosion associated with human activities; 4) stream bank erosion associated with human activities; 5) tributary landslides (road related); 6) tributary landslides (harvest related); 7) mainstem landslides, many of which are natural, and the delivery of sediment may be controllable to varying degrees; 8) debris torrents.

For the period 1954-1997, the long-term average annual sediment production rate for the entire Redwood Creek basin is estimated to be approximately 4750 tons per square mile per year. Approximately half was from mass wasting and half from fluvial erosion sources, including surface erosion. About half the sediment production was associated with roads and skid trails and roughly 10-20% was associated with timber harvesting but excluding harvest related roads and skid trails. About 30-40% of total sediment loads occurred naturally, or at least was not associated with specific land management causes.

Through the TMDL process and analyses, 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. Accelerated erosion from land use practices and other causes is impacting the migration, spawning, reproduction, and early development of cold water anadromous fish including coho salmon, chinook salmon, and steelhead trout.

The total allowable sediment load for Redwood Creek is estimated to be approximately 1900 tons of sediment per square mile per year. This number was derived from estimated average annual sediment loads (the TMDL) for the period 1954-1997 for three reference watersheds in Redwood Creek basin. Two of the watersheds, Panther Creek and Lacks Creek, are upstream of the park boundary, and Little Lost Man Creek is a tributary of Prairie Creek entirely within the park. There are no point sources of discharge for Redwood Creek; therefore there are no wasteload allocations established for this TMDL. Redwood Creek load allocations were developed for erosion processes, are associated with land use activities where feasible, and are based on the source analysis of the various erosional processes.

Aggradation in the upper mainstem of Redwood Creek and the tributaries appears to be reversing. The Redwood Creek Watershed Analysis indicated that 60-80% of flood-related instream sediment deposits are flushed out of tributary watersheds within ten years, in contrast to the mainstem where sediment is still being deposited and transported downstream.

Floodplains and Wetlands

Floodplains in the Redwood Creek basin are discontinuous along Redwood Creek from the south park boundary downstream to the confluence with McArthur Creek. The floodplain is continuous and broad downstream of McArthur Creek. Upstream of the south park boundary, the floodplain is poorly developed as the valley sideslopes are steep and form an inner gorge.

The larger Redwood Creek tributaries have developed floodplains near their confluences with Redwood Creek. These larger tributaries include: Prairie Creek, McArthur Creek, Tom McDonald Creek, Bridge Creek, Devils Creek, Panther Creek and Lacks Creek.

Downstream of the mouth of Lost Man Creek, the floodplains of Prairie and Redwood Creeks are relatively extensive, and support developments on private property including residences, businesses, ranches, dairies, and National and State Parks visitor facilities.

Tributaries of Prairie Creek with low enough gradients that floodplains have developed include Skunk Cabbage, Little Lost Man, Lost Man, May, Godwood and Boyes Creeks. Lost Man Creek

has only minor floodplain development along its lower reaches in the intact old growth forest. These floodplains are discontinuous and narrow in comparison to floodplains along Prairie and Redwood Creeks. The relatively resistant Franciscan bedrock in the northeast and southern portions of the Lost Man Creek watershed generally results in steep slopes and narrow, confined canyon with little floodplain development in comparison to the gentler topography and less confined stream reaches that allow broad, meandering stream valleys of the Prairie Creek Formation in about one-third of the project area.

The NPS uses the Cowardin system to define wetlands (Cowardin et al., 1979). Three types of wetlands are depicted on the U.S. Fish and Wildlife 1987 National Wetlands Inventory (NWI) maps of the project area. These types are classified by the persistence of the stream, the substrate, and the duration of inundation (seasonal flooding regime), as well as the position in the drainage. The upper reaches of the streams are mapped as R4SBC (Riverine, Intermittent, Streambed, Seasonally Flooded) or R3UBH (Riverine, Upper Perennial, Unconsolidated Bottom, Permanently Flooded). These riverine wetlands are present where the steep topography prevents the development of a floodplain. In the lower reaches of the watershed, the subdrainages coalesce to form a permanent stream, Lost Man Creek, which allows the development of a floodplain and streamside vegetation that is dependent on permanent running water. The riparian zones along Lost Man Creek are classified as PFO1C (Palustrine, Forested, Broad-leaved Deciduous, Seasonally Flooded). Palustrine wetlands are dominated by trees, shrubs, and emergent plants. The primary wetland functions and values associated with the naturally occurring wetlands in the project area are fish and wildlife habitat. The palustrine wetlands along Lost Man Creek also function as filters for sediment and to attenuate floods by reducing the velocity of flood waters.

In landscapes disturbed by timber harvest, small wetlands may be created by road and skidroad construction. These artificial wetlands form when ground water is intercepted by undercutting the slopes with heavy equipment during construction and emerges into road ditches and onto road and skidroad surfaces. Road fills, immediately upstream of road-stream intersections, often possess wetland characteristics as the accumulated sediment is saturated by stream flows. The average size of these artificial wetlands is estimated at about 100 square feet. With proper drainage of roads or when the original topography is restored, these wetlands disappear. The primary function of these artificial wetlands is habitat for amphibians.

Vegetation

The dominant vegetation communities in the project area are redwood forest, second growth forest dominated by Douglas-fir, and riparian. The entire project area is densely vegetated with a mix of old growth and regenerated stands of redwood, Douglas-fir, cedar, tan oak, alder, and madrone. The understory includes dense patches of salmon berry, huckleberry, blackberry, maidenhair fern, sword fern, wild iris, Oregon grape, wild parsnip, wild celery, and coltsfoot, rhododendron, and a variety of plant species common to old growth redwood forests.

There are important traditional Yurok plant resources located in the project area, including alder, cascara, hazel, huckleberry, iris, maidenhair fern, redwood, salmonberry, sword fern, thimbleberry, wild ginger, and *Woodwardia* fern (McConnell and Eidsness, 2000). Bear grass is also located near the project area in the Bald Hills area. This is considered the westernmost patch of bear grass as identified by Yurok and Karuk basketmakers in the 1920s.

The original vegetation community in the project site was coniferous forest dominated by coast redwood and Douglas-fir. Coast redwoods (*Sequoia sempervirens*) are endemic to California and southwestern Oregon and are well known as the world's tallest trees. Old-growth coastal

redwood forest remains on about 39,000 acres in the national and state parks. Approximately one-quarter of the Lost Man Creek watershed (1835 acres) in the lower, western portion of the watershed remains as old growth coast redwood forest. This old-growth is contiguous with the large tract of old-growth in lower Redwood Creek and Little Lost Man Creek. The Little Lost Man Creek watershed contains about 2,109 acres of old growth forest, the greatest percentage (89%) of total watershed area remaining as old growth for the major tributaries of Redwood Creek.

As of 2005, there were 3,940 acres of second growth 40 years or older within the project area. The type of vegetation present in the second-growth stands in the parks depends on the dominant vegetation at the time of cutting, how long ago the area was cut, which species were harvested, whether the cutting was selective or clearcut, the physiography of the cut area (slope, aspect, soil type, elevation), and whether the cutover areas were replanted and the method of replanting (seeding or planting seedlings).

Logging in old-growth was once primarily by the seed-tree method, where selected trees were left as a seed source for new growth and removed later. This type of logging occurred in the southern part of the project area south of Geneva Road and in the upper portions of Larry Damm and the North Fork, beginning in the 1940s and ending with park establishment in 1968.

North of Geneva Road, logging in the middle and lower portions of Larry Damm and the North Fork watersheds began in the late 1950s and culminated in the 1970s prior to park expansion in 1978. The dominant timber harvest method in this part of the project area, as in most of Redwood Creek basin in what later became the parks, was clearcut logging combined with seeding or planting to ensure revegetation, followed by thinning to produce higher value timber in a short period. Thinning is the usual practice in timber management to ensure that the plantings reach merchantable size in a shorter period of time.

The pattern of plant succession after timber harvest depends on the conditions at the particular site. In general, the pattern of plant succession after timber harvest begins with short-lived annual and biannual herbs in the first three years followed by the development of shrub communities, either from remnant plants that have survived timber harvest and flourished or from invading species capitalizing on the disturbed environment. Eventually, reduced light levels eliminate all but the most shade tolerant species.

Future dominant tree species are usually present as seedlings in each early succession type. Following logging, short-lived weeds dominate for about five years. Hardwood shrubs become abundant in 6 to 10 years following logging and dominate for 11 to 20 years.

In the redwood/Douglas-fir forests in the parks, thickets of red alder developed after timber harvest, especially on lower slopes near streams and other wet areas. These thickets are followed by Douglas-fir and redwood in the understory as the site stabilizes. Alder dominance may continue for 50 to 80 years. Alder might replace itself if disturbance continues, such as in landslide areas or on unstable slopes.

Along logging roads, plants from adjacent areas quickly colonize uncompacted fill along the sides of a road and colonize cut banks more slowly. The vegetation types are generally the same as those in the immediate area although the percentage distributions of species may differ between what is in the adjacent lands and what is on the road fill. The age of the vegetation along a road is typically within one to three years of the age of the road. Along cut banks, the age of the

vegetation is generally younger than the road. Where roads cut through more rocky soils or expose bedrock, vegetation is generally sparse or completely lacking.

On drier sites, brush may invade, especially blueblossom and coyote brush. Both alder and blueblossom are nitrogen fixers and contribute to the productivity of the soil. Alders colonize naturally from around streams at the base of a slope in response to disturbance by landslides and flooding, whereas blueblossom colonizes ridges and upper slopes in response to fire.

Clearcuts create gaps in the forest that increase the susceptibility of trees to wind effects including limb breakage, tree mortality, and wind-throw (trees uprooted or breaking due to force of wind). Soil compaction contributes to vulnerability to windthrow. Wind affects redwoods by breaking off stems and branches and creating windfalls that may include the roots. Openings in the canopy also increase the likelihood of windfall. Heavy winter precipitation saturates and softens soils, and intense winds then topple shallow-rooted redwoods. Landslides are another physical process that can topple trees and create forest openings. There are examples of landslides where trees have been toppled where slopes are less stable due to sheared bedrock along faults, and on the steep, wet slopes of inner gorges, and headwater areas.

Nonnative plants, also called exotic or alien species, quickly colonize disturbed habitats throughout the parks but may also invade undisturbed native vegetation. Soils along roads are particularly susceptible to invasion by alien plants. The soils are continually disturbed for road maintenance and also have a continual source of seeds from vehicles, maintenance equipment, and gravel shipments.

Old-growth redwood forest is too shady for some nonnative plant species. Timber harvest opens the canopy and allows the invasion of alien species such as pampas grass. Regrowth of the forest shades the ground, causing some non-natives like pampas grass to die out. Pampas grass has decreased in the project area as the canopy has regrown. Scotch broom and thistles are present in patches along the roadsides.

Riparian vegetation plays a crucial role in providing channel stability, shade, woody debris, and nutrients to streams. Riparian vegetation therefore exerts a major influence on aquatic habitat within stream channels.

Flooding and sedimentation have affected the riparian zone along the entire channel of Redwood Creek and along many tributaries, including Lost Man Creek. A combination of road building, timber harvesting, bank erosion, and landslides have reduced the original riparian vegetation along these creeks. Riparian vegetation has re-established in recent years, but regrowth is generally broadleaf species such as alder or willow rather than conifers.

Flooding has both positive and negative effects on streamside forests. The tallest redwood trees grow on the alluvial flats adjacent to the major streams. Alluvial flats are the product of repeated flooding and can be both produced and removed by major floods. Fine-grained silts and abundant moisture in alluvial flats encourages seedling establishment. Coast redwood is favored over other tree species in the alluvial flats because of its ability to tolerate flooding. It adapts to successive inundation by growing a new set of surface roots in the new soil layer.

Fluctuations in the water table can adversely affect roots and seedlings in alluvial flats. Aggradation of streams can accelerate bank erosion and directly topple trees or undercut banks and expose or weaken roots. Aggradation can also raise the water table and drown tree roots. The

deposition of gravel can smother seedlings. Permanent lowering of the water table can preclude redwood survival by removing needed moisture from the roots.

Wildlife

Animal species diversity is lower in the upland younger-aged redwood forest community in comparison to other plant communities (such as riparian forests) because of lower plant diversity and less structural complexity in the canopy of unmanaged second growth forests. The species diversity in second growth forests is especially low on those lands that were logged most recently and were reseeded without subsequent thinning, creating dense stands of small trees with minimal canopy development and understory vegetation.

The moist cool coastal environment of old-growth forest favors salamanders and frogs over lizards and snakes, which are more common in the drier vegetation types. Alligator lizards, the California red-sided garter snake, and coast garter snake are found in the project area which is drier and has greater temperature extremes than the unlogged old growth forest of the adjacent Little Lost Man Creek.

Amphibians commonly found in woody debris or other forest floor surface debris include ensatina and California slender salamanders. Roughskin newts are present in streams. Pacific giant salamander larvae are found in some of the perennial park streams with adults common to moist coniferous forests under logs and bark.

Pacific giant salamander larvae have been observed in the South Fork of Lost Man Creek, and probably occur throughout perennial streams in the watershed. Adults have been observed on or near roads that are proposed for treatment.

The project area is inhabited by Pacific treefrogs and northern red-legged frogs (*Rana aurora*). Tailed frogs have been found in Lost Man Creek.

Road ditches and other areas where roads or landings have failed or slumped create puddles that are sometimes used by frogs and some salamanders for breeding. Egg masses of northwestern salamanders have been observed in puddles in slumps in road fill.

Point count surveys for birds were conducted in the project area in both old growth and shrubbier, open areas. The most common species detected in the canopy were brown creepers, chestnut-backed chickadees, and golden crowned kinglets. Mid-canopy species included Steller's jays, Hutton's vireos and Pacific-slope flycatchers. Winter wrens and wrentits were common in the understory. Hermit, Swainson's, and varied thrushes are present, as well as some robins.

Pileated woodpeckers were relatively numerous, with fewer hairy woodpeckers and northern flickers. The presence of Vaux's swifts also indicates the old growth legacy of the project area.

Northern pygmy owls were regularly detected, with saw-whet owls heard occasionally.

Black bear and black-tailed deer are the most common large mammals in the project area. Managed timberlands surrounding the park provide excellent habitat for bear and deer, and resulted in an increase in bear and deer numbers during the period of intensive logging. Use of second-growth forested areas by deer and black bear has declined relative to when these areas were first cut.

Other mammals likely to occupy the project area include mountain lions, bobcats, coyotes, grey foxes, long-tailed weasels, raccoons, skunks, chipmunks, ground squirrels, brush rabbits, woodrats, flying squirrels, voles, shrews, and bats, but no surveys were done specifically targeting mammals.

Fish

Three species of anadromous salmon and trout that occupy the streams in the project area are discussed below under *Threatened and Endangered Fish*. Anadromous fish spend most of their life cycle in the ocean and return to freshwater to spawn.

Anadromous and resident salmonids identified in Redwood Creek include steelhead and rainbow trout (*Oncorhynchus mykiss*), coastal cutthroat trout (*O. clarki*), coho salmon (*O. kisutch*), and chinook salmon (*O. tshawytscha*). Most spawning and rearing occurs along the lower reaches of major tributaries and along the mainstem of Redwood Creek.

Coastal cutthroat trout are native to northwestern California, inhabiting most coastal streams north of the Eel River. Adult anadromous cutthroat return to freshwater in late autumn and early winter and spawn in small streams between February and May. Cutthroat trout are often found in the summer in the Redwood Creek estuary. Some coastal cutthroat trout that occupy streams in the project area are anadromous but this species is not currently listed or proposed, or a candidate species for listing, as threatened or endangered. RNSP fisheries staff suspects that a few resident, non-migratory populations of cutthroat trout inhabit the tributaries of Redwood Creek. The project area also is inhabited by resident rainbow trout (*Oncorhynchus mykiss*).

Other fish identified or reported in Redwood Creek include the Humboldt sucker (*Catostomus humboldtianus*), threespine stickleback (*Gasterosteus aculeatus*), coastrange sculpin (*Cottus aleuticus*), Pacific lamprey (*Lampetra tridentata*), tidewater goby (*Eucyclogobius newberryi*) and eulachon (*Thaleichthys pacificus*).

Sensitive Plants

There are no federally or state listed proposed, threatened or endangered plants in the project area. Plants known or suspected to occur in the project area and ranked by California Native Plant Society (CNPS) as sensitive due to limited distribution or limited numbers are listed in Table 4. The common names and rankings given here are from the on-line edition of the CNPS *Inventory of Rare and Endangered Plants* (7th edition, 2006). The rankings incorporate the CNPS Listing and a modifier from 1-3 indicating the degree of threat to a plant, with a higher number indicating a more serious threat. Threat code 1 indicates a plant that is seriously endangered in California (over 80% of occurrences threatened / high degree and immediacy of threat). Threat Code 2 indicates “fairly endangered in California (20-80% occurrences threatened)”, and Threat Code 3 is used for plants that are not very endangered in California (<20% of occurrences threatened or no current threats known.) These Threat Code guidelines represent a starting point in the assessment of threat level. Other factors, such as habitat vulnerability and specificity, distribution, and condition of occurrences, are also considered in setting the Threat Code. List 1B plants are rare throughout their range, generally endemic to California, and have a high vulnerability because of limited range or vulnerable habitat, low numbers of individuals per population, or limited numbers of populations. All 1B plants are eligible for state listing under the California State Endangered Species Act or for full protection under the state Native Plant Protection Act. List 2 plants would all appear as List 1B plants except that they are common beyond the boundaries of California. List 4 plants are on the “watch list” and have limited distributions, but their vulnerability or susceptibility to threat is currently low.

Table 4—Sensitive Plants Listed by CNPS

Common/Scientific Name		Habitat Type	CNPS Rank	Seen in LMC
California globe mallow	<i>Illamna latibracteata</i>	coniferous forest	1B.2	
Running pine	<i>Lycopodium clavatum</i>	coniferous forest	2.3	X
Bog club-moss	<i>Lycopodiella inundata</i>	coniferous forest	2.2	
Indian pipe	<i>Monotropa uniflora</i>	coniferous forest	2.2	
seacoast ragwort	<i>Senecio bolanderi</i> var. <i>bolanderi</i>	coniferous forest (banks)	2.2	
Small ground-cone	<i>Boschniakia hookeri</i>	coniferous forest	2.3	X
Heart-leafed twayblade	<i>Listera cordata</i>	coniferous forest	4.2	X
Purple onion grass	<i>Melica spectabilis</i>	dry coniferous forest	4.3	
woodnymph	<i>Moneses uniflora</i>	coniferous forest	4.3	
White-flowered rein orchid	<i>Piperia candida</i>	lower coniferous forest	4.3	
California pinefoot	<i>Pityopus californicus</i>	coniferous forest	4.2	X
Nodding semaphoregrass	<i>Pleuropogon refractus</i>	open coastal forest	4.2	
Trailing black currant	<i>Ribes laxiflorum</i>	coniferous forest	4.3	X
Slender false lupine	<i>Thermopsis gracilis</i> var. <i>gracilis</i>	coniferous forest	4.3	

In addition to CNPS-listed plants, park botanists have identified several species of plants throughout the parks as “park rare” which is defined as:

- the taxon is native;
- it is not federally or state listed as sensitive, rare, threatened, endangered or a candidate for listing, and not listed by CNPS, The Nature Conservancy, or CPC;
- fewer than five populations exist, or total number of plants in the park is less than 100; and
- the population or number of individuals are larger than above but park populations are threatened because of limited distribution.

Park-rare plants should be treated as CNPS List 4 plants for management and survey purposes.

Four species with a “park rare” designation as listed in Table 5 have not been found in the project area but are known from other locations in the parks in habitats similar to those in the Lost Man Creek project area.

Table 5—Plants Designated as “Park-rare”

Common/Scientific Name		# known populations	Habitat type	Known park locations
Goat’s beard	<i>Aruncus dioicus</i> var. <i>pubescens</i>	3	banks	Smith River, Klamath Beach Road, Redwood Creek
Clasping twistedstalk	<i>Streptopus amplexifolius</i> ssp. <i>americanus</i>	1	Moist coastal forest	Coastal Trail, Damnation Creek
Pacific yew	<i>Taxus brevifolia</i>	2	Mixed conifer forest	Williams Ridge, Jedediah Smith SP campground
Sugarscoop, foamflower	<i>Tiarella trifoliata</i> var. <i>unifoliata</i>	1	Moist shady banks	Boy Scout Tree Trail

Sensitive, Threatened, and Endangered Wildlife

The marbled murrelet (federally and state listed as threatened) and northern spotted owl (federally listed as threatened) are known to occur in areas or habitats proposed for treatments in this plan. The project area does not contain any designated critical habitat for any terrestrial wildlife species. Detailed species accounts, habitat status, and literature summaries for the two listed bird species that would be affected by the project may be found in *A Conservation Strategy for Managing Threatened and Endangered Species in Redwood National and State Parks* (Sakai 2003, as amended) and in the biological assessment on effects to threatened wildlife from this project (NPS 2006a).

Marbled murrelets are sea birds that nest in coastal old growth forest along the west coast of North America. The largest population of murrelets in Oregon and California is found in RNSP. Murrelet nests have been confirmed in lower Redwood Creek.

Suitable murrelet nesting habitat consists of mature and old-growth forest with nesting platforms and adequate canopy cover surrounding the nest sites. There are 871 acres of potentially suitable marbled murrelet nesting habitat in the action area (662 acres of contiguous old growth and 209 acres of residual old growth habitat.) Residual old growth or “legacy” trees left behind after logging—mainly redwood, but in some instances old growth Douglas-fir—are scattered throughout the action area. This quality of residual habitat as suitable murrelet nesting habitat varies depending on the density of residual trees plus density and size of any mature trees beneath or surrounding the residual old growth, and on the proximity of residual clusters to the blocks of contiguous old growth forest.

Surveys conducted in the Lost Man Creek watershed between 2003 and 2004 indicate marbled murrelets use a small proportion of the residual old growth habitat within the action area. Murrelet activity appeared to drop off with increasing distance away from the contiguous old growth. Based on these survey results, plus documented use of residual habitat elsewhere throughout the species range in the Pacific states, we assume that all stands with trees providing nesting opportunities for marbled murrelets have the potential to be occupied unless surveys indicate probable absence at a site.

Northern spotted owls are forest-dwelling birds that nest in both old growth and older second growth forests in RNSP. Suitable northern spotted owl nesting and foraging habitat consists of dense open-canopied forest stands, with associated large snags and large down logs. Suitable habitat within the project area includes old growth, second growth 40 years old or older, and moderate to high density old growth residuals regardless of the age of the second growth understory. Out of the 5,804 acres within the action area, approximately 4,172 acres are likely to be suitable nesting, roosting, and/or foraging habitat, although due to barred owl occupancy some of the suitable habitat is probably not available to spotted owls. Within the project area there are an estimated 1,400 acres of potentially suitable spotted owl nesting and roosting habitat that will be surveyed beginning in 2006.

There are no known spotted owl activity centers within the project area. Portions of home ranges of three spotted owl pairs overlap the project area. The activity centers of these pairs are monitored annually. Barred owls have been detected at all three of these activity centers, and appear to have taken up residence at two or possibly all three of these sites.

Residual old growth redwood, and to a lesser extent Douglas-fir, trees dot the landscape throughout the project area, in some cases supported by mature residual codominants. Most of the Lost Man Creek watershed was harvested more than 40 years ago. As of 2005, there were

3,940 acres of second growth 40 years or older within the project area. This second growth is of variable quality depending on the site, species composition, and its association with residual old growth. There are approximately 450 acres of young second growth within the project area considered unsuitable for spotted owls and marbled murrelets.

Noise has been identified as a source of disturbance and thus a potential threat to northern spotted owls and marbled murrelets during their respective breeding seasons (February 1 through September 15 and March 24 through September 15). If an adult is disturbed by sudden loud noises and leaves a nest, an unprotected chick is at risk of being preyed upon. Avian nest predators such as corvids (Steller's jays and ravens) learn to associate human presence with any food or trash left behind, and are attracted by human noise and disturbance.

Restriction periods have been established by the USFWS to protect birds from noise disturbance during nesting season. During restriction periods, no activity that creates noise in excess of ambient noise is permitted. Background noise in the interior of the parks is generally much lower than that expected or tolerated in developed areas in which the federal noise guidelines are generally applied. Few measurements of noise have been taken to estimate the noise generated by restoration activities in second-growth habitat. Background noise measured by park staff in the forest ranged from 45 to 60 decibels (dBA); human spoken conversation is generally about 45 dBA. Chainsaws were measured at 100 dBA at 10 feet away; 82 dBA at 100 feet; and 44 dBA at 500 feet. These were instantaneous measurements, rather than average sound levels measured over a period of time.

Pacific fishers are medium size carnivores in the weasel family that live in forested areas. Fishers are a federal candidate species for listing as threatened. No forest carnivore surveys have taken place specifically within the project area. In 2002, no fishers were detected in two sample units along the west-central and southern borders of the project area. There are no incidental observations of fishers within the action area in the park wildlife observation database. However, it is expected that fishers have the potential to use the action area for denning, resting, or foraging wherever suitable structures occur.

The number of acres of potentially suitable fisher habitat in Lost Man Creek is not known, but probably equates roughly with the amount of suitable spotted owl nesting and roosting habitat. Habitat structure for fisher denning, resting, and foraging is most likely present in residual old growth.

Threatened and Endangered Fish

Three species of anadromous salmonids federally listed as threatened are known to occur in the project area: the Southern Oregon/Northern California Coasts (SONCC) coho salmon (*Oncorhynchus kisutch*), the California Coastal (CC) chinook salmon (*O. tshawytscha*) and Northern California (NC) steelhead trout (*O. mykiss*). The term —evolutionarily significant unit” (ESU) is used to identify the species and the streams in which they occur. The project area contains designated critical habitat for all three ESUs. Additional information on these species and their habitat can be found in the biological assessment of the effects of this project that was submitted to NMFS (NPS 2006b).

Anadromous fish spend most of their life cycle in the ocean and return to freshwater to spawn. Different stocks of fish of the same species may migrate into freshwater at different seasons and in different stages of maturity. These stocks are commonly referred to by the season when they migrate into freshwater, e.g., summer and winter steelhead or spring-run and fall-run chinook.

The numbers of anadromous fish are governed by conditions in both freshwater and marine environments. Three factors have the greatest potential to affect the quality and quantity of freshwater habitat: water temperature, fine sediment, and habitat complexity or cover. Good freshwater habitat for anadromous fish contains complex habitat with both wood and rock, spawning gravels with low levels of fine sediment, water temperatures rarely more than 60°F, shade cover, and a well-developed riparian zone.

Salmonids require gravels free from excessive fine sediment to lay their eggs and for the eggs to develop into free-swimming fish. They also require deep pools for the young fish to feed and grow while protected from predators. The key fish habitat problems in Redwood Creek and its tributaries associated with sedimentation appear to be pool quality, gravel quality, and changes in channel structure which contribute to elevated temperatures.

Redwood Creek is used by chinook and coho salmon, steelhead, and coastal cutthroat trout. The estuary is a holding area for juvenile fish before they migrate from freshwater to the ocean. Young chinook salmon and some steelhead juveniles produced in the upstream reaches of the creek and the tributaries migrate downstream to the estuary in summer. Low summer river flows cause a sandbar to build that blocks the flow of the creek into the ocean. Chinook, steelhead, and sea-run cutthroat trout live in the estuary embayment where they feed on invertebrates and grow to a size that will enhance their chance for survival during the ocean stages of their life cycle. Juvenile fish migrate out to the ocean in the late fall or winter when the winter rains make the creek rise and break through the sandbar. Artificial breaching of the sandbar in the summer causes the juvenile fish to enter the ocean at a smaller size, which may decrease the chances of survival for these fish.

Anadromous fish populations in Redwood Creek have diminished substantially over the past 45 years. In 1965, CDFG roughly estimated the spawning escapement of 5000 chinook, 2000 coho, and 10,000 winter steelhead. Although channel deepening and pool development have begun to increase in all but the lower few miles of Redwood Creek following the intensive logging prior to the enactment of the state Forest Practice Rules, the mainstem 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 surface water available to fish and causing increased surface temperatures. Although sediment from Lost Man Creek affects only the lower portion of Redwood Creek below the mouth of Prairie Creek, sediment at that location contributes to subsurface flow conditions.

California Coastal Chinook Salmon—California Coastal chinook are the largest salmonids occurring in the parks' rivers and streams. Chinook spawn primarily in the larger streams, including Redwood Creek, and the main stems of Lost Man Creek and Prairie Creek.

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 January. Adult spring-run chinook in Redwood Creek 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. Stream barriers may impede chinook salmon spawning in the RNSP tributaries, but they may be able to surmount some barriers that may impede the smaller coho salmon. Chinook typically return from the ocean to rivers, larger streams, and larger tributaries to spawn between November and early January. In spring, chinook salmon fry (early life stage that develops from the egg) migrate downstream to rear in the Redwood Creek estuary before entering the ocean in the fall. Chinook salmon usually

return to freshwater after three to four years in the ocean, although two-year-old male spawners are commonly observed

Juvenile chinook salmon in Redwood Creek do not spend time rearing in upstream areas but use the Redwood Creek estuary instead. Chinook salmon usually return to freshwater after three to four years in the ocean, although two year old male spawners are commonly observed.

The Prairie Creek Fish Hatchery operated continuously from the mid-1930s until October 31, 1992, producing at Chinook at various times along with coho salmon, and cutthroat, rainbow, and steelhead trout. 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 in RNSP continue to indicate low numbers of returning salmon (D. Anderson, personal communication).

Critical habitat for California Coastal chinook salmon was re-designated on January 2, 2006. Potentially suitable habitat for these fish 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.

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 (aka NMFS) 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.

Lost Man Creek has about 3 miles of suitable habitat that is designated critical habitat under the above definition. 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 for both adult and juvenile fish provided by large woody debris, boulders and bedrock. Park fish surveys in Lost Man Creek have been done in two reaches, a lower reach and an upper reach. The lower Lost Man reach begins at the confluence of Prairie Creek and continues about 1.7 miles upstream to the second of the double bridges where Holter Ridge Road/bike-hike trail crosses Lost Man Creek. The lower Lost Man reach has been surveyed for spawning adults and carcasses since the 1980s. The upper Lost Man reach begins at the second double bridges and continues upstream for 1.2 miles to an extremely large log jam, which may be a fish barrier. Surveys on the upper Lost Man reach began in December 2001.

Southern Oregon/Northern California Coast Coho Salmon—Coho or silver salmon are smaller than the chinook, and spawn in Redwood Creek, Prairie Creek, and some of the smaller tributaries of these creeks including Lost Man Creek.

Coho salmon have a simple (relative to other anadromous Pacific salmon) three-year life cycle. Adult coho return to freshwater between November and early February to spawn. Adult coho

typically run upstream to spawn from late October to early March depending on access through the estuary. Recent data suggest that the peak of the spawning run begin in late November. After hatching, juvenile coho salmon generally spend one full year rearing in freshwater before entering the ocean. 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 presently move directly into the ocean, spending a minimal amount of time in the Redwood Creek Estuary. Adult migration through the Redwood Creek estuary is dependent on the mouth being open to the ocean. 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 use a variety of spawning sites but characteristically enter small coastal creeks or tributary headwaters of larger rivers to spawn. The tiny fry occupy shallow stream edges next to pools but move into deeper water as they grow. Coho salmon juveniles remain in the streams for one year before migrating to the ocean, typically between March and May. Most coho salmon return to freshwater after two years in the ocean. Optimal rearing habitat for juveniles is pools deeper than 3.5 feet that contain logs, large tree roots, or boulders in heavily shaded sections of the streams.

The total adult coho population in the Redwood Creek system may have once numbered more than 2,000. Most of the coho occurred in the Prairie Creek drainage and probably originated from the Prairie Creek Fish Hatchery (D. Anderson, field notes). Since the closure of the hatchery in 1992, numbers of coho are probably much lower.

Coho salmon in the Redwood Creek basin occur in the mainstem and the larger low gradient tributaries. General stream surveys were conducted in the basin in 1980 and 1981 to describe and characterize the salmonid rearing habitat and distribution of juvenile salmonids. Migration barriers were identified during these surveys. No coho were found during these early electrofishing surveys above the barriers. However, subsequent surveys in the 1990s have detected coho in streams that did not have coho in 1980-81. Whether these barriers still exist, have changed to allow fish passage, or new barriers have been created is unknown. Based on these data, RNSP fish biologists assume that coho occupy 26 miles of stream within the Lower Redwood Creek Basin. 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.

NOAA Fisheries has designated critical habitat for the Southern Oregon/Northern California Coast coho USU 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.

Stream reaches accessible to coho salmon within the parks are designated critical habitat. Critical habitat includes all waterways, substrate, and adjacent riparian zones of estuarine and riverine sections accessible to coho salmon. Accessible sections are those within the historical range of the fish populations that can still be occupied by any life stage of coho salmon. There are no

sections of streams within the parks that are inaccessible because of specific dams identified in the NMFS proposal or because of longstanding, naturally impassible barriers such as natural waterfalls in existence for at least several hundred years.

Northern California Steelhead Trout—Northern California steelhead trout are found in Redwood and Prairie Creeks, and 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.

Steelhead are the last of the salmonid species to return to freshwater in the annual cycle, generally between January and April. Steelhead juveniles rear in the streams for one to four years before their migration to the ocean. They then reside in marine waters for typically two or three years before returning to freshwater to spawn. Unlike other Pacific salmon, steelhead are capable of spawning more than once before they die. However, it is rare for steelhead to spawn more than twice before dying. Most of the multiple spawners are females, provided there are no barriers to migration and adequate amounts of water are left in the stream during the dry summer months.

Steelhead can be divided into two reproductive types, based on their state of sexual maturity at the time of river entry and the duration of their spawning migration. These two types are termed "stream maturing" and "ocean maturing." Stream-maturing steelhead enter freshwater in a sexually immature condition and require several months to mature, after which they spawn. Stream-maturing steelhead are also known as summer steelhead. Ocean maturing (or winter) steelhead enter freshwater in a mature state and spawn shortly after river entry. Summer steelhead return to a river or stream from spring to early fall and remain in deep pools until spawning occurs. The long freshwater holding time renders the adult steelhead especially vulnerable to predation and habitat changes.

Redwood Creek has both summer and winter runs of steelhead. Survey data indicate a continuous decline of summer steelhead since surveys began in 1981. Forty-four adult fish is the highest total number observed during summer surveys of portions of the mainstem of Redwood Creek. No adult fish were seen in 1989 and few fish were seen in the mid-1990s. No other streams within the parks in the Redwood Creek basin have been surveyed because these streams do not have large enough pools to support adult 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, 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).

NOAA Fisheries designated critical habitat in January 2006 for the distinct population segment of NC Steelhead between Redwood Creek, California and Russian River, California. The project area includes designated critical habitat for NC steelhead, which is essentially identical to the critical habitat for CC chinook and SONCC coho previously described.

Cultural Resources

Redwood National and State Parks contain a significant set of cultural resources including archeological sites, historic structures, cultural landscapes, ethnographic properties, and objects.

Archeological Resources—The majority of archeological sites in the parks are prehistoric. Sites are recorded throughout the parks, along the coast, inland and especially in the Bald Hills of the Redwood Creek basin. These sites range from temporary and seasonal camps to trail use sites to villages and sacred places, representing no less than a 4,500-year continuous record of habitation extending to after European contact at about 1850 by at least three different Native American groups and their ancestors. Fish, game, and acorns were particularly significant foods for the local Native Americans. In addition to villages of wooden plank houses and sweathouses, there were also numerous temporary summer camps and specialized use areas throughout the region. An extensive trade and travel network also existed. Today, the Tolowa, the Yurok, and the Hupa have ancestral ties to the parks. At the time of contact, the Yurok lived along the coast and the Chilula along Redwood Creek. The Chilula, whose territory included parklands in the Redwood Creek basin, were almost decimated after contact; most of those who remained were assimilated by the Hupa to the east of the parks.

The project area in the Lost Man Creek watershed lies within the ancestral lands of the Yurok people. Review of ethnographic literature, consultations with Native Americans, and archeological surveys indicate that pre-historic use of the heavily forested Lost Man Creek watershed was primarily limited to fishing, gathering, and hunting (Sloan 2006). Trails passed through the area, but no settlements were reported (Sloan 2006; McConnell and Eidsness 2000).

Historic archeology in Redwood National and State Parks consists of remains of Euroamerican settlement and activities from the late 1800s. Evidence of historic settlements, ranching, logging, mining, and recreation are all types of resources that can be found. Logging was the primary historic activity that occurred in the Lost Man Creek watershed. One former logging camp dating to the 1960s is located in the proposed project area.

Ethnographic Properties—Sloan (2006) reports that important traditional Yurok plant resources are located in the project area, including alder, cascara, hazel, huckleberry, iris, maidenhair fern, redwood, salmonberry, sword fern, thimbleberry, wild ginger, and *Woodwardia* fern (McConnell and Eidsness 2000). Bear-grass (*Xerophyllum tenax*) is also located near the project area in the Bald Hills. This is considered the westernmost patch of bear grass as identified by Yurok and Karuk basketmakers in the 1920s (O’Neale 1995). Two known ethnographic resources are documented in the Lost Man Creek project area, the bear-grass patch and a “goose pen” tree. The Bear-grass site may be eligible for listing on the National Register of Historic Places.

Historic Resources—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 on Lost Man Creek in 1936 as a permanent facility, the Prairie Creek Fish Hatchery. Salmon and trout were the two types of fish hatched at this facility. The hatchery was closed in 1993 and acquired by the NPS in 1996. It was listed on the National Register of Historic Places in 2000. The hatchery and its contributing elements are located outside the area of potential effect for the proposed project.

A former ranch site was found on Holter Ridge during field surveys conducted during this investigation. The site contains historic fenceline features, a historic trail segment, and non-contributing elements consisting of a pile of concrete debris and an old structure called the

—powdhouse” that was constructed by NPS staff in the 1980s during initial phases of watershed rehabilitation.

Visitor Use and Experience

Total visitation to the national park in 2005 was reported as 394,144 visits, with each visit representing 13 hours. There are no separate statistics for visitation in the project area. The visitor facilities nearest to the project area are the Holter Ridge Bike Trail and the Lost Man Creek picnic area. The Geneva and Holter Ridge roads were opened to hiking and bicycling in the late 1980s as the Lost Man Creek Trail and Holter Ridge Bike Trail; these trails are roads maintained for administrative access by park vehicles. The picnic area is located about 0.1 miles upstream of the confluence of Larry Damm and Lost Man Creeks and serves as the trailhead for the bike trail. Visitor use has primarily been in the old growth forests of the lower Lost Man Creek watershed and along the hiking/biking trail. The Lost Man Creek (formerly Geneva Road) portion of the hiking-biking trail passes through old growth forest for about 1.5 miles before entering second growth forest and joining Holter Ridge Road and the B Line North at the ridgetop. At the junction, Holter Ridge Road runs south for about 8 miles to join Bald Hills Road. From the intersection with Geneva (Lost Man Creek Trail) and Holter Ridge Roads, the B Line North runs 4.5 miles north and joins the Highway 101 Bypass north of the Newton B. Drury Parkway exit off the freeway.

The primary scenic resources in RNSP are the coastal redwood forest and the vistas of the Pacific Ocean and the rocky shoreline. Wildlife viewing, notably Roosevelt elk throughout the year and grey whales during their migrations, is an important visitor experience.

The coast redwood grows as a natural forest only in a narrow strip along the northern California and southernmost Oregon coast. Of the two million acres of old-growth redwood that existed in 1850, less than five percent are protected in national, state and local parks. Several of the tallest known trees in the world are located immediately adjacent to Redwood Creek in the parks.

Timber harvest and road building have altered the scenic qualities and vistas throughout the parks. Clearcut blocks are visible as distinct and sometimes abrupt vegetation changes on the forested hillslopes. The linear imprints of logging roads, both the treated and the yet-to-be treated, are frequently encountered through both logged and unlogged forests but the roads do not show up as clearly since the forest canopy has regrown after logging ceased. The project area itself does not feature the open vistas seen along Highway 101 and the Bald Hills Road. Visitors driving, bicycling, or hiking along Lost Man Creek Road or the Holter Ridge Bike Trail are within a closed-canopy forest. Because of safety considerations created by intensive heavy equipment work associated with watershed restoration, visitor use of the project area is discouraged during project operations. Watershed restoration staff have offered guided trips for the public to view restoration projects after the heavy equipment has been moved out of the project area. Visitors can view and hike through a completed watershed restoration project along the Ah Pah Interpretive Trail at the north end of the Newton B. Drury Parkway in Prairie Creek Redwoods State Park. The short hiking trail through old growth forest follows the route of a former logging haul road that was removed in 1996 and has exhibits showing photographs of the former road and restoration activities.

Watershed restoration work is interpreted through wayside exhibits along the Ah Pah Interpretive Trail, in the parks’ annual visitor guide, and by pamphlets available in the visitor centers. Park interpretive rangers lead guided walks and present programs at the campgrounds weekly during the summer on restoration work. Recent stream channel and wetland restoration exhibits are at the Elk Meadow Trailhead off Davison Road, a few miles southwest of the project area.

Other visitor activities in the vicinity of the project area including wildlife viewing (primarily Roosevelt elk) at the Elk Meadow Trailhead, environmental education for local schoolchildren at the Wolf Creek Outdoor School, and evening campfire programs at the Gold Bluffs Beach and Elk Prairie campgrounds in Prairie Creek Redwoods State Park.

Park Operations

The current Watershed Restoration program at Redwood National and State Parks is composed of a core group of permanent staff geologists, supplemented by term geologists as funding allows, who implement the physical component of the restoration efforts on park lands. Support is provided from various disciplines of the Resource Management and Science division, including the Fish and Wildlife, Vegetation Management, Cultural Resources, and GIS branches. Supporting research includes studies of erosion and sedimentation, vegetation, fisheries, wildlife, soils, hydrology, fire effects and cultural resources. Park maintenance staff and labor support crew in the Roads and Trails Branch of the Maintenance Division and administrative staff provide additional support.

The RNSP vegetation management branch is planning restoration work in second growth forests to shorten the time needed for these areas to regain characteristics and functions normally found in old growth forests. Management of second growth forests in the Lost Man Creek watershed is a high priority because road removal makes access to some areas difficult and increases costs of forest restoration.

The Lost Man Creek watershed restoration project area is included in the coniferous forest fire management unit described in the 2004 RNSP Fire Management Plan. All wildfires in this area will be suppressed and there are no planned prescribed fire or fuel reduction projects. Some of the roads in the project area will be retained for fire access and will be maintained to allow access by fire equipment.

Park road maintenance crews maintain roads within the parks at various levels. On visitor use roads, maintenance levels are high, with periodic grading and ditch and culvert cleaning and repair and maintenance. On abandoned logging roads scheduled for removal, maintenance is less regular, and focused mainly on erosion control and safety rather than on driver comfort and convenience. Road maintenance costs are approximately \$1700 per mile for brushing, ditch cleaning, and culvert maintenance.

Park operations related to visitor education and interpretation of park resources were described above in the visitor use and experience section.

Socioeconomic History

Humboldt County Recorder's Office research and oral history interviews conducted by Van Kirk (1999) indicate that after Euroamerican settlement of the region, the project area consisted of public domain lands under the jurisdiction of the U.S. General Land Office. 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, e.g. 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. It was purchased by the National Park Service in 1996. It was listed on the National Register of Historic Places in 2000. The hatchery buildings have been “mothballed” until additional funding is available for renovation and reuse in a manner that retains the integrity of the structure and its contributing elements that make it eligible for listing on the National Register.

The first significant human impacts in the watershed began with logging and associated road building following World War II.

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

The Sage Land and Lumber Company land included the relatively steep Franciscan graywacke slopes and the gentle “sloped” terrain of the Prairie Creek Formation along Holter Ridge. Their holdings were logged and tractor-yarded primarily in the 1950s. 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 1960s to early 1970s. 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.

The major haul roads (Geneva, Lower B 500 and Holter Ridge) plus numerous spur roads, were built in incremental segments as the loggers extended their reach into the timberlands. Geneva Road was built in 1947 as a primary haul route to the Geneva Lumber Company mill at the mouth of Little Lost Man Creek.

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 1970s just prior to park expansion. Only the lower portion of the watershed was not logged. Fir, redwood, hemlock and spruce were the principal marketable timber types harvested.

The town of Orick supported several timber mills and services for the growing community tied to the timber industry. The creation and expansion of the national park in 1968 and 1978, the removal of most of the old growth trees, and the enactment of legislation protecting water quality and endangered species contributed to the decline of the logging industry as the principal source of income for the town.

Environmental Consequences of the Alternatives

This section examines the effects of the alternatives for watershed restoration in Lost Man Creek on the natural and cultural resources in the project area, the park ecosystem, park visitors, park operations, and adjacent communities, and discusses effects of other past, present, and reasonably foreseeable actions related to the alternatives and to the resources in the parks and the region. This section also discusses the potential for impairment of park resources and values, as required by NPS policies.

Assumptions

The proposed action for watershed restoration in Lost Man Creek was developed based on research, monitoring, and assumptions derived from the observations, measurements, and experiences from the watershed restoration work undertaken in the parks since 1978.

The following assumptions have been used to develop the alternatives and to assess the impacts.

- Physical characteristics, processes, and functions underlie biological characteristics, processes, and functions.
- Climate and geological processes create topographic conditions, soils, and hydrological conditions.
- Soils and hydrological conditions and processes underlie vegetation communities.
- Hydrology and vegetation underlie wildlife and fish communities.
- Damage to hydrological systems and vegetation communities caused by the original logging and roads cannot be completely repaired nor can roaded areas be returned to a pristine or original condition.
- Rehabilitation of soil and hydrological conditions is the basis for restoration of watershed functions.
- Major storms are unpredictable from year to year but certain over the long-term.
- Untreated and unmaintained roads will fail eventually.
- Funding for watershed restoration is limited.
- Complete landform restoration costs more than less intensive treatment or partial restoration.
- Erosion control treatments only at stream crossings leave intervening untreated road segments inaccessible.
- Untreated road segments are at risk of failure that would cause resource damage although some segments have minimal risk of failure and other failure of other segments would result in minimal resource damage.
- Complete landform restoration costs more and takes longer because of limited funding.
- Less intensive restoration costs less and can be accomplished sooner.
- Complete landform restoration takes longer to accomplish, increasing the risk of that a major storm would cause road failures in other parts of the watershed that are awaiting treatment.
- Less intensive restoration can be completed over a greater area in a shorter time, but less intensive treatments have a greater risk from future failures over the long-term because the chance of a major storm occurring is greater over the long-term.

Methodology—Impacts on a particular resource are predicted based on impacts observed and measured from similar projects, relevant scientific research and publications, and best professional judgment of park specialists familiar with the resources. Impact analyses based on best professional judgment of park resource managers were derived from their analyses of effects of past watershed restoration actions within and outside of RNSP, including past monitoring; discussions with knowledgeable local and regional foresters, forest ecologists, geologists, hydrologists, geomorphologists, wildlife and fish biologists, archeologists, and watershed restoration specialists; and reports and studies prepared by academic, industry, and government agency personnel on the effects of watershed restoration in the Redwood Creek watershed and other watersheds in the region and in areas that have been logged.

Watershed restoration planning began in 1978 with an inventory of erosion problems visible on air photos available at the time of all the lands that had been acquired for the parks in 1968 and 1978. The inventory resulted in an initial estimate of the total road mileage and the number of road-stream and road-headwater intersections, which formed the basis for prioritizing restoration

areas. After an area is selected for restoration, the most recent aerial photos taken after the last timber harvest are used for a more detailed inventory of potential erosion problems.

Following photo inventory, field reconnaissance allows inspection of overgrown areas not visible on air photos and includes geomorphic field mapping to provide details of erosional features and to confirm whether resources are at risk if erosion occurs. The initial estimate of the mileage of roads needing treatment based on the initial air photo interpretation generally increases following field reconnaissance because not all potential erosion problems are visible on air photos or maps. Mapping is done in the winter to allow observation of runoff patterns and to mark runoff and erosion sites that might not be visible during the dry season.

Watershed restoration plans are developed for specific watersheds because each watershed differs in geology, topography, soil types, hydrology, vegetation type and coverage, intensity of logging, road density and the level of maintenance during and after logging, and the length of time that has passed since logging ceased.

Cumulative effects of the restoration alternatives are discussed for the Lost Man Creek watershed (the project area) and for the Redwood Creek watershed, of which Lost Man Creek is a tributary.

Impact Definitions

Impact topics were selected based on scoping comments and park resources and values that would be affected by watershed restoration. Impacts are analyzed for the type of impact (beneficial or adverse), the timing and duration of impact (short-term, long-term, one-time, occasional, repeated, etc.), and the severity or intensity of impact (no effect, negligible, minor, moderate, or major). These factors are also considered in the context of the geographic location of the park and the region.

Context—The context of a park action includes consideration of the effects on resources with the project area, and on similar resources within the parks, the local area surrounding the parks, and the region.

The geographic context of an impact includes consideration of the project area, the parks as a whole, and local and regional conditions. For example, chinook salmon and steelhead trout occur over a much larger geographic area than Lost Man Creek and Redwood Creek and the cumulative impact of the proposed action on salmon and trout includes consideration of effect on these species from actions outside the project area.

Timing and Duration—The timing of an impact is also part of its context. For example, removing brush and trees along a road in October does not affect nesting birds but brushing the same road in June would affect any birds that might be nesting in the vegetation.

The duration of an impact considers whether an effect would happen immediately, the length of time over which an impact occurs, and how long it would be noticeable. Duration is defined as short-term or long-term, although the duration of an effect is related to the resource affected. In general, long-term effects would be those that are repeated over at least several years or that would not be immediately noticeable.

Park research has shown that sediment discharged into Redwood Creek during major storm events remains in storage in the channel for decades or longer. For the Redwood Creek TMDL, the EPA analyzed effects based on 10 year rolling averages in recognition that trends are not discernible over shorter time frames and to allow for natural variation due to seasonal and annual

differences. The average annual sediment loading rate is useful for comparison only when monitoring and analyses are conducted over the long-term. Evaluation of sediment loading dynamics over less than a ten year period is unlikely to yield reliable data. Therefore for the effects of sediment on hydrological processes, short-term is defined as a period less than ten years and long-term would occur in a period of ten years or longer.

Short-term effects on annual vegetation would generally be on the order of a year or less, because a year includes one complete growing season. In the context of resources such as soils or plant communities, or for long-lived plants such as redwood trees, or for geological processes such as flooding, long-term refers to effects on the order of decades to centuries.

Type—The type of impact describes whether an action would benefit or harm a resource. A beneficial effect improves the condition of a resource, protects it from damage or loss, or favors the persistence of a resource. A harmful or adverse effect is one that worsens the condition of a resource, damages or degrades a resource, leads to the loss of the resource, alters it irretrievably in an undesirable way or changes its essential character so that the resource no longer possesses integrity or its defining characteristic. Adverse effects are unfavorable to the conservation and preservation of the resource. For cultural resources, the term “adverse” has a specific definition associated with federal regulations for implementing the National Historic Preservation Act of 1966, as amended.

Intensity—Intensity or degree refers to how much of an effect an action has on a resource and is described as negligible, minor, moderate, or major. Major effects are considered significant. Determining intensity relies on understanding the range of natural variation of a resource. If an action has no effect on a resource, or if the effect is barely noticeable or measurable, the effect is considered negligible. Negligible effects are those that are unnoticeable, undetectable, or result in no change to a resource, or that affect so few individuals that the effect cannot be distinguished from the natural variability for a resource. Significant effects are always noticeable and result in a permanent change to a resource over a large area.

Levels of change between negligible and significant are described as minor or moderate. Minor changes to a resource are detectable but there is no long-term or permanent alteration of the resource and the changes are within the range of natural variability. Minor effects are generally noticeable but result in only a slight change to a resource or occur in a small area, and do not change its function.

Moderate effects are always noticeable, and result in some change to the resource or its function, and occur in several areas. If an action changes the resource completely or a change is irreversible, the effect is considered significant or major. Actions are more likely to result in a gradient of change rather than a distinct level of change, so that some effects may be judged “minor to moderate” to indicate that portions of a resource in different locations might be affected slightly differently by the same action. For natural resources that are distributed discontinuously across a landscape or where individual elements of a resource are not exactly equivalent to other individuals or pieces of the same resource, a range of effects from a single action is likely.

The intensity of an impact also includes consideration of how widespread or local the area of impact would be, the amount of a resource that might be affected, or the number of times an effect would occur. If an action affects all of a resource within the parks, that impact would be considered major or significant. For example, erosion of disturbed soils following excavation of a single stream crossing would have negligible to minor effects on water quality of the entire stream. Excavation of all the stream crossings in the same drainage would create a greater

disturbance in that drainage than excavation of the same number of crossings in several drainages.

Channel adjustments at excavation sites are generally expected to be on the order of five percent or less of the total volume of material excavated. The monitoring report for one of the initial restoration projects in the Lost Man Creek watershed (Klein et al. 2005) defined minor erosion as less than two cubic yards of sediment moved at a given work site and a ~~minimum~~ of channel adjustment” as less than one cubic yard of sediment moved after restoration. Over the period 1980-1997, the total amount of material eroded from 207 stream crossings following treatment was about 63 cy per crossing for about 1400 cy excavated per crossing (Madej 2001). Best et al. (1995) showed that at locations where roads did cause streams to divert, the average erosion was about 3500 cy. These studies suggest that the likely volume of erosion from the excavated crossings would have been at least four times greater, and probably more without treatment. Most excavated crossings produced very little sediment. Twenty percent of the excavated stream crossings produced about 73 percent of the total volume eroded, mostly in the first few floods following treatment (Madej 2001.) Thus, the intensity of the effect from erosion of newly excavated areas is related to the size of rainstorms and the time since treatment, with the greatest effects over the short-term (less than 10 years). Post-excavation erosion on the order of less than two cubic yards per site is defined as negligible. Erosion of volumes of one to two cubic yards is defined as negligible; up to 5% of the total excavation volume is defined as minor, with erosion of more than 5% and less than 25% of the total excavation volume defined as moderate; and erosion of more than 25% of the total volume of excavated sediment defined as major.

In the absence of numeric targets specific sediment loading in Lost Man Creek and the difficulties of applying instream targets for Redwood Creek to the tributaries, the hillslope targets developed for the 1998 Redwood Creek TMDL are used for qualitative comparisons of the effects of the restoration alternatives for Lost Man Creek.

Intensity of effects on wildlife is determined based on the number of individuals affected in relation to the total population in the project area, the park, the region, and the range of the species. If only a few individuals of a plant or animal are affected, the impact would be considered negligible. If an action affects more than a few individuals but the effects are within the natural level of variability for a population or a resource, the effect is considered minor. If an action affects many or all individuals and causes changes to populations that are greater than the natural level of variability, the effect is considered moderate.

For sensitive wildlife and plants, there are two sets of definitions for intensity. One set of definitions is used in this EA based on the NEPA regulations (40 CFR 1500, *et seq.*) and the NPS guidelines for implementing NEPA. The USFWS uses a second set of definitions to accompany its determinations of effect under the Endangered Species Act. Negligible effects on listed species for the purpose of this EA are defined as those that are unnoticeable or that the USFWS has determined to have ~~no~~ effect.” The USFWS has defined a ~~no effect~~” determination as the ~~appropriate~~ conclusion when the action agency determines its proposed action will not affect listed species or critical habitat.” USFWS defines impacts that result in a determination of ~~may~~ affect but not likely to adversely affect” as “discountable or insignificant”; these effects are defined in this EA as minor. Adverse effects occur if impacts are not discountable, insignificant or beneficial. Impacts that are determined to be adverse but can be lessened or minimized, even though incidental take may still result, are considered moderate. An effect that is determined by the USFWS to result in jeopardy to a listed species is defined as major or significant.

Applicable Laws, Regulations, Policies, Guidelines, and Permits

Water Quality—The primary responsibility for water quality protection and enhancement in California has been delegated to the California Water Resource Control Board. In northern California, the North Coast Regional Water Quality Control Board (NCRWQCB) is responsible for adopting and implementing the Water Quality Control Plan for the North Coast Region. The plan specifies objectives, requirements, and implementation plans to protect the beneficial uses of water in the north coast area, including the parks. Water quality objectives in the plan do not allow any degradation of surface or groundwaters or permit any alteration of natural conditions. The plan also specifies the maximum contaminant levels for point (discharge from a discrete point) and nonpoint (dispersed runoff) sources.

The Redwood Creek TMDL is a specific plan to improve the impaired water quality of Redwood Creek. Both the TMDL and the appropriate implementation measures are incorporated into the State Water Quality Management Plan.

The NCRWQCB has indicated that the NPS would not be required to obtain a Stormwater General Permit for road removal or general maintenance of existing roads. The biological opinion that will be issued by NMFS to complete the consultation for effects of this project on listed salmonids is expected to include BMPs and the Terms and Conditions that would also protect water quality. One of the required terms and conditions is expected to be preparation of a Stormwater Pollution Prevention Plan (SWPPP) for any aspect of the project considered to be construction such as bridge or culvert installation if abandoned roads must be made drivable for the life of the project. The NPS would obtain permits from the U.S. Army Corps of Engineers under Section 404/401 of the Clean Water Act for bridge and culvert removals if any work involves regrading the stream channel, installation of structures below the high water mark, or placement of fill in the watercourse.

Floodplains and Wetlands Executive Orders—Compliance with NPS guidelines for implementing EOs 11988 (Floodplain Management) and 11990 (Wetland Protection) is not required for this project because the purpose of the action is restoration of watersheds and associated riparian wetlands. Effects to wetlands would result from removing fill in stream channels to restore natural conditions and functions. There would be no development in floodplains, and therefore, compliance with the floodplain executive order is not required.

Endangered Species Act Section 7 Consultations—Section 7 of the Endangered Species Act of 1973, as amended (19 U.S.C. 1536 (c)), requires that federal agencies consult with the USFWS and NMFS if agency actions have the potential to affect species listed or proposed for listing under the Endangered Species Act or designated critical habitat. The NPS initiated discussions about this project with both USFWS and NMFS on October 28, 2003 and February 8, 2005 under Section 7 streamlining procedures agreed upon among the NPS and the Arcata offices of USFWS and NMFS.

Two biological assessments have been prepared in accordance with legal requirements set forth under Section 7 of the Endangered Species Act and submitted to the USFWS and NMFS (NPS 2006 a, b). The biological assessment submitted to NMFS is intended to satisfy the Essential Fish Habitat (ESH) consultation under the Magnuson-Stevens Act (16 U.S.C. 1801).

Migratory Bird Treaty Act—The Migratory Bird Treaty Act (MBTA) protects migratory birds including hawks and songbirds. Several species protected under the MBTA nest in and around the project area. Seasonal restrictions on noise and habitat disturbance to protect nesting birds would be incorporated into the project. In areas where no murrelets were detected, work would

be allowed to proceed beginning July 10. Roads in some areas might be opened up for access prior to that date.

Cultural Resource and Tribal Consultations—The National Historic Preservation Act of 1966 requires federal agencies to consult with state historic preservation officer (SHPO) if an undertaking would have the potential to affect properties listed or eligible for listing on the National Register of Historic Places. NPS policies require consultation with affected American Indian groups. For this project, the NPS has consulted with the SHPO and with the Yurok Tribe. Other local affiliated American Indian groups were informed about the project but did not respond with any concerns.

Non-Impairment of Park Resources and Values—The NPS is required by law to manage park resources and values in such a way as to leave them unimpaired, unless a particular law directly and specifically provides otherwise. NPS management policies require that environmental documents disclose whether an action has the potential to impair park resources or values. Impairment is defined (Management Policies 1.4.5, NPS 2001a) as an impact that harms the integrity of park resources and values, including the opportunities that otherwise would be present for the enjoyment of those resources or values. Whether an impact rises to the level of impairment depends on the particular resource or value, on the timing, duration, and intensity of the impact, and whether the impact is direct or indirect. An impact is less likely to constitute impairment if it is an unavoidable result, which cannot reasonably be mitigated, of an action necessary to preserve or restore the integrity of park resources and values. Impairment is more likely to result from impacts that affect resources whose conservation is necessary to fulfill park legislation, or are key to the natural or cultural integrity of the park or the opportunities to enjoy the park. Separate non-impairment analyses and findings for each affected resource follow the analyses of effects on park resources.

Effects on Air Quality

In general, air quality in RNSP and the surrounding area meets or exceeds standards set by the EPA because the prevailing winds come from the northwest across the ocean where there are no emission sources. Air quality returns quickly to very good to excellent after vehicles and equipment cease operating or stirring up dust. The amount of time for regional air quality to return to pre-disturbance condition depends on the prevailing winds and the movement of air masses but air stagnation or long-term inversions that cause poor air quality are rare.

No Action—Under this alternative, there would be no dust or emissions from use of heavy equipment used for restoration. Roads that are still drivable would be maintained as funding permits, and considering parkwide priorities for maintaining other roads used by visitors and for resource management and resource and visitor protection. Road maintenance and use of administrative roads for fire management and other natural resource management projects would create dust and result in vehicle emissions. The volume of dust produced by vehicles using roads would be greater when the roads are dry, which is generally from July through October. Adverse effects on air quality from dust and vehicle emissions would be localized, occasional, and short-term. The overall effect on air quality under the no action alternative from vehicle emissions and dust generated by routine road maintenance activities would be adverse, short-term and negligible.

Alternative 2: Partial Restoration (Proposed Action)—Emissions would be produced by heavy equipment including loaders, excavators, bulldozers and vehicles use to transport people and equipment. Adverse effects on air quality from vehicle emissions would be mitigated by vehicle

maintenance and smog testing required as a condition for vehicle registration. Adverse effects on air quality from vehicle emissions would be short-term and localized.

Dust would be created in work areas by heavy equipment excavating about 545,000 cy of road fill to remove and fully recontour 16.8 miles of roads (4.2 miles at and 12.6 miles between stream crossings) and partially recontour an additional 11.1 miles of roads, including 146,900 cy of fill excavated to remove 163 stream crossings. Work is scheduled for completion in four years, but the total duration of the project could be 6 years if rainy weather begins early (mid October) rather than late (November). The first year of the project would involve 3 work areas, with each area requiring 4-5 weeks. The remaining 3 years are assumed to require 10-12 weeks for three different work areas. The earliest that work would begin would be June but this work would involve brushing and clearing of access roads, which would produce less dust than excavation. The longest period of road removal work would be about 13 weeks (July 10-October 15) in some areas outside old growth forest.

Dust from vegetation removal and excavation would settle on vegetation along the road corridor and persist until the first rains of the season wash dust off. There would be less dust generated on foggy days with high humidity and in the vicinity of stream crossings or shady areas where there is expected to be more residual soil moisture than along road reaches that are exposed to sun. Water trucks would be used to sprinkle clean water to abate excessive dust. Air quality would be adversely affected by dust and vehicle emissions but the effect is temporary and localized in the area where equipment is operating or where excavation is occurring. Outside work sites, the adverse effect on air quality would be negligible. At excavation sites, the adverse effect on air quality from dust would be minor where the equipment is operating. There would be no long-term adverse effects on the air quality or air quality related values in the parks.

Alternative 3: Full Restoration—Under this alternative, approximately 999,000 cy of soil would be excavated to remove and recontour approximately 27.4 miles of roads, including 149,300 cy of fill excavated to remove 174 stream crossings.

The full restoration alternative involves excavation of 450,000 cy more soil than would be excavated under the proposed action, or about twice as much excavation altogether. Assuming that the amount of dust created is directly proportional to the volume of soil excavated, approximately twice as much dust would be created under the full restoration alternative over the life of the project.

The vehicle emissions from equipment used under the full restoration alternative would be also be proportionally greater than under the proposed action because the project would take longer and the equipment would be working longer.

The adverse effects on air quality from vehicle emissions and dust would be temporary and localized at work sites. The dust would coat vegetation in the immediate vicinity of the work site and would persist until winter rains wash it off. Despite the larger volume of soil to be excavated under the full restoration alternative, the overall effect on air quality would still be negligible because no significant air quality related values would be affected outside the immediate work area and the dust would be a temporary condition. During excavation, the adverse effect on air quality from dust would be a temporary minor adverse effect at work sites.

Cumulative Effects—Cumulative effects on air quality in the parks result from dust from soil disturbance and emissions from vehicles and power tools associated with maintenance of park roads and trails, second growth management, fire management including preparation of roads and

firelines and smoke from prescribed fires and wildfire suppression, timber harvest on adjacent lands, vehicle emissions from public roads and highways, and smoke from wood stoves in adjacent communities. Adverse effects from smoke from prescribed fire and wildfires would have the greatest potential for moderate adverse effects but smoke is temporary for the duration of the fire. These effects are adverse, localized to widespread, temporary but repeated, and negligible to moderate. No long-term cumulative adverse effects on air quality or air quality related values in the parks are anticipated for the foreseeable future because the regional prevailing winds are from the northwest across the Pacific Ocean where there are no sources of air pollution.

Conclusions—Effects on air quality under both the proposed action (partial restoration) and the full restoration alternative would result primarily from dust generated by excavation of road fill. Dust produced by excavation and use of the roads would be mitigated by sprinkling the access roads with water carried on water trucks. The adverse effects on air quality would be localized at the excavation site and short-term, with the longest period of reduced air quality occurring during work hours from July 10 through October 15. No significant air quality related values would be affected outside the immediate work area and the dust would be a temporary condition. Although about twice as much dust would be generated under the full restoration alternative because there would be more excavation, the overall adverse effect on air quality from either Alternative 2 or Alternative 3 would be temporary, localized at work sites, and would not adversely affect any other resources such as scenic vistas. Therefore, the adverse effect on air quality and air quality-related values would be negligible to minor under both the proposed action and the full restoration alternative. The cumulative effects on air quality under any of the alternatives would be negligible, because the primary sources of air pollution in the project area are vehicle emissions on highways and smoke from fires, and state air quality standards in the project area are rarely violated by either source.

Effects on Soils and Topography

Watershed effects include effects on soils, topography, hydrology, and water quality from the project, as well as the earlier effects on these resources and processes that resulted from the logging and road-building before the lands became part of Redwood National Park. The adverse effects of soil erosion and excess sediment in streams are the primary issue addressed by watershed restoration. This section covers effects on soils and topography.

Erosion is a function of climate, soil, topography, and vegetative cover. Climate has both direct and indirect effects on erosion. The most direct climatic effect is rainfall intensity and duration. Rainfall intensity, duration, and frequency have a direct effect on the amount of runoff generated. Climate indirectly affects erosion because warmer areas with higher rainfall tend to have more vegetation to protect the soil from erosion.

Topography affects erosion because steeper slopes generate a higher flow velocity and tend to concentrate flows rather than allowing flows to disperse. Flatter slopes reduce the potential for sheet, rill, and gully erosion by reducing runoff velocity and maintaining sheet flow conditions. The size, shape, and slope of a watershed influence the amount of runoff. As runoff increases, the potential for erosion increases. Alterations to topography change drainage patterns. Changes to drainage patterns from altered topography and the effects of sediment in streams are discussed under effects on hydrology and water quality.

The orientation of a slope can also affect the ability for vegetation to become established, with vegetation establishment more difficult on hotter and drier south slopes. Vegetation cover directly affects erosion by reducing the impact of raindrops, reducing the velocity of runoff,

providing structural integrity to soil from roots, filtering sediment from runoff, increasing infiltration into soil, and increasing evapotranspiration.

Vegetation was cut and soils were disturbed to construct roads in the project area. Soils were also disturbed by subsequent logging as bulldozers skidded (dragged) logs across the surface of the land. Road construction and watershed restoration through road removal directly affect soil and topography of a site. Because watershed restoration involves road removal, which reverses the process of road construction, the soils and any vegetation that has regrown within and immediately adjacent to the road corridor would be disturbed again during watershed restoration projects.

Eroded soils enter watercourses as sediment, which reduces water quality. Sedimentation refers to the deposition of soil particles that are moved from their original position. Turbidity is used as an indicator of sediment suspended in water, but turbidity is affected by other factors besides sediment.

Instream numeric targets for sediment loads in Redwood Creek and its tributaries established through the TMDL process represent adequate stream habitat conditions for salmonid reproductive success. Instream targets are used to determine whether beneficial uses adversely affected by sedimentation are recovering over the long-term. Instream targets for the mainstem require a minimum of ten years of data collection to be able to determine trends and cannot be strictly applied to the tributaries. Sediment impacts often occur long after the sediment entered the stream, and in locations far removed from the sediment loading site. It is technically infeasible to vary the TMDL between the tributaries and the mainstem to account for temporal and spatial variations in sediment loadings and impacts. Because of the difficulties of applying instream targets for the mainstem of Redwood Creek to the tributaries, the final TMDL established hillslope targets that are desired conditions for any given site in the watershed and achievable at any point in time. The hillslope targets are expected to result in the reduction of erosion potential and future sediment delivery to streams to levels which will allow recovery of instream habitat from sediment impacts over the coming decades. The hillslope targets in the Redwood Creek TMDL are believed by the EPA to describe the attributes of a well-functioning watershed which supports both healthy aquatic habitat and ongoing road use and logging (USEPA 1998). Although there is no longer commercial logging in the project area or the parks, some the roads in the project area will be retained for administrative use, others would be used for access for the duration of the project, others would be removed, and some segments would be treated but not completely removed. The impact analysis discusses the differences between alternatives in relation to the hillslope targets.

Hillslope targets represent desired conditions for land management that are associated with properly functioning erosional processes and erosion rates that are not excessively accelerated by human influences. While the EPA expects recovery of sediment-impaired streams to take many years, hillslope targets provide an immediately useful set of measures of whether land uses known to contribute much of the human-caused share of sediment loading to Redwood Creek are being modified in ways which will minimize future erosion potential and sediment delivery. The numeric targets are based on scientific literature, available monitoring data for the Redwood Creek basin, and best professional judgement.

General Effects on Soils and Topography from Road Construction and Road Removal

Soils and topography in the project area were created over long periods of time by natural soil formation processes and by geomorphic processes that create large-scale landforms and move

soils down slopes. Soils and topography are directly affected in a much shorter time by other geomorphic processes such as landsliding and by excavation to build or remove roads.

Topography affects drainage patterns because water flows downhill in response to gravity. Constructing or removing roads directly alters topography with resulting changes to drainage patterns. The presence or absence of a road on a slope also affects drainage. Thus, alterations to topography indirectly affect the hydrology of an area by altering drainage patterns.

Earthwork with heavy equipment directly reshapes the topography by moving soils to create a flat road bench. Roads in mountainous terrain are constructed by cutting into hillslopes and often using the cut material to fill low spots to create a flat road surface or bench.

When roads and landings are built, the soil profiles (layers of soils) are altered as topsoil is excavated or pushed to the side (sidecasting) and underlying soil layers are exposed. Topsoil is often covered with lower layers as soils are excavated and moved to build a flat road bench or landing.

No Action—Under the no action alternative, no roads would be removed from hillslopes. Roads across streams (stream crossings) would remain in place. The original topography of the project area would continue to be altered by the presence of 32 miles of roads, with cuts and fills across slopes and fills in stream channels.

Roaded hillslopes would remain in unstable configurations susceptible to landsliding. There would be no disturbance of soils for recontouring slopes or excavating stream channels. The total acreage that has been restored to resemble original topography within the Lost Man Creek watershed would remain at around 2,370 acres (30%) of the project area.

At least 849,700 cy of soil along 32 miles of road, including 149,300 cy of soil in 174 stream crossings, would remain in unstable areas and be susceptible to landsliding and erosion. Road fill in stream crossings would continue to erode, with the majority of erosion occurring after major storms but with smaller amounts eroding on a more continuous basis after each storm event (chronic erosion). There would be less erosion from untreated sites under the no action alternative following small storms compared to newly excavated stream crossings under the proposed action the first year following excavation because the existing stream channels and hillslopes have some vegetation and have stabilized to a small degree. Long-term erosion on untreated sites under the no action alternative would be greater than under either of the restoration alternatives because more soil would remain in unstable locations and in stream crossings where it would be mobilized during major storms. Some untreated locations would experience chronic erosion while other untreated locations would be susceptible to mass movement, gullyng, or landsliding.

Roads that provide administrative access for resource management would receive occasional maintenance, including brushing, repair and replacement of drainage structures, and grading. Roads that do not provide administrative access would receive maintenance less frequently and at a lower level. All roads would continue to deteriorate. The rate of deterioration is expected to accelerate for road segments located in less stable areas, which includes steeper slopes, less stable soils, or in inner gorges of streams where the streams continually undercut the slopes. The rate of deterioration and risk of failure is also expected to accelerate at stream crossings as Humboldt crossings or culverts age and deteriorate.

Over the long-term, road failures are highly likely to occur although any heavy rain event would potentially cause slides. Road failures are expected to result in landslides, gullying, and mass movement. The effect of road failures on topography and soils would be adverse. For any individual road, small failures would be considered to have a negligible to minor adverse effect on topography and soils, because the topography and soils are already adversely affected by the original construction of the road. A catastrophic road failure in one location would be a minor to moderate adverse effect on the local topography and soils. Multiple catastrophic road failures at a single time or over the long-term could result in moderate to significant adverse effects on the topography of the subdrainages. Mitigation of significant alterations to topography over the long-term might not be possible following major road failures because heavy equipment access might not be available.

Under the no action alternative, Lost Man Creek would continue to contribute sediment to Prairie Creek and the lower section of Redwood Creek. Because the mainstem of Redwood Creek is already designated as sediment-impaired, the cumulative effect of the no action alternative on Lost Man Creek would be on-going during winter storms, and generally negligible on Redwood Creek. A storm of sufficient magnitude to cause catastrophic road failures in the Lost Man Creek watershed would almost certainly affect other parts of the Redwood Creek watershed and the contribution of Lost Man Creek would range from negligible to moderate for the cumulative effects of widespread road failure and sediment delivery into Redwood Creek. The effect of a catastrophic road failure in the project area would have a greater adverse effect on Prairie Creek than on Redwood Creek because Prairie Creek retains good quality aquatic habitat that would be affected. The reach of Redwood Creek that would be affected by catastrophic failure in Lost Man Creek is channelized by levees and is not suitable spawning habitat for salmonids.

Effects on Watersheds from Action Alternatives

Table 2 in the Alternatives section compares the miles of road removed, the estimated volumes of sediment excavated, and the estimated volumes of sediment prevented from eroding for Alternative 2: Partial Restoration (the proposed action) and Alternative 3: Full Restoration.

Alternative 2: Partial Restoration (Proposed Action)—The total area of ground disturbance from restoration of 28 miles of roads under the proposed action is estimated to be almost 216 acres (3.7%) of the 5,804 acres of the project area (2.7% of the 7728-acre Lost Man Creek watershed), as determined by air-photo interpretation followed by field reconnaissance and mapping. The pattern of soil disturbance would be relatively linear, following the haul roads, with minor excursions into the skid road networks to remove stream crossings.

Restoring almost 28 miles of road through excavation of 545,100 cy under the proposed action would prevent approximately 574,700 cy of soil from eroding (total erosion prevented). Of the total excavation volume and total erosion prevented, removal of 163 stream crossings by excavating 146,900 cy would prevent erosion directly into stream channels of 140,300 cy. Excavation of 398,200 cy for full removal and recontouring of 12.6 miles of roads between stream crossings and partial removal and recontouring of 11.1 miles of roads between stream crossings would prevent erosion of 287,600 cy that would damage aquatic habitat and 15,100 cy that would damage terrestrial habitat.

The proposed action would reduce the risk of both large-scale erosion processes (gully and rill erosion and landslides) and reduce chronic erosion of smaller volumes of sediment. Minor rilling would likely occur in the first winter following the restoration work until vegetation in recovered topsoil regrows and the newly disturbed soils settle. Rilling would be minimized by hardening

the newly restored slopes by compacting them with the heavy equipment, armoring with rock, or mulching with vegetation removed from the excavated areas and placed on the slopes.

Excavation and reshaping of sidecast fill would restore the surface runoff patterns to resemble original patterns and reduce the potential for mass movement caused by road fill failure. Topsoil with organic materials and soil horizons would be uncovered and moved to more or less original location. Soil formation processes would be accelerated by uncovering the original topsoil that contains organic material.

The proposed action would have a minor to moderate beneficial effect to soils in the project area by moving soils to stable locations and reshaping to restore runoff patterns, thus reducing the risk that mass movement would cause major soil loss. The proposed action would have a minor to moderate beneficial effect to topography in the project area by completely removing 12.6 miles of road and restoring the landforms to resemble the original shape of the hillslopes, and partially removing 11.1 miles of roads and restoring landforms. Both full and partial road removal and landform restoration would have minor to moderate benefits from reducing the potential for mass movement that could obliterate the original landforms.

Alternative 3: Full restoration— A total of 291 acres of soils (5 % of 5,804-acre project area and 3.7% of the 7,729-acre Lost Man Creek watershed) would be disturbed to fully restore 32 miles of roads under the full restoration alternative.

Restoring 32.1 miles of road through excavation of 999,000 cy under the full restoration alternative would prevent approximately 624,500 cy of soil from eroding (total erosion prevented). Of the total excavation volume and total erosion prevented, removal of 174 stream crossings by excavating 149,300 cy would prevent erosion of 154,200 cy. Of the 154,200 cy of erosion prevented by stream crossing excavation, 145,600 cy would be prevented from eroding directly into stream channels. Excavation of 849,700 cy for full removal and recontouring of 27.4 miles between stream crossings would prevent erosion of 309,000 cy that would damage aquatic habitat and 15,700 cy that would damage terrestrial habitat.

The full restoration alternative would have slightly greater long-term benefits to soils and topography than the proposed action from completely removing 32 miles of roads and restoring landforms under the full restoration alternative, versus complete removal and landform restoration of 12.6 miles of road and partial restoration of 11.1 miles under the proposed action. The full restoration alternative would prevent the erosion of an additional 49,800 cy of soil, which is about 9% greater than the volume of erosion prevented under the proposed action. The overall benefit to soils and topography under the full restoration alternative is judged to be similar to the benefits of the proposed action, which is a minor to moderate benefit to soils from prevention of landsliding, gullying, rilling, and other geomorphic processes that move soils and cause erosion.

Cumulative Effects—Under the proposed action, work in the Lost Man Creek watershed would have no direct effect on topography and soils in other subbasins in the Redwood Creek watershed. Topography in the other subbasins of Redwood Creek would remain altered by presence of logging roads. Soils would continue to erode in unstable areas along roads in the rest of the watershed. Landslides related to the presence of untreated roads would occasionally alter topography, particularly after major storms.

Around 1,400 miles of forest roads and over 5,000 miles of skid trails are estimated to have been built within the Redwood Creek basin. About 445 miles of roads and 3,000 miles of skid trails

were included within the national park boundaries. Full and partial removal of 28 miles of logging roads under the proposed action would have negligible short-term or long-term benefits to the watershed as a whole, and minor to moderate benefits to soils and topography in Lost Man Creek over the long-term. There would be negligible benefits to the Redwood Creek estuary from the proposed action. Over the very long-term, if failing roads within the park are removed and if roads upstream and outside the park are maintained and effective erosion control implemented prior to major storms, there would be a major benefit to soils and topography in the Redwood Creek basin from preventing unnaturally high levels of erosion. The long-term benefit to the Redwood Creek estuary from reducing the influx of sediment would be a moderate benefit to estuary functioning because the Redwood Creek levees would continue to alter the hydrology and functioning of the estuary.

Conclusions—There would be negligible short-term adverse impacts on soils from disturbance of 216 acres under the proposed action or disturbance of 291 acres under the full restoration alternative because the original logging and road construction had major adverse effects on larger areas of soils by removing vegetation, burying topsoil under road fill, skidding logs across unstable soils, and destabilizing slopes, which resulted in landslides and unnaturally high levels of erosion. Under both action alternatives, buried topsoil would be uncovered and repositioned, which would have both short-term and long-term benefits to soils from restoring the soil horizons. Soils would also benefit from mulching and the seed bank in the top soils which would accelerate the revegetation and reduce the potential for short-term erosion of the newly repositioned soils. There would be a long-term benefit to topography and geomorphology in the project area under the proposed action from complete restoration of landforms after removing 12.6 miles of road and from partially restoring landforms along an additional 11.1 miles of road. There would be a greater long-term benefit to topography and geomorphology under the full restoration alternative because an additional 4 miles of road would be removed and the topography would be restored along all roads (32 miles under the full restoration alternative versus 28 miles under the proposed action, with topography restored fully on 12.6 miles).

The benefit to soils and topography in the project area under either the proposed action or the full restoration alternative would be minor to moderate from restoring topography on 216 acres (2.7% of Lost Man Creek watershed) or 291 acres (3.7%) under the proposed action or full restoration alternative, respectively, with negligible to minor adverse effects on soils from erosion in the first few seasons following restoration work. The overall effect on soils and topography from heavy equipment work and restoration of topography under either the proposed action (216 acres) or the full restoration alternative (291 acres) in the 5,800-acre project area compared to the alteration of approximately 50,000 acres of the entire Redwood Creek basin within the park is a negligible short-term adverse effect on soils from redisturbance with a negligible to minor long-term benefit after restoration.

Effects on Hydrologic Conditions and Processes and Water Quality

The effects on hydrology that result from changes to hillslope topography due to excavation are generally indirect effects on hydrology. The effects on hydrology that result from excavation in stream channels are direct. The effects on water quality from watershed restoration projects are direct, primarily in the short-term, and more indirect over the long-term as sediment is prevented from entering water courses and reducing water quality.

The intensity and timing of effects on water quality prior to and following road construction and removal are related to rain events. Storms are uncertain over the short-term but certain over the long-term. Repeated, heavy rains increase the potential for catastrophic road failure. Roads could also deteriorate more gradually. Monitoring conducted in the parks since 1980 indicates

that untreated sites generally do not contribute significant amounts of sediment during small to medium magnitude storms but pose substantial risk of sediment delivery only during larger storms. The effects on logged and roaded hillslopes from storms with less than a 5 year return interval are defined as negligible. The effects of storms with less than a 25-year return interval are defined as minor. Effects of storms with a return interval of 25-50 years are defined as a moderate event, and the effects of storms with return intervals of more than 50 years and less than 100 years are defined as major storms. Effects of storms with a 100-year or greater return interval are defined as catastrophic. Under these intensity definitions, there has not been a major storm recorded in Redwood Creek. The damage associated with largest recorded storms on Redwood Creek (1950, 1955, 1964, 1983) would be moderate under these intensity definitions with the effects of the 1955 and 1964 storms approaching major.

The Redwood Creek TMDL for sediment is based on a simplifying assumption that sediment input equals sediment outputs in a properly functioning stream system in the long term. The TMDL also assumes that it is not necessary to attain a near pristine level of sediment loading to restore functioning aquatic habitat in the Redwood Creek basin as a whole. There is no reliable direct linkage to evaluate instream impacts from hillslope erosion sources because the sources and the impacts are separated in time and space but the level of sediment reduction on hillslopes is used to estimate the potential benefit to water quality.

There is no universal measurement of sediment loading relative to beneficial uses of a stream. It is generally not possible to make estimates of prelogging erosion in most of Redwood Creek and its watersheds because of the widespread logging that occurred prior to first estimates of sediment loading. The erosion potential in the Redwood Creek basin from a 50-year event is estimated to be 5 million cy in its current post-logging condition and the effects of that volume of sediment entering Redwood Creek is defined as major or significant. For this analysis, a major or significant effect on a tributary of Redwood Creek is defined as a similar volume of sediment in direct proportion between the drainage area of the Redwood Creek watershed and the drainage area of a tributary. The Redwood Creek watershed covers about 277 square miles, or 177,280 acres. The Lost Man Creek watershed covers about 7730 acres. If the two watersheds are directly proportional, a sediment discharge of about 200,000 cy of sediment into the main stem of Lost Man Creek in a short period of time would be a significant adverse effect.

Turbidity is used as an estimate of sediment input into a stream, in the absence of a direct measurement of sediment input or suspended sediment concentration. For sediment effects as measured by turbidity, a negligible effect on water quality is defined as not being detectable from the naturally occurring levels after a storm in an undisturbed (unroaded and unlogged) watershed. A significant adverse effect on water quality from sediment is defined as turbidity that remains above the highest recorded turbidity level for a stream after turbidity in nearby unmanaged watersheds has returned to naturally occurring levels. Prairie Creek upstream of Lost Man Creek and Little Lost Man Creek are the nearest unmanaged streams that can be used for comparison with Lost Man Creek.

No Action—Under the No Action alternative, there would be no actions taken to restore or rehabilitate watersheds. Administrative roads and roads that are used for recreational access (Geneva Road, Holter Ridge Road) would be maintained by routine vegetation clearing and ditch cleaning. Culverts would be replaced as they fail. Sections of road that fail would be repaired. In the majority of the project area, drainage patterns continue to be altered by roads and skid trails. Streamflow diversions would occur in major storms, resulting in gullying and landsliding.

Culverts would continue to degrade and would eventually fail. Erosion potential would remain moderately high. About 154,200 cy of sediment would remain in 174 stream crossings and would be at risk of mobilization from storm events or would contribute to chronic turbidity. Major storms would cause erosion along smaller steeper streams, with the eroded sediment transported to larger streams and eventually deposited along the lower gradient sections of Lost Man Creek, Prairie Creek, and Redwood Creek. High flow events (10-25 year return interval) would remobilize stored sediment and cause channel modification and redeposition of sediment in downstream habitat areas. Stream channels would continue to widen and become shallower if a major storm produces erosion at stream crossings.

Only the Geneva and Holter Ridge roads would be available for administrative vehicle use in wet weather. The TMDL target for annual inspection and maintenance and surfacing and drainage appropriate for use would be met only for Geneva and Holter Ridge Roads. The TMDL recommendation that roads used in wet weather should be rocked might be violated if access is required in wet weather for other roads in the project area.

Diversion of flow would result surface erosion and creation of debris flows and other mass wasting events that could be moderate to major, depending on the underlying soil type and topography.

Under the no action alternative, there would be no short-term increases in sediment and turbidity in the streams in the project area related to excavation of roads or stream crossings. There would be negligible to minor short-term increases in turbidity from excavation for culvert replacement on administrative roads that will be retained for fire management and along the B-line along the park boundary and Geneva and Holter Ridge roads. There would be no long-term benefit and the potential would remain for long-term moderate to significant adverse effects depending on the volume of sediment delivered into a stream. If the entire volume of sediment that is estimated to be stored along logging roads and in stream crossings (625,000 cy of erosion potential) eroded into the mainstem of Lost Man Creek in a short time, it would be a significant adverse effect on Lost Man Creek that would persist for many years. There would be no improvement to the impaired condition of Redwood Creek from reduction in sediment from Lost Man Creek but the effect would be negligible compared to the relative contribution from tributaries higher in the drainage that affect a longer reach of the mainstem of the creek (625,000 cy erosion potential from Lost Man Creek compared to 5 million cy erosion potential for Redwood Creek.)

Alternative 2: Partial restoration (Proposed Action)—There would be direct adverse effects on water quality from project work as measured by turbidity where newly disturbed soils erode into streams and from erosion of soils previously disturbed for original road construction and by logging. The intensity or degree of effect depends on the intensity and duration of storm events in the first winter following excavation. A major storm in the first season following restoration would have moderate adverse effects in Lost Man Creek if the 154,000 cy of sediment at stream crossings erodes in a short time and enters the streams. The potential for erosion would decrease each year following excavation as vegetation becomes established. In completed restoration projects throughout the park, a dense growth of alders 6-10 feet tall is generally observed on all disturbed surfaces within 4 years. Short-term adverse effects on water quality from turbidity immediately, and in the first few rainy seasons, after excavation would be reduced by working in streams at low-flow periods, working outside the rainy season, ~~—term-proofing~~ “work sites if storms are forecast, silt-fencing and other best management practices prescribed in the terms and conditions that NMFS is expected to proscribe in the Letter of Concurrence and the Biological Opinion issued for the NPS biological assessment (NPS 2006b). Organic matter and nutrients in the vegetation that is removed prior to excavation and placed on the recontoured slopes for mulch

would be recycled into soil as the material decomposes. Alders that regrow as pioneer species would fix nitrogen in the soils and improve the conditions.

Stream channels at stream crossing excavation sites would adjust following excavation, mostly during the first winter, with greater erosion occurring at crossings located in unstable soils, and the overall degree of adjustment depending on the magnitude of the rainstorms. The remaining road fill wedged in the interstices of the original streambed would be mobilized and flushed out in the first winter. Small portions of streambanks might settle or slide. If all 163 stream channels adjust in the first year and 5% of the total excavated volume mobilizes, a total of 6580 cy of sediment would enter stream channels. However, stream crossings would be treated over four years, with 16 crossings scheduled for treatment in 2006; 52 crossings in 2007; 77 in 2008; and 18 in 2009. Furthermore, not all sediment that does move in channel adjustments would enter the mainstem of Lost Man Creek in a given year because the sediment would have to move down each tributary. Direct short-term adverse effects on water quality from increased turbidity due to excavation would result for five to ten years, until vegetation has regrown into the excavated areas and unexcavated sediment in treated stream channels has flushed out. The fill mobilized in these adjustments and the increased turbidity would be negligible compared to the total volume of fill removed from the stream channels (131,600 cy) and from unstable slopes where sediment would damage aquatic habitat if it eroded (287,600 cy).

The stream channel would be excavated down to the original channel. The original channel bed armor would adjust in response to the logging slash located above and below the excavation site. Decaying logging slash or natural organic debris that is not excavated or moved out of a channel might collapse, causing a chain reaction up and downstream. Most of the sediment mobilized during these adjustments would be trapped by the large woody debris that is placed back in the channel after excavation. The channel configuration would stabilize in about 4 years, reducing the potential for stream aggradation (becoming wider and shallower) over the long-term.

Over the very long-term, beneficial indirect effects to Redwood Creek would be expected from prevention of future failures in Lost Man Creek but these effects would be negligible to minor (total erosion potential of 574,700 cy in Lost Man Creek compared to 5 million cy in Redwood Creek).

Under the proposed action, sheet flow and original drainage patterns would be restored on recontoured slopes over 216 acres. The channel configuration would be restored in 163 excavated channels. This would be minor to moderate long-term benefit in the immediate restoration area (3.7% of the total Lost Man Creek watershed).

The proposed action would meet the TMDL hillslope target of no stream crossings with diversion potential.

If culverts need to be replaced on roads needed for temporary access to the project area, the temporary culverts would be sized for at least a 50-year storm event. This would meet the TMDL target.

All landings and road fills (sidecasts) on slopes greater than 50% that would potentially deliver sediment to a water course would be pulled back and stabilized, which would meet the TMDL target.

Vegetation removed during restoration would be stockpiled in the project area and placed or scattered on the slopes for mulching. Mulch would be concentrated where there is the greatest

risk of exposed soils eroding and entering a stream. The heaviest concentration of mulch would be applied closest to streams, where slopes encourage flow convergence and lead directly to a stream, and on steeper slopes where there is faster runoff.

Mulching rather than replanting would be used for initial erosion control because planted vegetation doesn't grow through the first winter when the initial erosion control is needed. Small pieces of woody debris break down relatively quickly and add organic components to the soil. Larger pieces provide shade and cover for small animals and preserve moisture for pioneer plant species. Local mulch would be used to avoid introducing exotic plants and to support a native fungal community favorable to reestablishment of trees. Shredded redwood bark would be used where there is not enough woody debris to provide sufficient cover or where woody debris is not in contact with ground surface. Shredded redwood bark would be purchased from local lumber mills, which would reduce the potential for importing vegetation that is not endemic to the area.

There would be negligible increases in stream temperature along reaches where vegetation is removed. Streams would be exposed to direct sunlight for about 100-500 feet for each restoration site for a few hours daily. In most locations that will be restored, there is no vegetation because the roadbed material is too compacted or unstable for a thick canopy to grow. The velocity of streams in stream crossings and channel restoration sites is relatively high because of the steep topography, which also prevents the formation of pools that would be exposed to light longer. The steep topography and surrounding tall overstory trees also limit the duration of direct sunlight onto streams.

Landform restoration under the proposed action meets and generally exceeds the recommendations of the Redwood Creek TMDL as a tool for reducing instream sediment effects on water quality and hydrology because the TMDL assumes that logging will continue and roads will be retained and drivable. In the absence of these land uses in the park, watershed restoration would be more effective for reducing instream sediment.

Under the proposed action, approximately 545,100 cy of sediment would be removed from unstable locations and stabilized. Of that total amount, 146,900 cy would be removed from stream channels, which would be a direct benefit to hydrological functioning of those channels over both the short- and long-term by preventing erosion of 140,300 cy, and an indirect benefit to water quality from reducing the potential for 131,600 cy of sediment to enter the streams directly. Channel excavation would have short-term adverse effects for the first few seasons from increased turbidity; the intensity of the effects would depend on the intensity and duration of rainfall. The increased turbidity following storms would gradually decline as vegetation regrows, over a period of five to ten years.

Alternative 3: Full Restoration—Under this alternative, adverse effects on hydrology and water quality from major slope failures would be minimized to a greater extent than under the proposed action because 27.4 miles of road would be fully recontoured and removed under Alternative 3 versus removal and full recontouring of 12.6 miles and partial removal of 11.1 miles under the proposed action. Direct effects on water quality in Lost Man Creek from removal of fill in stream channels in the short-term and over the long-term would be similar under both Alternative 3 and the proposed action because approximately the same volume of road fill would be excavated under the two alternatives (149,300 cy under Alternative 3 versus 146,900 cy under the proposed action). Under full restoration, 154,200 cy of sediment would be prevented from eroding, compared to 140,300 cy under the proposed action. Full restoration would have a greater benefit to streams from preventing 145,600 cy from eroding directly into a stream channel compared to 131,600 cy prevented from eroding into a stream channel under the proposed action.

Cumulative Effects—The cumulative effect of other actions on water quality in the project area result primarily from past logging and road building in the park. Because the watershed is now protected in the national park, future actions that would affect water quality are related to park resource management projects including fire management and management of second growth forests.

The effect of restoration of Lost Man Creek would be a benefit to the water quality of Redwood Creek but the benefit would be negligible to minor because Lost Man Creek enters Redwood Creek very low in the watershed, and restoration in Lost Man Creek would not improve hydrological conditions or water quality in Redwood Creek upstream of its confluence with Prairie Creek.

The overall cumulative effects on hydrology and water quality in Redwood Creek in the park relate to past logging and road building, both within what is now the national park and upstream of current park boundaries.

Damage to forest resources and fish in the Redwood Creek watershed coincided with both intensive timber harvest and a series of large storms between 1955 and 1983 that were accompanied by widespread flooding and erosion. Land use activities significantly increased erosion above naturally high levels associated with storms. The large number of improperly designed and maintained roads, landings and skid trails in the Redwood Creek watershed causes increased surface erosion and fine sediment production and delivery, and an increased potential for stream diversions, rill and gully erosion, and road related landslides with corresponding increased in sediment production and delivery. Past timber harvest in what is now the park and outside the park on unstable slopes prior to the enactment of the state Forest Practice Rules and removal of riparian vegetation also contributed to increased erosion and sediment production. These factors led to the designation of Redwood Creek as a sediment-impaired stream.

Key changes in Redwood Creek mainstem channel structure over the past 40 years include increases in the volume of stored sediment; decreases in pool numbers and depth; increases in stream width and decreases in stream depth; reduced recruitment of large woody debris; deposition of high levels of fine sediments on the stream bottom; and reduced volumes of large woody debris.

NPS researchers estimate that approximately 55% of 1400 miles of roads in the basin are not maintained and are therefore more likely to fail during storms than maintained roads. There are several thousand crossings associated with these roads and it is likely that hundreds if not thousands of crossings continue to have diversion potential.

Hillslope numeric targets for the Redwood Creek TMDL are directly addressed by the proposed action. Hillslope numeric targets describe desired conditions for land management uses ongoing in the watershed and which are expected to continue to pose significant erosion potential in the future. Hillslope targets for the Redwood Creek watershed TMDL identify appropriate road design, location, inspection, and maintenance practices along with appropriate silvicultural practices in sensitive areas. These numeric targets are adapted to compare the proposed rehabilitation proposals in one tributary with ongoing land uses upstream in the whole watershed. The Redwood Creek TMDL did not include an estimate of the time required to correct the sediment- and temperature-impaired condition of the mainstem if the hillslope targets were met throughout the watershed.

Long-term improvement to the mainstem of Redwood Creek from reducing sediment from Lost Man Creek through road removal would be negligible because of the position of Lost Man Creek low in the watershed, especially if there are no erosion-inducing storm events. In the event of a major storm, there could be a greater improvement to the water quality of Redwood Creek from reduction of sediment that would otherwise be mobilized from Lost Man Creek. However, a major storm would cause erosion in unrestored areas elsewhere in the Redwood Creek basin and the contribution of Lost Man Creek to improved conditions in Redwood Creek would be negligible in comparison to the magnitude of adverse effects basinwide.

Conclusions—Both the proposed action (partial restoration) and the full restoration alternative would have long-term benefits to hydrology and water quality in Lost Man Creek from reducing erosion potential. Under either alternative, there would be direct short-term adverse effects on water quality in the first few rainy seasons following the project as the newly disturbed channels and hillslopes adjust and sediment washes downslope and downstream. The adverse effects on water quality would lessen as vegetation regrows and the soils stabilize. There would be an immediate benefit to hydrology following the project from restoration of natural drainage patterns, particularly in the 163 stream crossings under the proposed action or the 174 crossings under the full restoration alternative that are reopened over the four years of the project.

The effects on hydrology of Lost Man Creek from the proposed action would be beneficial, with the benefit judged to be moderate rather than major because there is only a 1-in-50 or 1-in-100 chance every year of a storm large enough to mobilize all 624,500 cy of sediment in the project area estimated to be subject to erosion (erosion potential). The 624,500 cy is the total erosion potential, which includes the sediment estimated for the full restoration alternative. The proposed action would prevent erosion of 574,700 cy but the additional 49,800 cy on the untreated roads would still constitute an erosional threat. This difference between the total erosion prevented under the proposed action and the full restoration alternative would not have major effects on hydrology because the difference between the erosion potential in streams between the proposed action and the full restoration alternative is 14,000 cy, or about 1300 cy per stream crossing.

Under the full restoration alternative, the benefits on hydrology would be slightly greater than under the proposed action because an additional 11 stream crossings would be reopened. The increased benefit under the full restoration alternative is not considered to reach the threshold for a major benefit to hydrology because of the small number of additional stream crossings that would be reopened and the 14,000 cy of additional erosion potential for these crossings.

Within each individual drainage channel where stream crossings are excavated under the proposed action, the effect of restoring the original drainage would be a major benefit over the long-term. However, the overall benefit within the project area would be moderate in the short-term because the original hydrology cannot be completely restored and 11.1 miles of roads would be only partially removed and therefore, subject to landsliding with eventual potential for delivery to streams. The full restoration alternative would have a greater long-term benefit to hydrology than the proposed action because about 4 more miles of roads would be removed altogether, and the landforms of 27 miles of roads would be completely restored, with resulting benefits to hydrological processes. Under the full restoration alternative, there would be major benefits to hydrology in individual stream channels that are reopened but the overall effect would be moderately beneficial in the project area because the original hydrology would continue to be altered by remaining skid roads.

The effects on water quality under both the proposed action and the full restoration alternative would be adverse in the short-term during the first few storms following restoration work, as the

newly excavated stream channels adjust. The short-term adverse effects would be minor, because mulching would prevent or reduce erosion of newly excavated soils adjacent to stream channels. The long-term effects on water quality under either the proposed action or the full restoration alternative would be moderately beneficial from reducing the threat of road failures that would deliver sediment to the streams. For individual stream channels, there could be major benefits if road failures are prevented, but the benefits are not likely to extend to all stream channels in the project area, and therefore, the overall benefit under either action alternative is a moderate, long-term benefit that would accrue when restoration is completed in the entire project area.

Effects on Floodplains

No Action— Under the no action alternative, stream channels would continue to aggrade (widen) and become shallower until all unstable sediment has moved downslope and washed out of the streams. This process is estimated to be on order of many decades to hundreds of years, based on observations of other intensively logged areas. The streams in the project area do not have well-developed floodplains, so the effect on floodplains under the no action alternative would be an indirect effect on the mainstem of Lost Man Creek downstream of the project area. The effect would vary from negligible to major, depending on the intensity and duration of storms and the amount of erosion that such storms cause.

Alternative 2: Partial Restoration (Proposed Action)—Stream segments that have floodplains that would be affected by the proposed action are the lower gradient reaches of Larry Damm Creek, the North Fork and mainstem of Lost Man Creek, Prairie Creek, and Redwood Creek downstream of the Prairie Creek. The primary function of the floodplain in the upper reaches of the Lost Man Creek watershed is to convey water in the stream channel but the floodplains are relatively steep-sided rather than being wide channels. Channel restoration at stream crossings would allow water to move in the stream channel rather than being diverted if culverts are undersized or if culverts or road fill fail.

The short-term effects on floodplains following restoration depend on the streamflow volume. At higher flows, a portion of the sediment load would be deposited up on the floodplain and removed from the active transport regime until the next flow high enough to remobilize it. This effect would continue until excavated areas are stabilized by vegetation. On other restoration areas, a dense growth of alders appears in four to ten years.

Under the proposed action, portions of the 11.1 miles of road that were only partially removed would continue to pose a risk of sediment entering a stream channels if road sections fail. However, failures along those 11.1 miles would not directly affect streams, the risk of failure is judged to be low, and therefore the potential risk to floodplains is low.

Channel excavation would restore floodplain function immediately. The benefits within individual stream channels would be negligible to moderate, depending on the size of the channel, the position of the channel in the drainage, and the degree of restoration in the original drainage area. The benefit to the more developed floodplain at the lower reaches of Lost Man Creek downstream of the immediate project area would be minor to moderate in the short-term. When all restoration is completed in the Lost Man Creek watershed, all channels readjust to the restored configuration, and the second-growth vegetation has reattained characteristics and functions more similar to those of the original old-growth forest, the long-term effect would be a moderate indirect benefit to the floodplain in the lower reaches of Lost Man Creek, provided there are no major hillslope failures from untreated roads or skid trails that would move new sediment into the stream channels.

Alternative 3: Full Restoration—There would be a greater benefit to floodplains under Alternative 3 than under the proposed action because 174 stream crossings and 27.4 miles of road would be removed and fully recontoured under Alternative 3 versus 163 crossings and 12.6 miles of roads under the proposed action. Under the proposed action, the 11.1 miles of road that would be partially removed would continue to pose a risk of sediment eventually reaching stream channels if road sections fail. However, the risk to floodplains under the proposed action is low because failures along those 11.1 miles would not directly affect streams and the risk of failure is judged to be low. Therefore, there is a negligible additional benefit to floodplains under the full restoration alternative.

Cumulative Effects—Restoration within the project area and from previous restoration work in the Lost Man Creek watershed between 1999 and 2004 would have negligible to minor short-term and minor to moderate long-term benefit to the floodplain in lower reaches of Lost Man Creek and to Prairie Creek. As restoration is completed within and outside the parks, and new logging roads upstream of the parks are constructed to standards in the state Forest Practice Act, there would be a long-term moderate benefits to the floodplain of Redwood Creek. Watershed restoration in Lost Man Creek would have a negligible benefit to the Redwood Creek floodplain, because Lost Man Creek and Prairie Creek enter the Redwood Creek floodplain at a point where the floodplain is confined by flood control levees.

Conclusions—Complete excavation of 163 stream channels under the proposed action and 174 stream crossings under the full restoration alternative would have short-term minor to moderate benefits to floodplains from restoring drainage within the stream channels. There would be a minor to moderate long-term benefit to the floodplain in the lower reaches of Lost Man Creek downstream of the project area under either the proposed action or the full restoration alternative from reducing the erosion potential by removing upstream roads. There would be only a slightly greater long-term benefit to floodplains under the full restoration alternative because the greater volume of material excavated under full restoration would not enter stream channels directly.

Effects on Riparian Wetlands

No Action—Without restoration, roads would continue to degrade and eventually fail, depositing sediment into stream channels. The stream channels would aggrade (widen) and become shallower as sediment is deposited in the stream channel. Riparian vegetation along the streambanks would be lost to bank erosion as stream flows reach areas that were above the average stream level in low gradient reaches. Higher gradient reaches have little or no riparian zone and there is less riparian vegetation that would be affected by aggradation. Vegetation along high-gradient stream reaches would be affected over the long-term by hillslope failures and landslides as road segments fail and the sediment reaches the stream.

In areas where water accumulates along aggraded streams, on roads where fill becomes saturated, behind blocked culverts, or in inboard ditches have accumulated sediments, wetlands may develop as indicated by the presence of wetland vegetation. These artificial wetlands function as breeding habitat for amphibians until the saturated fill is mobilized in large storms and eroded away.

Alternative 2: Partial Restoration (Proposed Action)—Restoration would remove small amounts of riparian or wetland vegetation that has regrown in aggraded channels, depressions in roads caused by fill failures, or in inboard ditches that have filled in with sediment. In the 163 stream channels that are excavated to original depth, there would be some recovery of riparian or wetland vegetation in those channels that have a low gradient and are not naturally well-drained. The estimated area of 100 square feet of potential wetlands associated with each stream crossing

would affect less than 0.4 acre of wetlands altogether, most of which were created because the drainage structures were too small for the flows or have plugged and do not function correctly.

There would be a minor to moderate long-term indirect benefit to riparian wetlands downstream of the project area along the low gradient reaches of Lost Man Creek from reducing the threat of sedimentation from mass wasting or landslides due to road failures in the project area.

Alternative 3: Full Restoration—The direct effects on riparian wetlands under the full restoration alternative would be similar to those under the proposed action but there would be additional benefits from fully excavating 174 stream crossings versus 163 under the proposed action and from full restoration of 27 miles of road versus 12 miles of full restoration under the proposed action. An additional 1100 square feet (0.025 acres) of riparian wetlands at stream crossings would be affected by excavation, which is a negligible benefit to wetlands. The full restoration alternative would have greater long-term indirect benefits to riparian wetlands because the risk of failure of untreated road segments would be reduced. However, the segments of roads that would not be treated under the proposed action do not pose a threat to streams or other aquatic habitat, and therefore, the additional benefit to riparian wetlands under the full restoration alternative is negligible in comparison to the proposed action.

Full restoration would remove a greater amount of riparian or wetland vegetation that has regrown in aggraded channels, depressions in roads caused by fill failures, or in inboard ditches that have filled in with sediment. The overall effect on riparian areas and other wetland types from restoration would be a short-term adverse effect but the effect would be negligible in comparison to the long-term benefits from restoring hydrological functioning and drainage patterns that contributed to the development of original riparian zones and wetland types.

Cumulative Effects—Riparian wetlands in the project area, and along Redwood Creek and some of the more heavily logged tributaries, have been destroyed or degraded by the original logging and road construction, and the effects of road failures. Riparian zones along the main stem of Lost Man Creek were not destroyed because the lower portion of the watershed was not logged, so that the riparian zone retained most natural functions and values. Second growth management proposed for the Lost Man Creek area would not be conducted in any stream corridors and would not affect riparian zones or isolated wetlands. The long-term effect on riparian wetlands in the project area from proposed management of second growth forests would be a minor to moderate indirect benefit, but the greatest benefit to riparian wetlands relies on the effectiveness of watershed restoration at preventing erosion that would lead to landslides that could bury riparian areas and vegetation with sediment.

Road removal and landform restoration drain the isolated wetlands that form behind blocked culverts, filled stream channels, ditches with no outflow, and slumps in road fills. These ponds and puddles serve as breeding habitat for some amphibians, which are adversely affected by loss of this habitat. The overall effect on the forest ecosystem is negligible because the wetlands are not an original component of the ecosystem and have very limited values. The adverse effect from loss of these wetlands is negligible compared to the potential adverse effects of loss of stream functions, including riparian wetlands, in the event of road and stream crossing failures.

Conclusions—There would be short-term adverse effects from excavating about 0.4 acre of riparian wetlands in isolated patches around culverts and stream crossings throughout the 5,800-acre project area under the proposed action, with a slight but negligible adverse effect from excavating riparian wetlands in the additional 11 stream crossings under the full restoration alternative. These effects are judged to be negligible because the wetlands around culverts and

stream crossings have formed through alteration of the original hydrology and drainage patterns by construction of the logging roads, inadequately sized culverts, and lack of maintenance to ensure adequate drainage. The values of the isolated wetlands are limited to amphibian habitat. Restoration of the original hydrology and reduction of the sediment threat to the streams would be a greater benefit to the animal populations and communities in the project area than the loss of isolated wetlands. There would be direct long-term minor benefits to riparian wetlands along restored stream channels and indirect long-term minor benefits to riparian wetlands along the mainstem of Lost Man Creek downstream of the project area. There is a negligible difference between the proposed action and the full restoration alternative in both beneficial and adverse effects on riparian wetlands because of the negligible difference in the acreage of riparian wetlands affected by restoration under either alternative.

Effects on Vegetation

No Action—Under the no action alternative, the original seed bank in the topsoil would remain buried beneath roadfill. The recovery of vegetation to pre-logging density and species composition would occasionally be set back as unstabilized fill along roads fails, causing landslides and other mass wasting processes that create bare ground with little topsoil. Some vegetation would be damaged or killed by road-related erosion and fill failures. Alders would colonize road fills and newly exposed ground, but landslides would bury and smother some alders and newly exposed soils would lose the vegetation cover that reduces erosion from raindrops. In the absence of recovery and repositioning of top soil, vegetation would continue to regrow on the original clearcuts and roads but the resulting species composition would favor Douglas-fir at densities and sizes not comparable to the original redwood forest. Brushing along 14.7 miles of access roads that would be maintained for administrative and recreational access (Geneva, Holter Ridge, B-Line North, A121, A170) would affect up to 3 feet on either side of the road for a total of 9 acres of vegetation. This vegetation is common along roads in the parks and the region and is routinely cut for road maintenance. The bear-grass clumps along the Holter Ridge road are important cultural resources that would be protected from disturbance.

Alternative 2: Partial Restoration (Proposed Action)—Vegetation would be removed on an estimated 216 acres for removal of roads and stream crossings. The bear-grass clumps along the Holter Ridge road are important cultural resources that would be protected from disturbance. Road maintenance along the major roads that would be retained for administrative and recreational access would affect about 9 acres of roadside vegetation that is routinely cut to maintain safe access.

Prior to excavation in treatment areas along roads, vegetation that has become established on road fills after logging ceased would be cut or grubbed and stockpiled to be spread on finished slopes following excavation as mulch to reduce surface erosion. Organic matter and nutrients in the vegetation would be recycled into the soil as the material decomposes. Use of on-site vegetation rather than imported mulch reduces the potential for introducing exotic plant species.

All vegetation that would be removed under the proposed action is vegetation that has regrown on cutslopes, fillslopes, or road fill after the original vegetation was cut for road construction or logged. This vegetation is small alders and Douglas-fir, shrubs, forbs, and grasses. The alders, shrubs, forbs, and grasses are common in the parks and are regularly cut for maintenance of the road corridors. No large mature or old growth trees would be removed. The majority of trees that would be cut are red alder or Douglas-fir less than 24 inches dbh, all of which have regrown after logging. Trees greater than 18" dbh would be removed only if necessary to achieve rehabilitation objectives.

The buried topsoil that contains the seed bank, nutrients, and organic matter important for reestablishment of original vegetation would be recovered and repositioned on the restored slopes.

Mulching is more effective than replanting for initial erosion control because vegetation would not be planted until late into the growing season and would not grow fast enough to provide the initial erosion control needed over the first winter rainy season. The small pieces of woody debris used as mulch break down relatively quickly and add organic components to the soil, particularly after being in place through the rainy season. Local mulch does not introduce exotic plants and supports a native fungal community favorable to reestablishment of trees. Shredded redwood bark from local mills would be used for mulch where not there is not enough woody debris to provide sufficient cover or where woody debris is not in contact with ground surface.

The woody debris placed on areas adjacent to streams reduces surface erosion and provides habitat for seedlings, fungi, microorganisms, insects, amphibians, and small mammals. Larger pieces of mulch provide immediate shelter for small animals, preserve moisture for pioneer plant species, and provide shade for small animals during the next summer. The local mulch enhances the recovery of the forest ecosystem components on the former road corridor by using local materials adapted to the specific conditions on the restoration site.

There would be direct benefits to vegetation from uncovering topsoil and moving it back to more or less its original location. There would be a long-term indirect benefit to vegetation from accelerating soil formation processes by uncovering the original topsoil that contains organic material and nutrients. There would be an indirect minor to moderate benefit to vegetation from reducing the potential for mass movement and landslide processes that set back vegetation succession and bury some vegetation under the slide.

Alternative 3: Full restoration—The effects on vegetation under the full restoration alternative are similar to the effects under the Proposed Action but an additional 75 acres would be affected because there would be full restoration of 27.4 miles versus 12.6 miles fully restored under the proposed action with partial restoration of 11.1 miles. Under the full restoration alternative, skid roads used to access and excavate sites with erosion potential would be fully recontoured to the maximum extent reasonably and safely feasible. Skid roads that are not used for access to other work sites would not be treated and existing vegetation assemblages would continue to grow, with the exposed subsoil tending to favor Douglas-fir over other tree species.

Both the total area of topsoil re-exposed and the restoration disturbance area would be greater under the full restoration alternative than under the proposed action (75 acres more under the full restoration alternative than for the proposed action).

Cumulative Effects—Only one restoration project at a time is conducted in the parks, so there would not be cumulative effects on vegetation outside the Lost Man Creek watershed from removing vegetation along other roads slated for removal. Restoration on about 1700 acres of second growth forests (thinning dense Douglas-fir and tan oak) in the Lost Man Creek drainage is proposed, with some forest restoration planned prior to road removal so that there would be access for second growth management. Second growth management would not occur in streams or in buffers and would not happen in same areas where soils and vegetation would be disturbed by watershed restoration. Outside the watershed and forest restoration project areas, logged areas of the parks would continue to recover although the recovery in some dense second growth stands that were not thinned after replanting would require centuries to reattain characteristics and functions associated with old growth forest. Fire in the project area would be managed with a full

suppression strategy, which will require preparation of several ridgetop roads to ensure access for fire engines and crews. Fire road preparation includes brushing, culvert and ditch cleaning, and grading.

Conclusions—There would be adverse effects on vegetation from removal of vegetation on 216 acres on and along roads under the proposed action and on 291 acres under the full restoration alternative. This would be a negligible to minor effect under either alternative, because the vegetation to be removed has grown back following logging and road construction destroyed the original vegetation assemblage, is common in the parks, and would be routinely cut for road maintenance. The vegetation that is removed would be used for mulch which would promote the regrowth of native species and reduce the potential for importing non-native plants. This would be a short-term minor benefit to vegetation under either alternative. There would be an indirect long-term benefit to vegetation from enhancing soil formation processes by recovering and repositioning buried topsoil, and a direct minor long-term benefit to vegetation from recovering the original seedbank in the topsoil. The overall effect on vegetation under either the proposed action or the full restoration alternative would be an adverse effect from removal of vegetation (short-term for annual plants and shrubs but longer-term for long-lived trees) but that effect would be negligible to minor because the original vegetation was already cleared for road construction and logged in the adjacent areas.

Effects on Wildlife

No Action—The effects on terrestrial wildlife from clearcut logging in what is now the park were localized on individual animals but widespread throughout timber harvest areas, and were generally adverse from loss of vegetation used for shelter and food over the short-term. Small, more sedentary animals were more affected than more mobile animals such as birds and medium to large mammals because these animals could move out of an area when logging occurred. As forests regrew, some species such as deer, elk, and bear benefited from new browse. Populations of bear and elk probably increased as logged forests regrew because of the increased availability of some types of food such as cambium layers on young redwoods favored by bears and shrubs for elk browse. Overall effects on populations of terrestrial wildlife in the project area were negligible to major depending on the degree of mobility and whether a species favored old growth habitats or could survive in logged areas. Effects on animals that are considered to be old growth specialists are covered under the threatened and endangered species section, because widespread loss of old growth habitat reduced populations as habitat was lost to logging and development throughout the range of temperate coniferous forests. Adverse effects on aquatic species following logging were more substantial than on terrestrial species because of major sediment deposition into streams and widespread loss of forest cover that caused higher stream temperatures. The overall initial effect on aquatic species was adverse, localized on individual animals but widespread over timber harvest areas, and moderate to major, with aquatic species populations in smaller streams subject to more damage because the entire stream was damaged.

Under the no action alternative, there would be negligible short-term effects on terrestrial wildlife because there would be no disturbance from equipment and no removal of vegetation along about 32 miles of roads. The no action alternative would adversely affect aquatic species in the short-term if major storms cause widespread road failures. The long-term adverse effects on terrestrial wildlife under the no action alternative would result from eventual failure of untreated stream crossings and road segments that would cause landslides resulting in loss of vegetation and from sedimentation of streams. Long-term adverse effects on aquatic species such as tailed frogs or salamanders downstream from failures of untreated roads and stream crossings would be minor to moderate from sediment that enters streams, and because water temperatures would be higher as

streams become shallower from mass wasting due to landslides and loss of vegetation that provides shade.

The long-term adverse effects under the no action alternative are expected to range from negligible for larger, more mobile species such as deer and bear that range over larger areas that would be affected by landslides related to road failures to moderate for populations of small aquatic animals that live in streams where sediment would be delivered.

Alternative 2: Partial Restoration (Proposed Action)—Effects on larger or more mobile terrestrial animals would result from noise and disturbance during heavy equipment work. These effects would be adverse, localized, and short-term for the duration of the work although there would be no noise and disturbance during nighttime when no equipment was working or where daily limited operating periods were in effect to protect marbled murrelets. Following restoration, populations of terrestrial wildlife would initially be low in the newly disturbed areas but would increase as vegetation regrows. Aquatic species, primarily macroinvertebrates in the streams, would initially be affected by increased sediment during storms the first season following the restoration work but would increase due to the increase of stream habitat.

The woody debris placed on areas adjacent to streams provides habitat for seedlings, fungi, microorganisms, insects, amphibians, and small mammals. Larger pieces of mulch provide immediate shelter for small animals and shade for small animals during the next summer. These short-term direct benefits mitigate the loss of habitat from vegetation removal.

Loss of about 216 acres of vegetation in fully and partially removed roads would be a minor adverse effect on mobile terrestrial wildlife species that are capable of moving to nearby areas that are not disturbed by restoration work. Soil disturbance and removal of 216 acres of vegetation is a direct short-term adverse effect for smaller animals that cannot move out of newly disturbed areas that would have no shrub or tree cover. The short-term adverse effect persists for several years until shrubs and alder regrow to serve as habitat.

There would be short-term adverse effects on aquatic wildlife as sediment is mobilized after rain events in the first few seasons following restoration. Aquatic wildlife species would benefit over the long-term because there would be more habitat after stream channels are excavated, once the channels have adjusted. The short-term adverse effect on aquatic wildlife would be negligible in comparison to the major effects of the original logging and road-building and subsequent road failures. The long-term benefit to aquatic wildlife would be minor to moderate from restoration of hydrological functions in excavated stream channels and reduced risk of road failure.

Alternative 3: Full restoration—Under the full restoration alternative, removal and complete landform restoration of 27.4 miles of road would affect up to 291 acres of vegetation. Effects on terrestrial wildlife under a full restoration alternative are similar to those described under the proposed action but more individual animals would be affected because an additional 75 acres of vegetation that serves a wildlife habitat would be removed along an additional 14 miles of road.

There would be slightly greater short-term adverse effects on aquatic wildlife under the full restoration alternative action as sediment is mobilized after rain events in the first few seasons following restoration, because an additional 11 stream channels would be excavated under the full restoration alternative compared to the proposed action, and a corresponding benefit over the long-term.

Cumulative Effects—The logging that occurred in the project area prior to park establishment and expansion had significant adverse effects on certain terrestrial and aquatic species of wildlife. Small terrestrial species that are less mobile were directly affected by logging. More mobile wildlife species were indirectly affected by widespread loss of forest habitat and damage to streams. Aquatic species were directly affected where stream channels were blocked with Humboldt crossings and indirectly affected by loss of shade when the forest canopy was removed and by sedimentation of streams from landslides and erosion from bare slopes. The adverse effects of sedimentation continued after forest vegetation regrew. Several species that suffered major population declines from loss of forest habitat due to logging throughout their range were listed as threatened under the federal or California endangered species acts.

Conclusions—There would be temporary direct adverse effects on terrestrial wildlife from noise and disturbance associated with heavy equipment work in the project areas under both the proposed action and the full restoration alternative. There would be short-term indirect adverse effects primarily on smaller and less mobile wildlife species over about 216 acres from soil disturbance and removal of vegetation in restoration areas under the proposed action, and similar effects under the full restoration alternative from removal of 291 acres of vegetation that is wildlife habitat. There would be direct adverse effects on amphibians from draining small isolated wetlands that formed behind blocked culverts and ditches and in slumps along road fill failures under both action alternatives, with only a slightly adverse greater effect under the full restoration alternative because only an additional 1100 square feet of riparian wetland would be affected by stream channel excavation. These adverse effects on amphibians would be negligible to minor in the long-term and would be outweighed by the long-term benefit from restoring original drainage patterns and riparian areas along restored stream channels, and the long-term benefits from reducing the risk of catastrophic failure of roads that could bury riparian areas and streams. The effects on individual animals that are displaced or destroyed by soil disturbance and removal of vegetation are significant and permanent, but the overall adverse effect on wildlife populations in the project area would be short-term and negligible. The long-term effects on terrestrial wildlife in the project area would be a minor indirect benefit from reducing the risk of erosion-related landslides that destroy habitat and a negligible benefit from restoration of vegetation on road fills. There would be a minor to moderate indirect benefit to aquatic animals from restoration of stream channels and riparian zones. The full restoration alternative would have slightly greater short-term adverse effects on aquatic wildlife than the proposed action from excavation of an additional 11 stream crossings, and slightly greater benefits to aquatic wildlife over the long-term once the stream channels readjust. The difference between the proposed action and the full restoration alternative for both short-term adverse effects and long-term benefits to aquatic wildlife is negligible compared to the total number of stream crossings restored. The slightly greater long-term benefit to aquatic wildlife under the full restoration alternative is outweighed by the adverse effects on listed threatened bird species from removal of an additional 75 acres of habitat. In addition, the increased cost of a full restoration alternative would reduce the overall acreage of restoration that could be accomplished elsewhere in the parks, which would increase risk to other park resources.

Effects on Threatened Wildlife

Two sensitive terrestrial species would be affected by watershed restoration in Lost Man Creek, northern spotted owls and marbled murrelets. The impact analysis is based on the biological assessment prepared by the NPS (NPS 2006a) and the resulting biological opinion and letter of concurrence issued by the USFWS for effects on northern spotted owls and marbled murrelets (USFWS AFWO file number 8-14-2006-2836, dated May 30, 2006).

Pacific fishers are a candidate species for listing under the federal Endangered Species Act. These forest-dwelling carnivores would be affected by some of the watershed restoration activities and would experience similar benefits and adverse effects as marbled murrelets and spotted owls. Adverse effects on fishers would be mitigated through the same mitigation measures that would be implemented to protect murrelets and owls.

Methodology—Because of the difficulty of determining the nesting status of marbled murrelets, forest stands are surveyed to determine whether murrelets occur in these areas, and the presence of murrelets is used to indicate nesting status. The quality and amount of residual habitat within an area is quantified using geographic information system (GIS) computer models. Similar GIS models were also used to quantify and predict effects on northern spotted owls. This residual habitat GIS model was used to quantify the amount of potentially suitable habitat within the project area, quantify degraded habitat, and determine where to conduct surveys for owls and murrelets. The survey results and habitat data are combined to quantify and analyze impacts on marbled murrelets and owls from noise, disturbance, and vegetation removal.

GIS modeling was done only for the proposed action. Effects under the full restoration alternative are estimated in proportion to the increased acreage of vegetation that would be affected under the full restoration (291 acres) compared to 216 acres under the proposed action, or an additional 25% ($216 \text{ ac}/291 \text{ ac} \approx 75\%$)

To document as accurately as possible the effects on residual habitat in the project area, all old growth and mature trees in the Lost Man Creek watershed and throughout other areas of the park were mapped using air photo interpretation, digitized, and scanned into a GIS database. Given that the numbers and locations of trees vary across the landscape, residual old growth trees were buffered using a standard approach to avoid the subjectivity inherent in case by case habitat suitability assessments. For example, if there was one old growth tree per acre that lacked mature residuals around it, a 0.1 acre buffer was centered on that tree. Where higher densities of old growth trees per acre occurred, or a low density of old growth surrounded by a high density of mature trees, each old growth tree was buffered with 0.5 acre. These larger buffers in many cases overlap creating “lands” of residual habitat.

Effects on marbled murrelets from habitat modification were determined through computer-generated estimates of the acreage of habitat affected by project work. When a ground disturbance polygon intersected a residual habitat polygon (“buffer”) it was assumed that the residual habitat would be adversely impacted even though no old growth trees would be removed by project activities. This is a general assumption because the quality, e.g. bole and crown height, tree density, of both the old growth and mature residual habitat is not precisely known. Thus, acres of habitat affected include either individual old growth residual trees or old growth trees plus associated mature second growth. Only that portion of the road disturbance polygon that contained or was likely to impact residual habitat was included in the effects analysis, while the remaining portion of the disturbance polygon in second growth was categorized as unsuitable. In areas with dense (e.g. higher quality) clusters of residual old growth intersecting a ground disturbance polygon, the area of potentially affected habitat was expanded to include the contiguous residuals to avoid underestimating the area that could be negatively affected by restoration activity.

Based on the best available information and given the type of actions that are proposed, the disturbance polygon of the rehabilitated site plus a 50-meter-wide buffer adjacent to the edge of the disturbance polygon (“one of increased predation threat”) was used as the potential area that could attract an increased number of corvids, particularly Steller’s jays, thus increasing the

potential for predation on murrelet eggs or chicks to occur. As was done in the habitat degradation analysis, only the residual habitat falling within the ground disturbance polygon and surrounding 50-meter-wide buffer was included in the calculation of effects.

No Action—Under the no action alternative, there would be no adverse effects on marbled murrelets, northern spotted owls, or Pacific fishers from noise and disturbance. Long-term indirect adverse effects on marbled murrelets from degraded habitat quality would continue for centuries until logged forests reattain characteristics of suitable for murrelet nesting. Retaining abandoned logging roads without restoration in the Lost Man Creek watershed would have a minor to moderate adverse effect on murrelets from the potential loss of old growth trees that could topple due to slope failures along untreated roads. Murrelet populations would continue to decline from lack of high quality nesting habitat in sufficient quantity to support population recovery throughout the range of the species. The Lost Man Creek area is considered to be important for the long-term survival of the species, so that loss of the Lost Man Creek populations would contribute to the decline of murrelet populations over the range of the species in California. Adverse effects on northern spotted owls and Pacific fishers from past loss of habitat would continue but the effects on owls and fishers would be negligible in the project area compared to effects on murrelets which are more dependent on old growth habitat for successful nesting than the other two species.

Alternative 2: Partial Restoration (Proposed Action)— This project would have negligible to minor adverse effects on spotted owls through loss or modification of suitable habitat. Suitable habitat within the project area includes old growth, second growth 40 years old or older, and moderate to high density old growth residuals regardless of the age of the second growth understory. Approximately 118 acres (1.3%) of the total suitable owl habitat in the project area would be removed by road rehabilitation activities in the home ranges of the three known owl territories that overlap the action area. An additional 82 acres of suitable owl habitat would be removed outside the known home ranges.

The acres of suitable habitat within the ground disturbance polygons (affected habitat patch size) range from 0.01 acres to 15.0 acres, with average patch size ranging from 2 acres in the Lost Man Creek territory to almost 3 acres in the Little Lost Man Creek territory. In addition to the acres affected in each of the known territories, approximately 82.0 acres of potentially suitable nesting and roosting habitat outside of known territories, but within the action area, would potentially be impacted by restoration activities. Taken together, the total acres of potentially suitable nesting and roosting habitat that could be impacted by project activities is 199.4 acres (4.8%) of the potentially suitable nesting and roosting habitat in the action area. Because the affected habitat acres outside of known territories are dispersed throughout the remainder of the action area in small patches similar to those in the known territories, loss of this additional suitable habitat is not expected to adversely impact spotted owls that may establish a territory in a new location within the Lost Man Creek watershed in the future.

Because no spotted owls have been detected to date within those portions of the action area that have been surveyed, and surveys would be conducted prior to project activities taking place, the likelihood of direct injury from removal of vegetation along roads that would be removed is negligible. If spotted owls are detected in stands with roads proposed for removal, seasonal restrictions would be put in place between February 1 and September 15 if nesting occurs, or in occupied stands where reproductive status could not be determined, to ensure protection of vulnerable juveniles as well as nesting adults. Should surveys indicate that spotted owls are located in any portion of the project area and their reproductive status confirmed as nesting,

appropriate seasonal restrictions, e.g. no noise disturbance prior to July 10, would be put in place to protect nesting and fledgling spotted owls.

The likelihood of direct injury of nesting adult marbled murrelets or chicks by project activities is negligible. Surveys have been or would be completed prior to project activities taking place. In areas with occupied behaviors or other high levels of murrelet activity seasonal restrictions would be required through September 15 to protect nesting birds and chicks.

This project could affect the marbled murrelet due to noise disturbance from heavy equipment operating during the breeding season. Adverse effects on marbled murrelets from noise-generating activities would be generally avoided by scheduling project activities in locations where murrelets would not be affected, outside the seasonal restriction periods, or under daily limited operating period (DLOP). No trees with the potential to provide a nesting opportunity would be removed by project activities.

In areas where heavy equipment would be operating during the breeding season in or within 0.25 miles of sites with murrelet presence, noise disturbance would be reduced by implementing a DLOP where the use of power tools and heavy equipment would be restricted to the time period from two hours after sunrise to two hours before sunset. Heavy equipment would be permitted access through old growth forest and residual old growth to road removal sites between June 15 (the earliest possible start-up date for project implementation) and September 15 during the DLOP.

Of the 27.9 miles of haul roads, skid roads, and stream crossings scheduled for removal, 7.3 miles of roads in or within 0.25 miles of suitable murrelet habitat would be removed after September 15. Work on access roads that require upgrading would be restricted until after September 15 in or within 0.25 miles of old growth. There are 1,282 acres of occupied or potentially occupied marbled murrelet habitat (including old growth and residual old growth) within 0.25 miles of these sites. Before September 15, 0.3 miles of road within 0.25 miles of occupied suitable murrelet habitat would be removed resulting in two acres of potentially occupied habitat that would be subjected to noise disturbance during the breeding season. Also before September 15, work would begin on the remaining 20.3 miles of road that are greater than 0.25 miles distant from suitable habitat, or where surveys have indicated murrelets are not occupying the adjacent habitat. Using the GIS models, 254 acres of potentially suitable residual habitat are calculated to occur within 0.25 miles of these roads with earlier start dates. The 254-acre figure exceeds the total amount of residual habitat acres in the action area due to some of the same acres being impacted in multiple years.

Restrictions on heavy equipment work to limit noise disturbance would be imposed on all noise-generating activities within 0.25 miles of the large block of old growth (old growth buffer) and within 0.25 miles of all murrelet survey stations where occupied behaviors were recorded during surveys with two exceptions. The A120 road is located almost entirely within unsuitable marbled murrelet habitat, with minimal amounts of residual old growth within 0.25 mi. However, at the end of the A120 road where work would need to begin during the breeding season in 2007, approximately 0.2 miles occurs within the occupied site buffer with one acre of residual habitat within 0.25 miles of this road segment. Work would also need to begin on the far end of the A300 road during the breeding season in 2009, along approximately 0.1 miles of road that is within 0.25 miles of 1.0 acres of residual habitat. Therefore, any murrelets nesting in these two acres of residual habitat would be negatively affected by noise disturbance.

There are 125 acres of residual habitat outside of old growth and/or occupied murrelet buffers that have been surveyed or would be surveyed (or resurveyed) prior to road treatment. Given the slight chance that murrelets could occur in suitable habitat in subsequent years within 0.25 miles of these roads, there is a potential for disturbance to any murrelets nesting within these 125 acres of residual old growth habitat. Work on roads that are within 0.25 miles of survey stations where murrelet occupancy is noted by future surveys would not be allowed until after September 15. Work on roads that are within 0.25 miles of survey stations where murrelet presence was noted (or is noted by future surveys) would be limited daily to the hours between two hours after sunrise and two hours before sunset. Due to the limited number of presence detections and the nature of the detections (high fly-overs), allowing work within the DLOP is not expected to result in an adverse impact. Work on roads that are within 0.25 miles of stations without any murrelet detections would not affect murrelets and would not be subject to any limited operating period.

If a specific road scheduled for treatment is subject to seasonal restrictions or a DLOP, these restrictions would also be applied to heavy equipment access to that site due to the increase in noise volume and relatively slow speed of heavy equipment access to a work site. There would be no noise restrictions on heavy equipment or passenger vehicles along the main access routes, with the exception of the portion of Geneva Road through contiguous old growth, because these roads are subject to a moderate amount of vehicular traffic on these roads throughout the year. Murrelets nesting within 0.25 miles of these roads are expected to be habituated to vehicle traffic noise. A two-hour DLOP would be imposed during the breeding season along the portion of Geneva Road through contiguous old growth. Seasonal restrictions and DLOPs would reduce noise disturbance, resulting in negligible adverse effects on murrelets from vehicle and heavy equipment access to work sites.

Preliminary mapping of the area of potential ground disturbance associated with haul road, landing, skid road, and stream crossing removal has indicated that residual old growth habitat would be negatively affected by vegetation removed. Although the project area does not contain designated critical habitat for marbled murrelets, the proposed action is likely to cause the modification of 22.6 acres of habitat that meets the definition of marbled murrelet critical habitat primary constituent elements, with 15.9 acres within 0.25 miles of occupied sites, sites with murrelet presence, or roads in unsurveyed areas. No old growth trees would be removed but potential nesting platforms in old growth trees are likely to be exposed to increased threat of corvid predation due to removal of protective second growth canopy in or adjacent to residual old growth, and these trees rendered unsuitable for nesting until the understory canopy re-develops beneath the residual old growth trees. Some trees growing in the road fill that would be removed have developed height and crown conditions that provide cover to limbs of residual old growth and contribute to the canopy closure of the residual ~~lands~~ ^{—edges}.

The proposed action is likely to have indirect adverse effects on nesting marbled murrelets by creating corvid flight corridors and access to murrelet nest platforms when protective canopy around residual old growth trees is eliminated. Project activities also could indirectly influence corvid behavior and activity when openings are created that cause food-producing shrubs or trees to become established in the vicinity of residual old growth, effectively creating ~~—edge~~ ^{—edge} effects similar to those described in the corvid/nest predation literature. A number of studies in Oregon and Washington (cited in McShane et al. 2004) found Steller's jays to be most abundant along forest edges bordered by early seral vegetation with berry-producing shrubs. Other studies indicate that the type of edge plays a role in predation rates; rates were lower near feathered edges or natural edges compared to abrupt or suburban edges (McShane et al. 2004). Nelson and Hamer (1995) found that successful murrelet nests were a mean of 545 ft and a minimum of 180

ft away from a forest edge, defined in their study as “natural openings, including...roads and clearcuts”. All nests that failed because of predation were located within 210 ft of an edge.

The original logging of the project area resulted in habitat containing all attributes of high quality Steller’s jay habitat, e.g. logged areas with individual legacy trees and patches of such trees, and forest openings created by roads and landings. Point count data indicate that Steller’s jays are fairly ubiquitous throughout the project area. However, in the 30-50 years since the area was last logged, conifers have regrown along many of the roads and landings, filling in gaps in the canopy, and shading out understory vegetation that can be primary food sources for Steller’s jays. Re-opening these areas by removing trees from the fill slopes would undoubtedly re-create an edge that could attract Steller’s jays, as well as allow for high numbers of jays to persist in the project area, perhaps for a longer period than if vegetation was not removed for road restoration.

The proposed action would result in additional edge habitat being created along either side of 27.9 miles of roads, landings, skid roads, and stream crossings slated for removal. A total of 96.5 acres of residual habitat could be affected by increased corvid activity following removal of vegetation and ground disturbance in project areas. Of that total, 30 acres are in contiguous old growth and 55.9 acres occur within 0.25 miles of occupied sites, sites with presence, or roads in unsurveyed areas.

This project may affect and is likely to adversely affect marbled murrelets in occupied or potentially occupied nesting habitat due to degradation of 24 acres of suitable nesting habitat due to habitat modification; harassment on 2 acres of suitable habitat from heavy equipment operation during the breeding season; and harm from degradation of habitat due to the increased risk of corvid predation on 73 acres.

The project would not remove suitable marbled murrelet nesting habitat. Degradation of 24 acres of suitable nesting habitat would not result in a net reduction of suitable habitat but would result in a relatively short-term delay in the development of high quality of nesting habitat as the logged forest recovers. The harassment on 2 acres due to heavy equipment operation would be a short-term one-time disturbance that is not expected to influence future reproduction. The 73 acres that would be degraded due to increased predation risk would not result in a net reduction of suitable habitat but would result in a relatively short-term increase in predation risk that is not expected to have a long-term influence on murrelet numbers and reproduction.

This project may cause disturbance to fishers using the project area for rest sites. Fishers may be affected by road rehabilitation if they are denning or resting in structures near areas where project activities are taking place. Fishers are known to avoid areas of loud noise and would most likely leave the area to avoid contact with humans. Due to the timing of the proposed action, late in the fisher breeding season when kits would be mobile and traveling among den sites, it is unlikely that females with kits would be adversely impacted by project activities.

Alternative 3: Full Restoration—There would be greater short-term adverse effects on northern spotted owls and marbled murrelets under the full restoration alternative because more habitat would be affected for removal of 5 additional miles of road, more intensive work along the additional 14 miles that would be fully restored under Alternative 3 but only partially restored under the proposed action, and because there would be more time required to complete heavy equipment operations. The long-term benefit to spotted owls and marbled murrelets under full restoration would not differ substantially from the benefits under the proposed action because the habitat would eventually become more suitable even with partial restoration. This benefit from either the proposed action or full restoration would be on the order of decades to centuries. There

could be an adverse effect on listed birds in the event of a catastrophic road failure of an untreated segment under the proposed action that would not occur under the full restoration alternative but the overall effect on threatened birds under the proposed action and the full restoration alternative would be similar.

Cumulative Effects on Threatened Birds—The action area borders private industrial timber land on its eastern edge along Holter Ridge. Timber harvest has occurred in the recent years on this private land and is likely to continue in the future. Spotted owls and/or marbled murrelets that nest in habitat in the Lost Man Creek watershed near Holter Ridge Road would continue to be subject to increased noise disturbance from heavy equipment being operated on private lands, from helicopter logging that has occurred on private lands near the ridge top in the past few years, or from increased predation threat.

Cumulative effects on northern spotted owls would result from continued loss of suitable habitat and from increasing competition with barred owls, which are expanding their range and are considered to constitute the most imminent threat to the recovery and continued survival of northern spotted owl populations.

The total allowable incidental take authorized by the USFWS for marbled murrelets for all park projects for consultations completed by December 2005 (other than the current Lost Man Creek watershed restoration project) is 5,671 acres of habitat potentially affected by noise disturbance. The NPS reported potential incidental take of 3,687 acres (64% of total allowed) in 2005. Projects for which take of murrelets due to noise disturbance was reported in 2005 were annual maintenance of facilities, roads and trails (2,110 acres in six locations under authorization originally obtained in 1998); Skunk Cabbage Trail use (59 acres under 1998 authorization); and Howland Hill Road repair (1,577 acres under 1999 authorization). Projects for which take was authorized but not reported in 2005 because no actions were taken under these authorizations are two watershed restoration projects (take originally authorized in 1998 and 2001); helicopter use for emergency access (2001 authorization); and culvert replacement on the Mill Creek and Lost Man Creek trails (2005 authorization).

The total allowable incidental take for northern spotted owls authorized by the USFWS for all park projects under consultations completed by December 2005 (other than the current Lost Man Creek watershed restoration project) is 5,167 acres of habitat potentially affected by noise disturbance. The NPS reported potential incidental take of northern spotted owls on 775 acres (15% of total allowed) in 2005. All reported take of spotted owls in 2005 was due to noise disturbance for annual maintenance of facilities, roads and trails due to downed tree removal and brushing trails. Other sites and projects for which incidental take of marbled murrelets was reported either do not affect northern spotted owls (helicopter use, Lost Man Creek watershed restoration under the 2001 authorization) or surveys were completed to determine that no owls would be affected in these areas.

On-going projects for which consultations with the USFWS have been completed and which have been determined that the projects may affect but are not likely to adversely affect northern spotted owls or marbled murrelets are management of exotic plants throughout RNSP, fire management throughout the parks, management of Port-Orford-cedar in the northern part of the parks, and vehicle beach access (although beach access does have adverse effects on western snowy plovers and the NPS has been authorized direct take of one plover annually.)

Projects for which consultations with the USFWS have been completed but the project has not been implemented include rehabilitation of Alder Camp Road in Del Norte County, and

development of visitor facilities at Freshwater Lagoon Spit. The USFWS has concurred with the NPS determination that these projects may affect but are not likely to adversely affect northern spotted owls or marbled murrelets.

Proposed projects for which consultations are underway and for which incidental take is expected to be requested in 2006 or 2007 but the amount of take has not been determined include construction, use and maintenance of trails and backcountry facilities; tree-clearing from 2005-6 winter storms; and management of second growth forests in the South Fork of Lost Man Creek. Of these projects, trail and backcountry facilities are expected to substantially increase the take of marbled murrelets by thousands of acres due to potential take from increased corvid predation threat along existing and proposed trails, noise disturbance from trail construction, with minor acreage from habitat degradation.

Conclusions—The NPS biological assessment submitted to USFWS in March 2006 described the project and the potential effects of the project on northern spotted owls and marbled murrelets. The USFWS issued Biological Opinion (USFWS AFWO file number 8-14-2006-2836, dated May 30, 2006) and a letter of concurrence with the NPS determination that the project may affect but is not likely to adversely affect northern spotted owls and that the project may cause disturbance to Pacific fishers using the project area for den sites. No incidental take of northern spotted owls is anticipated and none has been authorized by the USFWS. The overall effect on northern spotted owls would be a negligible short-term adverse effect with a negligible to minor benefit related to regrowth of vegetation on restored slopes. The benefit from regrowth of forest vegetation would be on the order of several decades.

The NPS requested, and the USFWS authorized, incidental take of marbled murrelets expected from harassment of nesting birds due to operation of heavy equipment in 2 acres of occupied nesting habitat during the breeding season; harm of murrelets due with an increased risk of corvid predation on 66 acres of nesting habitat; and harm of murrelets associated with 7 acres of nesting habitat due to habitat degradation. The USFWS biological opinion concluded that the level of anticipated take from this project is not likely to result in jeopardy to the marbled murrelet, or destruction or adverse modification of critical habitat for the marbled murrelet.

The USFWS does not require formal consultation under Section 7 of the Endangered Species Act on alternatives that are not the proposed action. The project was developed in consultation with the USFWS to minimize adverse effects on marbled murrelets by reducing the amount of vegetation that would be removed. Assuming that the effects on marbled murrelets under the full restoration alternative would be directly proportional to the acreage of vegetation affected, the amount of incidental take of marbled murrelets under the full restoration alternative would be at least 25% greater than under the proposed action. The NPS did not request that the USFWS analyze this hypothetical increase in incidental take to determine whether it would jeopardize the continued existence of the marbled murrelet. Because the incidental take under the proposed action is associated with noise disturbance and increased threat of predation and not direct take, it is assumed that the full restoration alternative would not jeopardize the continued existence of marbled murrelets. Similarly, it is assumed that the effects on northern spotted owls and Pacific fishers under the full restoration alternative are proportional to the 25% increase in vegetation affected under full restoration, and that the project may affect but is not likely to adversely affect northern spotted owls and that there would be a slight increase in disturbance to Pacific fishers that might use the project area for den sites.

Effects on Threatened Fish Species

No Action—Under the no action alternative, there would be no direct short-term adverse effects on listed fish species from minor erosion of sediment from excavation for watershed restoration activities. Routine road maintenance would have negligible adverse effects from brushing and grading. Short-term adverse effects from increased erosion at stream crossings for replacement of culverts along main haul roads would be reduced by implementation of best management practices described in the NPS biological assessment for Annual and Periodic Road Maintenance, and the resulting biological opinion and letter of concurrence issued by NMFS in 2003 (file number 151422SWR02AR6347) with the 2006 addendum. There would continue to be long-term adverse effects on fish as untreated roads and stream crossings fail and sediment erodes into streams. These adverse effects would range from minor to moderate for the tributaries of Lost Man Creek, depending on the volume of sediment released into streams at road crossings on intervening segments and the distance of the erosion site from the stream. There would be long-term adverse effects on fish in the mainstem of Lost Man Creek as sediment from the tributaries moves into the mainstem. This effect would occur over a longer time and would increase the chronic turbidity of Lost Man Creek, but the intensity of the effect would more likely be minor than moderate.

Alternative 2: Partial Restoration (Proposed Action)— The excavation required for restoration has the potential to cause short-term negative effects on salmonids and their habitat through increased sedimentation in the first rainy season after excavation and the removal of riparian vegetation that results in higher stream temperatures. Post-excavation stream channel adjustments are expected to occur. To minimize disturbance to the buried natural armor of the stream channel, 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 high flows following excavation. 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 rock and wood in the original streambed. 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.

Surface erosion would occur during the first winter following excavation in a stream channel and turbidity related to suspended sediment would be likely to increase for the first few years as sediment washes out of interstices in the channel armor until the channel adjusts to its restored form. Suspended sediment and chronic turbidity are suspected to contribute to decreased survival of young salmonids. To minimize surface erosion that has potential to contribute fine sediment to a stream and increase suspended sediment as measured by increased turbidity, vegetation debris and slash would be spread on side banks of stream crossings as mulch.

Water temperature would not increase significantly as a result of removing vegetation along the streams at excavation sites. The length of the streams 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 high. The projected slope of the streams ranges from 15 to 40 percent. Thus, water would not pool up along areas of excavation. 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 significant increases in downstream water temperature as a result of the proposed actions.

Woody debris uncovered during excavation would be stockpiled and placed in the finished channel excavation to mimic natural woody debris. Much of the vegetation removed during excavation would be stockpiled and evenly distributed along the finished surface of the stream crossing. This woody debris would reduce surface erosion, capture sediment moving through the excavation area, and provide cover for fish and the aquatic invertebrates that they eat.

Alternative 3: Full restoration—There would be greater long-term benefits to fish from complete restoration from the prevention of road failure along about 11 miles of roads that would be partially restored under the proposed action rather than fully restored. Complete excavation of all sidecast road fill and stream channel fill would have greater short-term impacts from increased temperature and increased turbidity in the first season following restoration and until vegetation regrows. However, the remaining miles that would be fully restored pose a small risk of sediment delivery to streams, so the increased benefit to fish from full restoration would be negligible but the short-term adverse effects would be slightly greater than under the proposed action.

Cumulative Effects—Fish stocks throughout the Pacific Northwest region are threatened by the cumulative impacts of livestock use, road construction, timber harvest, stream channelization, water diversions, hydroelectric development, overfishing, and the influence of hatchery fish on both disease resistance and genetic fitness of native stocks (USDC 1997a and 1997b).

Though few scientific data are available for accurate estimates of past salmonid populations in Redwood Creek, the limited data available indicate that the anadromous fishery of Redwood Creek has experienced a substantial reduction during the last 30 years. Present populations of salmonid species are well below those reported in historical accounts. The earliest accounts circa 1890 reported Redwood Creek as having supported a substantial salmonid fishery (Van Kirk 1994).

Degraded stream habitat is a major contributor to the decline in numbers of salmon and trout. The combined effects of timber harvest (i.e., removal of forest cover and construction of logging roads) and significant storms have deposited large amounts of sediment in Redwood Creek and degraded habitat. Erosion and hillslope mass wasting caused sedimentation of the mainstem that filled deep pools, and major flood events caused significant channel adjustments including channel widening, aggradation, and bank erosion. The resultant widened streambed and shallow riffles provide little or no cover for fish. Sedimentation negatively affects egg survival and fry emergence, and fish food organisms, i.e. benthic invertebrate production. The relatively unlogged Prairie Creek drainage in Prairie Creek Redwoods State Park was negatively affected by a large influx of fine sediment in 1989 from a slope failure during construction of the U.S. Highway 101 Redwood Park Bypass. Other factors contributing to and exacerbating population declines are natural events including severe floods, extended drought and poor ocean conditions, overfishing, and the prolonged effects of past hatchery practices.

The Redwood Creek TMDL describes fish populations in Redwood Creek as “much reduced” compared to historic accounts. Habitat conditions are still degraded relative to pristine conditions but are showing signs of improvement. Although channel deepening and pool development have been observed in all but the lower few miles of Redwood Creek, the mainstem generally lacks an adequate pool-riffle structure and cover. Coarse sediment deposited in the mainstem allows a large proportion of the summer base flow to infiltrate and flow subsurface, thereby limiting the surface water available to fish and increasing surface water temperatures. Spawning habitat in Redwood Creek is slowly improving as gravels are cleaned of fine sediment. Tributary water temperatures are generally suitable for salmonids but suboptimal along much of the mainstem.

Other on-going and reasonably foreseeable projects for which the NPS has prepared biological assessments and completed consultations with NMFS for potential effects to listed fish species throughout the parks include annual and periodic road maintenance (NMFS biological opinion and letter of concurrence 151422SWR02AR6347, March 2003); previous Lost Man Creek Watershed Restoration projects (151422SRW01AR54:BW, July 2003); fire management (NMFS biological opinion and letter of concurrence 151422SWR04AR99149:BW, January 2005); and relocation of the RNSP maintenance facility (NMFS biological opinion 151422SWR2003AR8948:BAD, October 2005). The maintenance facility project will be located outside the Redwood Creek watershed and will not have any effects on fish in the project area or in Redwood Creek.

The NPS requested incidental take for California Coastal chinook salmon, Southern Oregon/Northern California Coasts coho salmon, and Northern California steelhead under the NPS biological assessment prepared in 2003 for the Annual and Periodic Road Maintenance program, and the 2006 addendum. NMFS authorized an unquantified amount of take based on miles of stream affected under a biological opinion and letter of concurrence 151422SWR02AR66347 issued in March 2003.

Future actions anticipated within the project area include road and trail maintenance downstream of the project area, fire suppression in case of wildfire but no planned fire management actions (fuel reduction, prescribed fire), and management of second growth forests on less than 400 acres outside riparian and old growth areas. Of these projects, trail and road maintenance is likely to have negligible to minor short-term adverse effects on listed fish if culverts are replaced.

Conclusions—No direct mortality of listed fish is expected in the project area under the proposed action because a logjam creates a barrier to anadromy that blocks access to much of the project area for listed fish. Under the full restoration alternative, there would be a similar effect with no direct mortality of listed fish. There would be short-term adverse effects on listed fish in three miles of streams under the proposed action from the movement of newly excavated sediment remaining in the stream channels in the first season as the newly restored stream channels adjust. The adverse effects under the full restoration alternative would be slightly greater because an additional 11 stream crossings would be excavated but the difference between the proposed action and the full restoration alternative would be negligible because the stream crossings are in reaches that are not accessible to the fish. Short-term adverse effects under the proposed action would be mitigated through implementation of BMPs listed in the terms and conditions of the biological opinion that will be issued by NMFS prior to project implementation. Under the full restoration alternative, the same BMPs would be required to mitigate short-term adverse effects.

Using the guidelines outlined in the current and previous biological assessments and terms and conditions specified in associated biological opinions, cumulative adverse effects to anadromous fish or their habitat are expected to be minor and short-term. Long-term benefits to listed fish are expected from the reduction of threats associated with erosion and sedimentation of streams resulting from failure of untreated roads and stream crossings, and from restoration of drainage patterns and geomorphic processes.

Based on the size, nature and duration of the proposed watershed restoration actions, it is the determination of the NPS that the proposed project may affect and is likely to adversely affect California Coastal chinook salmon, Southern Oregon/Northern California Coasts coho salmon, and Northern California steelhead, 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 from the long-term reduction in sedimentation of streams in the project area.

With listed fish as with listed terrestrial wildlife, formal consultation with NMFS under Section 7 of the Endangered Species Act is not required for alternatives to the proposed action. Assuming that the effects on listed fish under the full restoration alternative would be directly proportional to volume of sediment prevented from being delivered directly to a stream, the full restoration alternative would prevent erosion of about 10% more sediment for an additional 11 stream crossings. Under the full restoration alternative, the short-term adverse effects from channel adjustments during the first winter and the long-term benefits from restoration of the additional 11 stream crossings would be slightly greater than under the proposed action. Both the short-term adverse effects and the long-term benefits would be minor to moderate in the Lost Man Creek watershed, and would be negligible for the listed fish in other tributaries of Redwood Creek.

Effects on Cultural Resources

Cultural Resources are defined as archeological resources, prehistoric or historic structures, cultural landscapes, and traditional cultural properties. These resources are called “*Historic Properties*” when they are either listed in or are determined eligible for listing on the National Register of Historic Places under §106 of the National Historic Preservation Act (36 CFR 800, *Protection of Historic Properties*). Criteria for determining eligibility of listing such resources on the National Register include the following:

Potential impacts to historic properties either listed in or eligible to be listed in the National Register of Historic Places for this project were identified and evaluated in accordance with the Advisory Council on Historic Preservation’s regulations implementing §106 of the National Historic Preservation Act (36 CFR 800, *Protection of Historic Properties*) by (1) determining the area of potential effects; (2) identifying resources present in the area of potential effects that are National Register listed or eligible; (3) applying the criteria of adverse effect to affected resources; and (4) considering ways to avoid, minimize or mitigate adverse effects.

Under the Advisory Council’s regulations a determination of *no historic properties affected*, *adverse effect*, or *no adverse effect* must be made for historic properties. A determination of *no historic properties affected* means that either there are no historic properties present or there are historic properties present but the undertaking will have no effect upon them (36 CFR 800.4(d)(1)). An *adverse effect* occurs whenever an impact alters, directly or indirectly, any characteristic of a cultural resource that qualifies it for inclusion in the National Register, e.g. diminishing the integrity (or the extent to which a resource retains its historic appearance) of its location, design, setting, materials, workmanship, feeling, or association. Adverse effects also include reasonably foreseeable effects caused by the alternatives that would occur later in time, be farther removed in distance or be cumulative (36 CFR 800.5(a)(1)). A determination of *no adverse effect* means there is an effect, but the effect would not meet the criteria of an adverse effect, i.e. diminish the characteristics of the cultural resource that qualify it for inclusion in the National Register (36 CFR 800.5(b)).

Thus, the criteria for characterizing the severity or intensity of impacts to National Register listed or eligible archeological resources, prehistoric or historic structures, cultural landscapes, and traditional cultural properties are the §106 determinations of effect: *no historic properties affected*, *adverse effect*, or *no adverse effect*. A §106 determination of effect is included in the conclusion section for analysis of impacts to each National Register listed or eligible cultural resource.

A 1960s-era logging camp and remnant features of a former historic ranch on Holter Ridge were identified archeological sites. A patch of bear-grass was identified as an ethnographic resource

and a goosepen tree was recorded as an isolate. All were documented on state 523 Primary Record Forms (Sloan 2006). The bear-grass patch is likely eligible for listing on the National Register of Historic Places as traditional cultural property. There is currently insufficient evidence to determine if the historic ranch on Holter Ridge is eligible for listing on the National Register. The NPS is assuming that this site is a historic property. The logging camp is not yet 50 years old, and therefore does not meet eligibility criteria for the National Register. The goose pen tree was documented as an ethnographic resource by the Yurok Tribe but is an isolate find not currently eligible for the National Register of Historic Places, since there is no evidence that this particular goosepen tree was actually used by Native Americans.

No Action— Under the no action alternative, roads that are passable by vehicles and that have been identified as needed for administrative or fire access would be maintained under the regular park road maintenance program by occasional brushing, grading, and culvert replacement as funding permits. These roads include Holter Ridge Road, Geneva Road, the B-Line, the A121, and the A170. Brushing and grading along Holter Ridge Road could result in negligible to minor adverse impacts to the ethnographic bear-grass site. Road maintenance would have negligible effects on the former logging camp and the Holter Ridge Ranch site. No impact to other resources identified would be expected from the No Action alternative. Overall, the no action alternative would result in negligible to minor adverse impacts to cultural resources.

Alternative 2: Partial Restoration (Proposed Action)—No cultural resources have been identified in areas proposed for treatment. Therefore, impacts to cultural resources from the proposed action would be the same as for the no action alternative. Continued use and maintenance of existing access roads would result in negligible to minor adverse impacts to cultural resources. The bear-grass site along Holter Ridge Road would be marked to protect it from being cut during brushing or damaged by equipment used for road maintenance.

Alternative 3: Full restoration—No cultural resources have been identified in areas proposed for treatment. Therefore, impacts to cultural resources from the full restoration alternative would be the same as for the no action alternative. Continued use and maintenance of existing access roads would result in negligible to minor adverse impacts to cultural resources.

Cumulative Effects on Cultural Resources—Cultural resources throughout the remainder of the parks would be unaffected by the proposed action. Fire suppression activities might affect the cultural resources in the project area.

Conclusions—Both the proposed action and the full restoration alternative would have negligible to minor adverse effects on cultural resources. Although important cultural resources may occur in the vicinity of the Lost Man Creek watershed, the proposed action would have negligible to minor adverse effects on as yet unknown cultural resources, these effects would be highly localized, and the effect would not be considered severe. In addition, activities undertaken under the proposed action or under the full restoration alternative would not change the treatment and management of archeological resources.

Under the terminology of Section 106 of the National Historic Preservation Act, no adverse effect to historic properties determined eligible for or listed on the National Register of Historic Places is expected from the proposed project. As with the Endangered Species Act, the NPS consults with the SHPO only on the proposed action. The full restoration alternative would not affect any additional cultural resources and therefore, would not be expected to adversely affect any historic properties determined eligible for or listed on the National Register of Historic Places.

Effects on Park Visitors

No Action—Park visitors would not experience any delays or road closures from moving heavy equipment to and from restoration sites on Lost Man Creek Road for several days between June and October. Road failures in the project area would result in poor water quality following rain storms, but most of the storms occur at times of very low park visitation. A major road failure could introduce sediment into the streams but this is an on-going effect in most tributaries of Redwood Creek and most visitors are unlikely to notice this effect.

Alternative 2: Partial Restoration (Proposed Action)—A few park visitors would experience very short delays or closures of primary access roads to the Lost Man Creek picnic area as heavy equipment is moved to the project area on the Lost Man Creek Road. Most equipment would be moved early in the morning when there are few visitors seeking access to park trails. Some park visitors would see a slight decrease in water quality due to increased turbidity following the first season, and especially the first rainstorm, after restoration. There are fewer park visitors between November and April when the winter rains produce higher flows that result in channel adjustments.

Alternative 3: Full restoration—The effects on park visitors under the full restoration alternative are similar to the effects under the proposed action.

Cumulative Effects—Over the long term, park visitors would be able to enjoy clearer water in Lost Man Creek and Prairie Creek after restoration is completed and the channels adjust. Some visitors would be able to see salmonids spawning in Lost Man Creek if fish populations recover.

Conclusions—The overall effect on park visitors from watershed restoration under either the proposed action or the full restoration alternative would be a long-term future benefit from clearer water and more fish visible in spawning reaches in Prairie Creek and Lost Man Creek downstream from the project area. These benefits to park visitors would be negligible to minor.

Effects on Park Operations

No Action—The Geneva, Holter Ridge, and B Lines would remain to provide administrative and recreational access. Ridgetop roads used for fire management access would remain. These roads would receive routine maintenance, including brushing, grading, and culvert replacement. Under the no action alternative, road maintenance costs would increase as roads continue to deteriorate. When untreated and unmaintained roads fail as the roads continue to deteriorate, the NPS would incur higher costs for repair of some failed sections to be able to reach other failures that might threaten streams occupied by listed fish.

Alternative 2: Partial Restoration (Proposed Action)—Overall maintenance costs would decrease after road removal because would be removed and no long-term access would be needed. Access for some resource management projects such as management of second growth forests would be more difficult. The costs of maintaining access for fire management, general administrative access, and recreational access would be the same as under the no action alternative.

Alternative 3: Full restoration—The cost of road maintenance under the full restoration alternative would be same as under the no action alternative and the proposed action.

Cumulative Effects on Park Operations—Full and partial removal of about 28 miles of roads in Lost Man Creek would reduce emergency repairs needed after road failures, particularly after major storms. Completion of watershed restoration in Lost Man Creek would reduce the total

mileage of roads that need treatment. One of the highest priorities for restoration would be completed.

Conclusions—The overall effect on park operations under either the proposed action or the full restoration alternative would be minor to moderate, with funding for routine road maintenance obtained through cyclic maintenance and repair/rehabilitation funding, and funding for watershed restoration through a Servicewide line item construction source.

Effects on Adjacent Communities

No Action—There would be a slight economic loss for local heavy equipment contractors under the no action alternative because no contracts would be let for road restoration work.

Alternative 2: Partial Restoration (Proposed Action)— There would be a slight economic benefit to the community and a minor to moderate economic benefit for local heavy equipment contractors from the contracts for road restoration work.

Alternative 3: Full restoration—There would be slightly greater economic benefits to local heavy equipment contractors under the full restoration alternative because about twice as much road fill would be excavated under the full restoration alternative and the contract payments are based on the excavation volumes.

Cumulative Effects—Over the long-term, watershed restoration in the parks and reduction in sediment from sources upstream of the parks would improve the functioning of the Redwood Creek estuary, which would improve sport fishing and any tourism related to sport fishing. The town of Orick would occasionally benefit from improved flood protection from the Redwood Creek levees if levee function is improved by reducing the overall sediment coming from upstream that fills in the channel.

Construction of a wastewater treatment system for the community of Orick proposed in the draft *Redevelopment Plan for the Humboldt County Redevelopment Project* would have moderate to major benefits to Orick over the long term.

Conclusions—Effects on the adjacent community of Orick under either the proposed action or the full restoration alternative would be indirect from purchases made in the town by the selected contractor and would be negligible to minor.

Non-Impairment of Park Resources

The NPS is prohibited by law and policy from taking an action that will impair park resources or values. This section describes the effects on resources under the proposed action and why those effects would reduce existing impairment of park resources and values.

Air Quality—Adverse effects on air quality would result from temporary localized dust or vehicle emissions during routine road maintenance under the no action alternative, and from dust and vehicle emissions from heavy equipment operation under the proposed action and the full restoration alternative. Dust from excavation during restoration would be reduced by using water trucks to sprinkle water on road surfaces. The cumulative effects on air quality under any of the alternatives would be negligible, because the only sources of air pollution in the project area are vehicle emissions and smoke from fires.

These adverse effects are negligible under the no action alternative. Therefore, the no action alternative would not impair air quality or air quality related values in the park.

The overall adverse effect on air quality from the proposed action is negligible to minor, short-term during excavation but repeated over four years, and very localized. Therefore, air quality and air quality related values would not be impaired by the proposed action.

The overall effects on air quality under the full restoration alternative are slightly greater than under the proposed action because about twice as much soil would be excavated. The effects would be short-term during excavation, localized at work sites, and repeated over the four years of the project. These effects are adverse but negligible to minor. Therefore, the full restoration alternative would not impair air quality or air quality related values in the park.

Topography and Soils—The topography of the project area is considered to be impaired by the original construction and existence of logging roads and landings (no action). The soils themselves can be considered impaired in those areas where soil profiles have been altered but the effect on the integrity of the soil components is less than the effect of destroying the original placement of soil horizons.

A catastrophic road failure in one location would be a minor to moderate adverse effect on the local topography and soil. Multiple catastrophic road failures could result in moderate to significant adverse effects on the topography of the subdrainages. Significant adverse alterations to topography would be long-term and mitigation of such effects might not be possible under a no action alternative in which only administrative roads receive routine low-levels of maintenance and without reconstructing access roads for heavy equipment. This would be considered to exacerbate the existing impairment. Thus, the no action alternative would not correct the existing impaired condition of soils and topography in the project area created by logging and road building prior to the establishment of the park.

Under the proposed action, the original landforms would be restored and soils would be moved back to a semblance of the original soil horizons. This would contribute to correcting the impairment of topography created by constructing the roads. Soil horizons would more closely resemble their original placement and would redevelop as the soil formation processes continue to act.

The proposed action would not further impair the topography and soils of the project area and would reduce the level of impairment created by logging and road construction, and associated road-related slope failures.

Under the full restoration alternative, the original landforms would be restored and soils would be moved back to a semblance of the original soil horizons. This would contribute to correcting the impairment of topography created by constructing the roads. Soil horizons would more closely resemble their original placement and would redevelop as the soil formation processes continue to act.

The full restoration alternative would not further impair the topography and soils of the project area and would reduce the level of impairment to these resources in the project area created by logging and road construction, and associated road-related slope failures.

Hydrology and Water Quality—Under the no action alternative, there would be no improvement to the existing sediment- and temperature-impaired condition of Redwood Creek. The no action alternative has the potential to contribute to the impaired condition of Redwood Creek if roads in the project area fail catastrophically in Lost Man Creek. The no action alternative also has a

potential for direct impairment of Lost Man Creek, which is currently not identified separately as impaired under 303d, in event of a major storm that could create road failures.

The hydrology of the project area related to drainage patterns has readjusted to the new topography created by logging and road construction. The original drainage patterns would be restored by excavation of blocked stream channels and restoration of landforms by removing roads. There would be an immediate direct benefit to stream hydrology from restoring flow channels and hillslopes in the project area. Therefore, the proposed action would not further impair hydrology of streams in the project area.

Water quality in Redwood Creek is designated as impaired for sediment and temperature under the EPA 303d TMDL process. The proposed action would improve water quality in Redwood Creek slightly over long-term by reducing the potential for additional sediment input from Lost Man Creek via its tributaries. Thus, the proposed action would not cause further impairment of water quality of Redwood Creek. The proposed action would reduce or eliminate the potential for impairment of water quality in the project area, including Lost Man Creek, and thus would not impair or cause and impairment to water quality in the park.

The full restoration alternative would restore hydrological conditions more closely to the original conditions because an additional 11 miles of roads would be fully removed. The full restoration alternative would improve water quality in Redwood Creek slightly over long-term by reducing the potential for additional sediment input from Lost Man Creek via its tributaries, and would more fully restore hydrological conditions than would the proposed action. Thus, the full restoration alternative would not cause further impairment of water quality of Redwood Creek. The full restoration alternative would reduce or eliminate the potential for impairment of water quality in the project area, including Lost Man Creek, and thus would not impair or cause and impairment to water quality in the park.

Floodplains and Riparian Wetlands

Under the no action alternative, there would be no restoration, and thus no benefits to floodplains or riparian wetlands. The floodplain of Lost Man Creek retains much of its original structure. The no action alternative would not affect the floodplain of Lost Man Creek unless there is a catastrophic failure of roads associated with a major storm. It is unlikely that the no action alternative would impair or cause an impairment to floodplains without a catastrophic storm event that could create an impairment to many park streams. Therefore, the no action alternative is unlikely to impair floodplains or floodplain functions or values in the park.

The proposed action would indirectly benefit floodplains in the low gradient segments of streams downstream of the project areas by reducing the risk of sedimentation from major slope failures upstream. There would be only a negligible benefit to the floodplains of Prairie and Redwood Creeks from restoration in Lost Man Creek under the proposed action. Therefore, the proposed action would not impair floodplains or associated functions or values in the project area.

The full restoration alternative would indirectly benefit floodplains in the low gradient segments of streams downstream of the project areas by reducing the risk of sedimentation from major slope failures upstream. There would be only a negligible benefit to the floodplains of Prairie and Redwood Creeks from restoration in Lost Man Creek under the full restoration alternative. Therefore, the full restoration alternative would not impair floodplains or associated functions.

There would be no direct effect on riparian wetlands in Lost Man Creek under the no action alternative. In the event of a catastrophic storm, riparian wetlands could be adversely affected by

road failures that deposit large quantities of sediment in riparian zones. The no action alternative would not create a direct impairment to riparian wetlands but it could contribute to impairment of riparian wetlands in the event of a major storm that causes catastrophic road failures in the project area.

The proposed action would have short-term adverse effects on riparian and wetland vegetation that would be removed for stream channel restoration. Riparian wetlands would benefit from restoring drainage patterns, and from a reduced risk of being buried by streamside landslides caused by road failures. Therefore, the proposed action would not impair riparian wetlands.

The full restoration alternative would have short-term adverse effects on riparian and wetland vegetation that would be removed for stream channel restoration. Riparian wetlands would benefit from restoring drainage patterns, and from a reduced risk of being buried by streamside landslides caused by road failures. Therefore, full restoration alternative would not impair riparian wetlands.

Vegetation—The original logging of old growth forest caused what would now be identified as an impairment to park resources. Logging conducted between park establishment in 1968 was described in the park expansion legislation as a “~~de~~rogation of the values, and the purposes for which the park was established...” and was directly responsible for the expansion of the park in 1978. The vegetation has regrown but the ecological characteristics and functions of the original old growth forest continue to be impaired by the logging. The no action alternative would not cause any additional impairment to the existing vegetation in the project area but there would be no improvement to the impaired condition of vegetation under the no action alternative. The impaired condition would persist for centuries while the forest regrows.

The 216 acres of vegetation that would be removed under the proposed action consists of understory vegetation and red alder and Douglas-fir trees up to 24” in diameter. All vegetation that would be removed has grown back following logging prior to the project area being included in the park. This vegetation that would be removed is not old growth, is common in the parks and the region, and is routinely removed for road maintenance, although on smaller scale along the edges of linear corridors. Therefore, the proposed action would not create an impairment to park vegetation resources.

The 291 acres of vegetation that would be removed under the full restoration alternative consists of understory vegetation and red alder and Douglas-fir trees up to 24” in diameter. All vegetation that would be removed has grown back following logging prior to the project area being included in the park. This vegetation that would be removed is not old growth, is common in the parks and the region, and is routinely removed for road maintenance, although on smaller scale along the edges of linear corridors. Therefore, the full restoration alternative would not create an impairment to park vegetation resources.

Wildlife—Under the no action alternative, there would be occasional temporary disturbance to wildlife along about 12 miles of roads during routine maintenance. There would be no removal of wildlife habitat in the project area. Therefore, the no action alternative would not impair park wildlife resources.

Individuals of small and less mobile wildlife species that occupy the 216 acres of vegetation that would be removed under the proposed action would be displaced or killed by removal of vegetation and excavation and replacement of road fill where the vegetation has regrown on road fills and in stream channels. Loss of these individual animals is not expected to adversely affect

the overall population of any of these species in the parks as a whole. Therefore, the proposed action would not impair park wildlife resources.

Individuals of small and less mobile wildlife species that occupy the 291 acres of vegetation that would be removed under the full restoration alternative would be displaced or killed by removal of vegetation and excavation and replacement of road fill where the vegetation has regrown on road fills and in stream channels. Loss of these individual animals is not expected to adversely affect the overall population of any of these species in the parks as a whole. Therefore, the full restoration alternative would not impair park wildlife resources.

Threatened and Endangered Species—No critical habitat for either northern spotted owls or marbled murrelets would be affected by the Lost Man Creek watershed restoration project.

The no action alternative would result in noise during routine maintenance of roads that would be retained for administrative use. Maintenance would occur outside respective breeding seasons of northern spotted owls and marbled murrelets. Therefore, the no action alternative would not create an impairment for threatened wildlife species.

The NPS submitted a final biological assessment to the USFWS on March 10, 2006 that described the project, potential effects of the project on northern spotted owls and marbled murrelets, and measures to minimize adverse effects on these two species. The USFWS issued a Biological Opinion file number 8-14-2006-2836, dated May 30, 2006, which concurred with the NPS determination that the project may affect but is not likely to adversely affect the northern spotted owl and that the project may affect and is likely to adversely affect the marbled murrelet. The NPS requested, and the USFWS authorized, incidental take of marbled murrelets expected from harassment of nesting birds due to operation of heavy equipment in 2 acres of occupied nesting habitat during the breeding season; harm of murrelets due with an increased risk of corvid predation on 66 acres of nesting habitat; and harm of murrelets associated with 7 acres of nesting habitat due to habitat degradation. The biological opinion concluded that the level of anticipated take from this project is not likely to result in jeopardy to the marbled murrelet, or destruction or adverse modification of critical habitat for the marbled murrelet.

Based on the size, nature and duration of the proposed watershed restoration actions, it is the determination of the NPS that the proposed project may affect and is likely to adversely affect California Coastal chinook salmon, Southern Oregon/Northern California Coasts coho salmon, and Northern California steelhead, 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 from the long-term reduction in sedimentation of streams in the project area. NMFS is reviewing the biological assessment and preparing a biological opinion, and has indicated that they will concur with the NPS determination.

Based on the biological assessments prepared by the NPS for the effects of Lost Man Creek watershed restoration, and the resulting biological opinions received or expected from USFWS and NMFS, the NPS has determined that the project would not create an impairment to populations of threatened birds or fish.

Under the full restoration alternative, an additional 75 acres of vegetation would be removed for complete removal of an additional 11 miles of road, compared to the proposed action. The project was developed in consultation with the USFWS to minimize adverse effects on marbled murrelets by reducing the amount of vegetation that would be removed. Assuming that the effects on marbled murrelets under the full restoration alternative would be directly proportional

to the acreage of vegetation affected, the amount of incidental take of marbled murrelets under the full restoration alternative would be at least 25% greater than under the proposed action. The NPS did not request that the USFWS analyze this hypothetical increase in incidental take to determine whether it would jeopardize the continued existence of the marbled murrelet. Because the incidental take under the proposed action is associated with noise disturbance and increased threat of predation and not direct take, it is assumed that the full restoration alternative would not jeopardize the continued existence of marbled murrelets. Similarly, it is assumed that the effects on northern spotted owls under the full restoration alternative are proportional to the 25% increase in vegetation affected under full restoration, and that the project may affect but is not likely to adversely affect northern spotted owls.

Based comparison of the size, nature and duration of the proposed watershed restoration actions with the more extensive full restoration alternative, the proposed project may affect and is likely to adversely affect California Coastal chinook salmon, Southern Oregon/Northern California Coasts coho salmon, and Northern California steelhead, 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 from the long-term reduction in sedimentation of streams in the project area. Assuming that the effects on listed fish under the full restoration alternative would be directly proportional to volume of sediment prevented from being delivered directly to a stream, the full restoration alternative would prevent erosion of about 10% more sediment for an additional 11 stream crossings. Under the full restoration alternative, the short-term adverse effects from channel adjustments during the first winter and the long-term benefits from restoration of the additional 11 stream crossings would be slightly greater than under the proposed action. Both the short-term adverse effects and the long-term benefits would be minor to moderate in the Lost Man Creek watershed, and would be negligible for the listed fish in other tributaries of Redwood Creek.

Therefore, the full restoration alternative would be unlikely to create an impairment to threatened birds or fish species in the project area.

Non-Impairment of Cultural Resources— No adverse effects to historic properties are anticipated from routine road maintenance under the no action alternative. Therefore, there would be no impairment to cultural resources under the no action alternative.

No adverse effects to historic properties are anticipated from the proposed action. Therefore, there would be no impairment to cultural resources under the proposed action.

No adverse effects to historic properties are anticipated from the full restoration alternative. Therefore, there would be no impairment to cultural resources under the full restoration alternative.

COORDINATION AND CONSULTATION

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REFERENCES

- Anderson, D.G. 1988. Juvenile salmon habitat of the Redwood Creek basin in Humboldt County, California. Master's Thesis. Humboldt State University, Arcata, CA. 99 pp.
- Anderson, D.G. 1995. Biological supplement to Redwood National and State Parks U.S. Army Corps of Engineers application: coho salmon utilization of Redwood Creek estuary. Unpub. Rep. on file at Redwood National and State Parks, Orick, CA. 13 pp.
- Anderson, D.G. and R.A. Brown. 1982. Anadromous salmonid nursery habitat in Redwood Creek watershed. *In*: Proceedings of the first biennial conference of research in California National Parks. University of California, Davis. Davis, CA.
- Best, D.W., H.M. Kelsey, D.K. Hagans and M. Alpert. 1995. Role of fluvial hillslope erosion and road construction in the sediment budget of Garrett Creek, Humboldt County, California. USGS Professional Paper 1454-M.
- Bloom, A.L. 1998. An assessment of road removal and erosion control treatment effectiveness: A comparison of 1997 storm erosion response between treated and untreated roads in Redwood Creek Basin, MSc. Thesis, Humboldt State University, Arcata, CA.
- Brown, R.A. 1988. Physical rearing habitat for anadromous salmonids in the Redwood Creek basin, Humboldt County, California. Master's Thesis. Humboldt State University, Arcata, CA. 132 pp.
- California Native Plant Society. 2006. CNPS Inventory of Rare and Endangered Plants. CNPS Inventory On-line. <http://cnps.web.aplus.net/cgi-bin/inv/inventory.cgi>. v7-06a, 1-24-06.
- Carey, A.B., S.P. Courtney, J.F. Franklin, J.M. Marzluff, M.G. Raphael, J.C. Tappeiner, and D.A. Thornburgh. 2003. Managing second-growth forest in the redwood region to enhance marbled murrelet habitat. Scientific panel on restoration of marbled murrelet habitat. Unpub. Rept., Sustainable Ecosystems Institute. 60 pp.
- Cody, G. 2004. Methodology for Assessing Impacts to Cultural Resources. National Park Service, Denver Service Center. Electronic file –Intensity Definitions for CR for GMPs”, 7/14/04. Denver, CO.
- Cook, C., and A. Dresser. 2004. Erosion and channel adjustments following forest road decommissioning, Six Rivers National Forest. Eureka, CA.
- Cowardin, L.M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. U.S. Fish and Wildlife Service, Office of Biological Services, Washington, DC. Publ. No. FWS/OBS-79/31. 107 pp.
- Hagans, D. K., and W. E. Weaver. 1987. –Magnitude, Cause and Basin Response to Fluvial Erosion, Redwood Creek Basin, Northern California.” *In Erosion and Sedimentation in the Pacific Rim Steeplands—Proceedings of a Symposium, Corvallis, Oregon, 1987*, R. Beschta, T. Blinn, G. E. Grant, G. G. Ice, and F. J. Swanson, eds. International Association of Hydrological Sciences, IASH-AISH Publication No. 165, p. 419-428.

Harden, D.R., D. C. Marron and A. MacDonald. 1982, Friends of the pleistocene-1982 Pacific cell field trip: Late Cenozoic history and forest geomorphology of Humboldt County, California, August 5-8, 1982. 249 pp. Available at park offices in Arcata, CA.

Holden, B., III. 2002. Redwood Creek basin 2000-2001 spawning and carcass survey. Annual Progress Report. Redwood National and State Parks, Orick, CA. Available at park office in Orick, CA.

Janda, R. J., K. M. Nolan, D. R. Harden, and S. M. Colman. 1975. Watershed conditions in the drainage basin of Redwood Creek, Humboldt County, California, as of 1973. U.S. Geological Survey open file report 75-568. 266 pp.

Jordan, W. R., III. 1992. Those RE-Words: a glossary and a few comments. Land and Water: The Magazine of Natural Resource Management and Restoration. Vol. 36, Nov./Dec. 1992, pp. 13-15. Fort Dodge, IA.

Klein, R D. 2003. Erosion and turbidity monitoring report, Sanctuary Forest stream crossing excavations in the upper Mattole basin, 2002-2003. Prepared for Sanctuary Forest, Inc, Whitethorn, CA.

Klein, R., T. Spreiter, and G. Gibbs. 2005. Erosion and Turbidity Monitoring in Lost Man Creek, Redwood National and State Parks Annual Report for 2003-2004: Year 2. 47 pp. Copy available at park offices in Arcata and Orick, CA.

Madej, M.A. 2001. Erosion and sediment delivery following removal of forest roads. Earth Surface Processes and Landforms 26: 175-190.

McConnell, R. B., and J. P. Eidsness. 2000. Report on Ethnographic Inventory/Contemporary concerns for Lost Man and Little Lost Man Creek Watershed Restoration Project. Copy available from park archives in Orick, CA.

McDaniel, P. 2006. The Twelve Soil Orders. Soil Taxonomy. University of Idaho, College of Agriculture and Life Sciences, Soil and Land Resources Division. Moscow, ID. <http://soils.ag.uidaho.edu/SoilORDERS/index.htm>. January 25, 2006.

McShane, C., T. Hamer, H. Carter, G. Swartz man, V. Friesen, D. Ailey, R. Dressler, K. Nelson, A. Burger, L. Spear, T. Mohegan, R. Martin, L. Henkel, K. Brindle, C. Strong, and J. Kearny. 2004. Evaluation report for the 5-year status review of the marbled murrelet in Washington, Oregon, and California. Unpub. Rept. EDAW, Inc. Seattle, WA. Prepared for the U.S. Fish and Wildlife Service, Region1, Portland, OR.

National Park Service, U.S. Department of the Interior. 1981. Watershed Rehabilitation Plan. Redwood National Park/California. 65pp. Denver, CO.

National Park Service, U.S. Department of the Interior. 2001a. Management Policies 2001. 137 pp. Washington, DC.

National Park Service, U.S. Department of the Interior. 2001b. A Biological Assessment of Impacts to Terrestrial Threatened and Endangered Species from the Watershed Restoration Program in portions of Lost Man Creek Watershed in Redwood National and State Parks (RNSP). Copy available at South Operations Center, Orick, CA.

National Park Service, Department of the Interior. 2005. Road Strategy: Access and Treatment Priorities for Parkland in the Redwood Creek Watershed. Redwood National and State Parks, Division of Resource Management and Science. Copy available at park offices in Arcata and Orick, CA.

National Park Service, U.S. Department of the Interior. 2006a. A Biological Assessment of Impacts to Terrestrial Threatened and Endangered Species from Lost Man Creek Erosion Control and Disturbed Land Restoration Plan in Redwood National and State Parks (RNSP). Copy available at park offices in Arcata and Orick, CA.

National Park Service, U.S. Department of the Interior. 2006b. 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). Copy available at park offices in Arcata and Orick, CA.

Nelson, S.K. and T.E. Hamer. 1995. Nest success and the effects of predation on marbled murrelets. Pages 57-67 *in* C.J. Ralph, G.L. Hunt, M.G. Raphael, and J.F. Piatt (Tech. eds.). Ecology and conservation of the marbled murrelet. Gen. Tech. Rept. PSW-GTR-152. U.S. Dept. of Agriculture, Forest Service, Albany, California.

Nolan, K.M., and D. R. Harden. 1976. Graphic and tabular summaries of water and suspended-sediment discharge for two periods of synoptic storm sampling during 1975 in the Mill Creek drainage basin, Del Norte County, California: U.S. Geological Survey, Open-File Report 76-473, 13 p.

O'Neale, L. M. 1995. Yurok-Karuk Basket Weavers. Phoebe Hearst Museum of Anthropology, University of California, Berkeley. [Originally published in 1932 in University of California Publications in American Archaeology and Ethnology 32:1.]

Pacific Watershed Associates. Evaluation of Road Decommissioning, CDFG Fisheries Restoration Grant Program, 1998 to 2003. Arcata, CA.

Raphael, M.G., D. Evans Mack, J. M. Marzluff, and J.M. Luginbuhl. 2002. Effects of fragmentation on populations of the marbled murrelet. *Studies in Avian Biol.* 25:221-235.

Redevelopment Agency of the County of Humboldt. 2005. Redevelopment Plan for the Humboldt County Redevelopment Project. Plus maps, appendices, and draft environmental impact report. County of Humboldt, Community Development Services Department, Office of Economic Development, Eureka, CA. available at <http://www.co.humboldt.ca/planning/econdev/redevelopment>.

Sakai, H. 2003. A conservation strategy for managing threatened and endangered species in Redwood National and State Parks. Unpub. Rep. on file at South Operations Center, Orick, CA

Scrivener, J. C., and B. C. Andersen. 1982. Logging impacts and some mechanisms which determine the size of spring and summer populations of coho salmon fry in Carnation Creek. *In*: Proceedings of the Carnation Creek Workshop: a ten year review. G. F. Hartman, ed. Pacific Biological Station, Nanaimo, BC, Canada.

Sloan, K. 2005. South Fork and Middle Fork Lost Man Creek Cultural Resources Inventory and Assessment, Redwood National and State Parks. Yurok Tribe Environmental Program, Klamath, CA. Prepared for NPS under Task Agreement Number J84859599A7. Copy available at park office in Orick, CA.

Sloan, K. 2006. Addendum South Fork and Middle Fork Lost Man Creek Cultural Resources Inventory and Assessment, Redwood National and State Parks. Yurok Tribe Environmental Program, Klamath, CA. Prepared for NPS under Task Agreement Number J84859599A7. Copy available at park office in Orick, CA.

Spies, T. A., and Cline, S. P. 1988. Coarse Woody Debris in Forests and Plantations of Coastal Oregon. Chapter 1 *in* Maser, C., Tarrant, R. F., Trappe, J. M., and Franklin, J. F., tech. eds. From the Forest to the Sea: a Story of Fallen Trees. Gen. Tech. Rep. PNW-GTR-229. 153 pp. Pacific Northwest Research Station, U. S. Dept. of Agriculture, Forest Service. Portland, OR.

Switalski, T.A., J.A. Bissonette, T.H. DeLuca, C.H. Luce, and M.A. Madej. 2004. Benefits and impacts of road removal. *Frontiers in Ecology*. 2(1): 21-28.

U.S. Department of Agriculture, Natural Resources Conservation Service. 2005. Lost Man Creek Watershed Soils Overview. Redwood National and State Parks. July 2005. Arcata, CA.

U.S. Department of Commerce, National Marine Fisheries Service, National Oceanographic and Atmospheric Administration. 1997. Endangered and threatened species; threatened status for the southern Oregon/northern California coast evolutionarily significant unit (ESU) coho salmon; final rule. *Fed. Reg.* 62(117):33038-33039.

U.S. Department of Commerce, National Marine Fisheries Service, National Oceanographic and Atmospheric Administration. 1998. Biological Opinion and Conference Opinion. Watershed Restoration Program: Routine and Non-Routine Road Maintenance in Redwood National and State Parks. Copy available at park office in Orick, CA.

U.S. Department of Commerce, National Marine Fisheries Service, National Oceanographic and Atmospheric Administration. 1999a. Designated critical habitat; central California coast and southern Oregon/northern California coasts coho salmon; final rule and correction. *Fed. Reg.* 64(86):24049-24062.

U.S. Department of Commerce, National Marine Fisheries Service, National Oceanographic and Atmospheric Administration. 1999b. Endangered and threatened species; threatened status for two chinook salmon evolutionarily significant units (ESUs) in California. *Fed. Reg.* 64(179):50394-50415.

U.S. Department of Commerce, National Marine Fisheries Service, National Oceanographic and Atmospheric Administration. 2000. Endangered and Threatened Species: Threatened Status for One Steelhead Evolutionarily Significant Unit (ESU) in California; Final Rule. *Fed. Reg.* 65(110): 36074-36094.

U.S. Department of Commerce, National Marine Fisheries Service, National Oceanographic and Atmospheric Administration. 2006. Endangered and Threatened Species: Final Listing Determination for 10 Distinct Population Segments of West Coast Steelhead; Final Rule. *Fed. Reg.* 71(3):834-862.

U.S. Department of the Interior and California Department of Parks and Recreation. 1999. Redwood National and State Parks, Humboldt and Del Norte Counties; final general management plan/ general plan; environmental impact statement/ environmental impact report. Vol. 1: USDI National Park Service and California Department of Parks and Recreation. Denver, CO.

U.S. Department of Transportation, Federal Highway Administration. 1995. Best Management Practices for Erosion and Sediment Control. Report No. FHWA-FLP-94-004. Eastern Federal Lands Highway Division. Sterling, VA.

U.S. Environmental Protection Agency. 1998. Total Maximum Daily Load for Sediment. Redwood Creek, California. EPA Region 9. December 30, 1998. 71pp.

Van Kirk, S. 1994. Historical information on Redwood Creek. Unpub. Rep. on file at Redwood National and State Parks, Arcata, CA.

Van Kirk, S. 1999. Historic Resources Study, Lost Man and Little Lost Man Watersheds. Copy available in park archives, Orick, CA.

Walter, T. 1985. Prairie gully erosion in the Redwood Creek basin, California: Redwood National Park Technical Report 16, National Park Service, Redwood National Park, Arcata, Calif., 24 pp.

Weaver, W., and D.K. Hagans. 1994. Handbook for Forest and Ranch Roads: a guide for planning, designing, constructing, reconstructing, maintaining and closing wildland roads. Prepared for the Mendocino County Resource Conservation District, Ukiah, CA, in cooperation with the California Department of Forestry and Fire Protection and the USDA Soil Conservation Service. 149 pp. + appendices.

Appendices

Appendix 1—Public Scoping Letter

L7617 (SF Lost Man Creek)

April 13, 2004

Dear Interested Party:

The National Park Service (NPS) proposes to remove abandoned logging roads in the Lost Man Creek watershed to restore natural watershed functions and to protect park resources including ancient redwood forest and high quality anadromous fish habitat that are threatened by erosion from the roads.

The project area is located in Redwood National and State Parks within the Lost Man Creek watershed, approximately 5 miles northeast of the town of Orick in Humboldt County, California. Lost Man Creek is a major tributary of Prairie Creek, which is within the Redwood Creek watershed. The project area encompasses the upper portion of the Lost Man Creek watershed (map 1).

We are currently conducting public scoping to identify issues and information needed to assess the environmental effects of the proposed action. This scoping letter describes the purpose and need for the project, a list of preliminary issues, and the environmental review process.

Purpose and Need for Action

The purpose of the proposed action is to reduce adverse effects on park resources from erosion of sediment from abandoned logging roads and to enhance visitor use and enjoyment of the parks through restoration of watersheds damaged by past logging and poorly constructed roads.

Public Law 95-250 directed the NPS to protect the existing irreplaceable park resources, including redwood forests and streams, through the rehabilitation of areas within the park contributing significant sedimentation because of past logging disturbances and road conditions.

The upper portion of the Lost Man Creek watershed contains approximately 28 miles of abandoned, eroding logging roads and about 200 miles of skid roads (roads used by bulldozers to drag logs to locations where they could be loaded onto trucks). As the roads have aged, many have become increasingly prone to failure and pose a threat to downstream resources. Culverts not washed out in earlier storms are now corroded, allowing water to saturate and destabilize road fills. Logs placed in streams in lieu of culverts have decayed, allowing stream crossings to collapse into the streams. Sediment and small woody debris are plugging drainage structures and diverting flow away from their natural watercourses. Diverted flow is creating gullies, and saturating and destabilizing slopes that did not evolve under these increased moisture regimes. Woody debris buried beneath road fill is rotting; creating zones of weakness that make sections of road prone to landsliding. The sediment released from failing roads is impacting streams by burying the spawning and rearing habitat of fish federally listed as endangered, including coho salmon, chinook salmon and steelhead trout. The influx of sediment causes streams to widen and destabilizes banks, resulting in increased landsliding and loss of old growth trees.

Preliminary Issues:

The NPS has identified the following issues to be considered in the EA:

- Effects on rare, sensitive, threatened and/or endangered plants and animals and their habitats
- Effects on water quality
- Effects on historic and prehistoric sites or features
- Effects on visitor enjoyment and safety
- Effects on geomorphology, soils and watershed processes
- Effects on park facilities and infrastructure
- Effects on administrative access for management of wildland fire and second growth forests

Environmental Assessment Process

The NPS is preparing an environmental assessment (EA) that will consider a full range of alternatives in accordance with the National Environmental Policy Act. Your early involvement in the process will assist us to determine the environmental issues and alternatives to be addressed in the EA. As part of the planning process, detailed erosion potential and resource assessments are being conducted along all roads and at all stream crossings within the project area. An interdisciplinary team will analyze the data and prioritize areas for erosion and watershed restoration treatments. The EA will be distributed to interested or affected persons, organizations, agencies, and tribes for review and comment. The NPS will make a final decision on the proposed action at the end of the review period after considering all comments.

Schedule:

The tentative schedule for the project is as follows:

Public Scoping	Spring 2004
Prepare EA	Summer 2004
Public Comment Period	Fall 2004
Complete Project Planning	Spring 2005
Initiate Project Implementation	Either Fall 2005 or Summer 2006

We are requesting your input to assist us to identify issues and provide us with information that the NPS may not be aware of. Please send your issues and information in writing by May 15, 2004 to Bill Pierce, Superintendent, Redwood National and State Parks, 1111 Second Street, Crescent City, California 95531. If you have further questions regarding this project, please contact Supervisory Geologist Terry Spreiter at 707-464-6101 extension 5240 or via e-mail at terry_spreiter@nps.gov.

Sincerely,

/s/ Bill Pierce

Bill Pierce
Superintendent

Enclosure
Map 1

Appendix 2—Roads to Be Treated or Used for Access

Road Name/Number	Miles	Treatment and/or Access
A100	4.1	Treatment
A100 N	0.2	Treatment
A110	0.5	Treatment
A111	0.7	Treatment and Access
A112	0.6	Treatment and Access
A120	2.2	Treatment and Access
A121	1.3	Access
A130	1.3	Treatment
A131	0.5	Treatment
A140	3.0	Treatment and Access
A141	1.9	Treatment and Access
A142	0.6	Treatment
A150	1.3	Treatment
A160	2.2	Treatment
A170	1.4	Treatment and Access
A200	0.7	Treatment and Access
A300	1.1	Treatment and Access
A350	0.4	Treatment
A400	0.5	Treatment
Shangri La	1.1	Treatment and Access
B200	0.6	Treatment and Access
B200/500	1.2	Treatment and Access
Upper B500	1.5	Treatment and Access
Geneva Road	2.4	Access
Holter Ridge	6.7	Access
B-Line North	1.6	Access
Total linear project area	39.6	

Appendix 3–Best Management Practices to Minimize Project Effects on Fish

Riparian cover on fish-bearing streams and 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.

Effective erosion control measures shall be in place at all times during restoration activities. Activities within the 5-year floodplain of fish-bearing streams 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 bodies of water. Note: The maintenance of all roads used to access work sites for the North Fork of Lost Man and Larry Damm Creeks are listed and covered in the current Routine/Non-Routine Road Maintenance BA.

- Any disturbed ground must receive appropriate erosion control treatment prior to the beginning of the wet season.
- 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 dry season, project operations will temporarily cease and sites will be winterized. If periods of dry weather are predicted outside of the NOS, additional small work items may be done, if they can be completed within the window of predicted dry weather. Only those repairs needed to reduce risks from active erosion will be undertaken outside of the NOS, in coordination with NOAA Fisheries.
- 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. Adequate erosion control supplies (gravel, straw bales, shovels, etc.) shall be kept at all restoration sites to ensure excavated material is kept out of water bodies.
- 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.
- 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.

- Petroleum products, chemicals, fresh cement, deleterious materials, or water contaminated by the aforementioned shall not be allowed to enter flowing waters.
- Disruption of natural hydrologic flow paths, including diversion of streamflow and interception of surface and subsurface flows, shall be minimized during excavation.
- 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' "Water Drafting Specifications" [NMFS 2001, in NPS 2006]
- Streams with significant surface flow capable of sediment transport off-site must be diverted around excavation areas. The diverted flows shall be returned to their natural stream course 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.

Listed salmonids that would be in the area would be removed prior to and during stream flow diversion and dewatering. Listed salmonids would be relocated to a suitable in-stream location immediately up or down stream of the work area. This would be done by qualified fishery biologists using nets to capture and relocate listed salmonids when practical. When it is necessary to use electroshockers, the NPS would follow with NMFS guidelines. The NPS would apply for take of listed salmonids if capture and relocation are needed during culvert replacement and installation because the current RNSP section 10 permit does not cover the capture and relocation of listed salmonids during these activities.

GLOSSARY

Alluvium—Soil and rocks that have been moved downslope by water.

Armor—Rocks lining the streambed that prevent water from downcutting.

CMP culvert—Corrugated metal pipe culvert.

Coarse woody debris—any dead standing or fallen tree stem at least 4 inches diameter at breast height on snags and at the large end on fallen trees.

Colluvium—Soils and rocks that have moved downslope in response to gravity without the influence of water.

Cut bank, cut slope—The uphill part of a road on a slope where the substrate has been excavated (cut) to create a level road surface. A cut section is that part of the constructed roadway that is lower in elevation than the original ground surface.

Debris flow—A type of large-scale earth movement on a slope where the earth moves slowly downslope. A shallow debris slide moves along planar or undulating surfaces. The head scarp is near vertical. Cracks parallel to the slope are usually present in the crown region. Blocks break up into smaller and smaller parts as the slide moves toward the toe of the slope. Movement is relatively slow compared to a debris torrent. On a forested debris flow, trees will appear “jackstrawed” or have curved trunks.

Debris torrent—A type of large scale earth movement on a slope where the earth moves extremely rapidly downslope due to complete saturation of the soil. A failed surface contains a serrate or V-shaped scarp, and irregular flanks often with levees in the lower portions of the slide. Displacement occurs along a planar surface, and the surface scar is long and narrow. Debris torrents typically follow drainage routes, scouting the channel valley to bedrock and mobilizing soils and vegetation, including trees. Torrents typically build up sufficient energy during failure such that the liquefied material accumulates only where the stream valley slope flattens drastically.

Diversion Potential—A condition at a stream crossing where, if a drainage structure plugs or overflows, the flow could move out of the natural drainage and down a road or inboard ditch, causing gullying, mass wasting, erosion, or road failure.

Earthflow—A slow-moving, deep seated landslide with an irregular and hummocky surface.

Erosion—Movement of soil particles by wind, water, or gravity.

Erosion Control—A systematic, ongoing program that improves and maintains the conditions of roads to prevent erosion and sediment impacts on various resources. Erosion control is used on roads that cannot be permanently closed because they are needed for current and future land management.

Fill slope—The downhill part of a road on a slope where excavated material has been placed to create a level road surface or where excess excavated material has been dumped.

Fluvial—Related to moving water, generally in a stream.

Geomorphology—The study of landscapes and the processes that form them.

Grade—The slope of the surface of a road or the ground.

Gully—An erosional feature greater than 1 foot deep and 1 foot wide (1 square foot). Gullies may form when rills coalesce.

Haul road—A major logging road used by logging trucks to carry cut logs out of the cutting area.

Hillslope failure—Rapid movement or collapse of a hillslope due to the loss of its structural cohesiveness. On logged lands, hillslope failures commonly occur through the loss of vegetation and saturation of soils with water.

Humboldt crossing—A stream crossing in which logs are placed parallel to the stream flow, and buried in the road fill in place of a culvert or bridge

Inboard ditch—A ditch on the uphill side of a road against the cutbank.

Interfluvial—Areas between stream channels.

Intermittent stream—A stream with water flowing at some but not all times of the year.

Landform restoration—A process that reshapes and recontours landforms after roads have been completely removed. In complete landform restoration, all haul roads and some minor roads and skid trails are completely removed and the areas reshaped and recontoured. In partial landform restoration, all major roads and a limited number of minor roads are completely removed and the areas reshaped and recontoured. Some individual minor roads, or portions of roads that are not completely removed, remain and are decommissioned under the partial landform restoration approach.

Mass Wasting—The movement of rock and soil that is controlled directly by gravity and includes gradual movements such as creep and solifluction and rapid movements such as rockfalls, landslides, debris avalanches, and mudflows. Mass wasting excludes stream erosion.

Organic material—Soil components derived from the decaying remains of plants or animals rather than weathered rock.

Outsloping—To add a slight angle on a surface of a road so that water drains off the road onto a slope below.

Perennial stream—A stream with permanent flowing water.

Reach—A section of stream.

Rehabilitation—Actions taken that allow systems to function naturally again by restoring some attributes. Rehabilitation does not necessarily restore exactly the predisturbance characteristics but does establish geologically and hydrologically stable landscapes capable of supporting the natural ecosystem.

Residual Stand—The trees that remain after logging. In relation to marbled murrelets and northern spotted owl, those trees remaining after logging that provide constituents of nesting habitat for either species.

Restoration—Actions taken to bring back conditions that existed before human disturbance. The explicit goal of restoration is to re-create the historic ecological system, function, and process.

Riparian—The zone along a stream that is influenced by the stream. Typically refers to vegetation along waterways that is adapted to moist growing conditions and occasional flooding. Riparian areas are terrestrial areas where the vegetation complex and microclimate conditions are products of the combined presence and influence of perennial and/or intermittent water, associated high water tables, and soils that exhibit some wetness characteristics. The riparian zone is that area within which plants grow rooted in the water table of rivers, streams, ponds, or seeps.

Rill—An erosional feature less than 1 foot deep and 1 foot wide (1 square foot) created by microtopographic irregularities on the ground surface.

Road bench—The level portion of a road on a slope on which vehicles travel.

Sedimentation—Deposition of eroded soil into a stream.

Scarp—An abrupt change in grade on a slope.

Skid road—A minor logging road used to drag (skid) cut logs by bulldozer to a place where the logs can be loaded onto a logging truck and hauled out of the cutting area.

Slump—A geologic features that involves movement of a block of earth, or a series of blocks, such that displacement is along a concave-upward surface, creating a depression in the surface of the ground. Slumps are characterized by steep head scarps and contain flanks with scarps that decrease in height from the head region to the toe. The upper surface of the blocks are either flat or tilted back into the hillslope, and may contain trees leaning upslope. Often the movement grades into a more translational nature toward the lower portion of the slump, which may contain a zone of uplift, and trees leaning downslope.

Stream crossing—Where a road crosses a flow course or stream channel.

Teepee burner—A 25-to-35-foot-tall iron cone used to burn sawdust and wood chip waste from sawmills. Teepee burners are no longer allowable under air quality regulations.

**Finding of No Significant Impact
Lost Man Creek Watershed Restoration Plan
Redwood National and State Parks
Humboldt County, California
August 2006**

This Finding of No Significant Impact (FONSI) should be attached to the *Lost Man Creek Watershed Restoration Plan Environmental Assessment* (EA) dated June 27, 2006. This FONSI together with the EA constitute a complete record of the conservation planning and environmental impact analysis process for this proposal. There are no changes to the EA needed as a result of public comment.

The NPS will implement as its selected action Alternative 2 of the EA, Partial Restoration, which is also the proposed action and the environmentally preferred alternative. The selected action is one of three alternatives presented in the EA, which also considered the no action alternative and a full restoration alternative that are outlined later in this FONSI.

The Lost Man Creek Watershed Restoration Plan EA is tiered off the Redwood National and State Parks 1999 *Final General Management Plan/General Plan, Environmental Impact Statement / Environmental Impact Report* (GMP/EIS). The GMP directed that watershed restoration work within the parks should emphasize partial landform restoration, with complete removal of all major logging roads and limited removal of minor roads that pose the greatest threat to the parks' resources.

The GMP outlined the following management goals that are relevant to watershed restoration in Lost Man Creek:

- Protect and preserve the natural resources of the parks.
- Restore lands, ecosystems, and processes that have been altered by modern human activities.

Strategies for natural resource management and protection from the GMP that guide watershed restoration include:

- Support the perpetuation of ecosystem processes and components, including the redwood forest ecosystem as the prime RNSP resource.
- Restore and maintain RNSP ecosystems as they would have evolved without human influences since 1850.

Purpose and Need for Watershed Restoration in Lost Man Creek

The purpose of watershed restoration is to reduce adverse effects on park resources from erosion related to abandoned logging roads and from sedimentation of streams through rehabilitation of watersheds and restoration of watershed functions damaged by past logging and poorly constructed roads. The NPS will remove all or part of about 28 miles of abandoned logging roads in the Lost Man Creek watershed. This action is needed to control erosion, restore watershed functions, and protect park resources damaged by past land use and threatened by erosion associated with logging roads, especially high quality anadromous fish habitat.

Selected Action

The selected action is Alternative 2: Partial Restoration, which identified in the EA as the proposed action. There are no changes in actions, mitigations, or other key elements of the proposed action described in the EA.

Under the selected action, the NPS will contract with heavy equipment operators to treat 27.9 miles of abandoned roads dispersed throughout 5,804 acres in the South Fork, Middle Fork, and North Fork (including Larry Damm Creek) sub-basins of Lost Man Creek to reduce or prevent erosion of abandoned logging roads.

The restoration in Lost Man Creek will focus on removing fill from stream channels and headwater swales, placing excavated material in stable locations, retrieving and stabilizing material that was sidecast during road construction, and shaping all repositioned material to blend with the surrounding hillslope topography and drainage patterns. Road corridors will be recontoured, with excavated material placed against the cutbank or moved to stable locations if the cutbank is potentially unstable.

All locations along haul roads and most locations along skid road with the potential to erode and deliver sediment to the stream system will be fully excavated and restored as closely as possible to their pre-disturbance topography to restore pre-disturbance hydrological function and patterns. Those sites where erosion and sediment would damage high value terrestrial habitat down slope will also be fully excavated. Of the almost 28 miles of roads that will be treated, approximately 4.21 miles at stream crossings and 12.6 miles between stream crossings will be fully removed and the road corridor recontoured to resemble original topography.

About 11.14 miles of roads between stream crossings will be partially removed and recontoured where road failures would not cause severe damage to either streams or high value terrestrial habitat. Some sections of haul roads and skid roads that have the potential to erode, but where sediment would be unlikely to be delivered to a stream, will not be fully excavated. Those sites where full excavation would remove advanced second growth forest will receive a reduced level of treatment to reduce adverse effects on marbled murrelets and northern spotted owls from removal of forest vegetation.

Along the roads that will be partially removed, some untreated road segments and some skid roads will be inaccessible to heavy equipment at the completion of the project. The NPS has determined that none of road segments that will remain pose a significant threat to streams or terrestrial habitat, and therefore it is not cost-effective to remove these roads.

Approximately 398,200 cubic yards (cy) of road fill will be excavated for full and partial removal of the 23.7 miles of roads between stream crossings. Approximately 146,900 cy of fill will be excavated to remove 163 stream crossings along 4.2 miles of road.

Under the selected action, as well as the no action and full restoration alternatives, approximately 12 miles of roads (Geneva, Holter Ridge, and the B-Line North) that are passable by vehicles, relatively stable and pose a low risk of failure and that have been identified as needed for administrative or fire access will be maintained under the regular park road maintenance program by occasional brushing, grading, and culvert replacement as funding permits. These roads will be used for access to the project sites during implementation of the selected action. An additional 15 miles of roads will be upgraded for project access and then removed as part of the selected action.

Alternatives Considered in the Environmental Assessment

The June 2006 EA described three alternatives

- Alternative 1: No Action
- Alternative 2: Partial Restoration (selected action)
- Alternative 3: Full Restoration

The two action alternatives address removal of roads and restoration of landforms to resemble the original topography and restore drainage patterns that existed prior to the construction of the roads for logging.

Under the No Action alternative (Alternative 1), abandoned logging roads would remain in place. No failing roads would be removed, no stream crossings would be excavated, and no landforms would be recontoured to resemble original topography and restore drainage patterns. No additional work to restore damage to streams from logging roads would be undertaken in the Lost Man Creek watershed. The total mileage of roads removed in the Lost Man Creek watershed would remain at about 25 miles.

Under Alternative 3: Full Restoration, 32 miles of roads would be removed, including 4.63 miles at stream crossings, and the landforms restored to resemble the original topography. These 32 miles include the 28 miles of roads that will be removed under the selected action plus an additional 4 miles. Between stream crossings, approximately 27.4 miles of road would be fully removed and recontoured. Approximately 849,700 cy of road fill would be excavated for full removal and recontouring of the 27.4 miles of roads between stream crossings. Approximately 149,300 cy of fill would be excavated to remove 174 stream crossings.

Under the full restoration alternative, all locations along all haul and skid roads that have the potential to erode and deliver sediment to both aquatic and terrestrial sites would be fully excavated and recontoured to restore pre-disturbance drainage patterns. All sections of road between stream crossings would be fully excavated and the natural hillslope topography restored to the maximum extent reasonably and safely feasible. Only locations that cannot be safely accessed due to erosion that has already occurred or because of excessively steep slopes would be left untreated. Skid roads used to access and excavate sites with erosion potential would be fully recontoured to the maximum extent reasonably and safely feasible. Skid roads that are not used for access to other work sites would not be treated.

Environmentally Preferred Alternative

The environmentally preferred alternative is the action that best promotes the environmental policies outlined in the National Environmental Policy Act. These policies include fulfilling the responsibilities of each generation as trustee of the environment for succeeding generations; attaining the widest range of beneficial uses of the environment without degradation or risk to health or safety; and preserving important historic, cultural, and natural aspects of our national heritage.

The NPS has determined that Alternative 2: Partial Restoration (the selected action) is the environmentally preferred alternative. This alternative will reduce erosion and sediment delivered into streams to restore and improve downstream habitat for threatened fish species

while minimizing the adverse effects on threatened bird species caused by removing vegetation that has regrown on and adjacent to abandoned roads between stream crossings.

Although Alternative 3: Full Restoration would reduce potential erosion to a greater extent (about 625,000 cy of soil prevented from eroding under Alternative 3 versus about 575,000 cy in Alternative 2), almost twice the volume of soil would be excavated under Alternative 3 (999,000 cy) as under Alternative 2 (545,000 cy). Excavating twice the volume of soil would disturb up to twice the area of vegetation, including second growth forest areas, which would increase the adverse effects on northern spotted owls and marbled murrelets from habitat degradation and increased threat of predation due to removal of forest cover in the vicinity of potential nest trees.

Although this vegetation has grown back after logging and is not the original forest cover, the areas from which vegetation is removed are susceptible once again to invasion by exotic species because a greater amount of light enters openings where the forest canopy is removed. Openings in the forest canopy are also susceptible to colonization by both native and non-native berry-producing plants that are food sources for corvid birds and other nest predators, which are a major factor affecting marbled murrelet nesting success. The areas from which vegetation is removed will require 20- 40 years for trees to regrow into suitable habitat for many birds but alders will regrow to heights between four and ten feet on almost all excavated areas within four years.

The risk of failure of untreated road segments in partially excavated areas under the selected action has been judged to be acceptable in comparison to the higher environmental and fiscal cost associated with full restoration. Doubling the excavation volume under the Full Restoration alternative would also almost double the cost of the project. Because full restoration costs more, a smaller area can be restored for a given cost, increasing the overall time needed to complete watershed restoration in the park as a whole, which exposes other areas to road-related erosion and continuing resource damage. Full restoration requires more time to accomplish the work, increasing the risk that a large storm will occur with a corresponding increased risk from road failures in areas that have not yet been restored. Full excavation also results in a larger area of newly exposed soils at restoration sites that have a greater short-term risk from erosion in a major storm.

The majority of road fill excavated under the Full Restoration alternative would be between stream crossings (850,000 cy under Alternative 3 versus 398,000 cy under Alternative 2). The potential for damage to aquatic habitat by direct delivery of eroded sediment is not as high for road reaches between stream crossings as the potential for erosion at stream crossings. The number of stream crossings and volume of erosion prevented under Alternative 3 is only about 10 percent greater than under Alternative 2 (174 crossings with 146,000 cy prevented from eroding into streams under Alternative 3 versus 163 crossings with 132,000 cy prevented from eroding into streams under Alternative 2). Thus, while Alternative 3: Full Restoration would result in a 10 percent greater reduction in erosion over the long term, it has greater short-term impacts on threatened birds from removal of more vegetation, which reduces cover for these birds, and increases the area of exposed soils susceptible to colonization by berry-producing shrubs that are a food source for avian nest predators of marbled murrelets, and invasive exotic plants including Himalaya berry. The greater area of newly exposed soils under a Full Restoration alternative also results in an increased risk of erosion if a major storm occurs in the first season following restoration. The short- and long-term risks to fish from erosion into streams can be mitigated more effectively than the short-term risks to birds from noise and removal and degradation of habitat.

The NPS has determined that Alternative 2: Partial Restoration will have less short-term adverse effects on threatened bird species than Alternative 3: Full Restoration while protecting the most sensitive terrestrial habitat areas from road-related landslides and still eliminating erosion into the stream channels that degrades habitat for threatened fish species. The U.S. Fish and Wildlife Service (USFWS) concurred with the NPS determination that the project may affect but is not likely to adversely affect northern spotted owls, and may affect and is likely to adversely affect marbled murrelets in 66 acres of occupied or potentially occupied nesting habitat from increased threat of corvid predation, habitat degradation on 7 acres, and noise disturbance in 2 acres. However, the USFWS determined that the project is not likely to jeopardize the continued existence of marbled murrelets, or result in destruction or modification of critical habitat. NOAA Fisheries (also known as National Marine Fisheries Service [NMFS]) concurred with the NPS determination that the project may affect and is likely to adversely affect Southern Oregon/Northern California Coast (SONCC) coho salmon, Coastal California (CC) Chinook salmon, and Northern California (NC) steelhead trout, their habitat, and Essential Fish Habitat. After reviewing the best available scientific and commercial information, current status of these fish species, and their designated critical habitats, the environmental baseline for the action area, the anticipated effects of the Lost Man Creek restoration project, and the cumulative effects, NMFS issued a biological opinion that the implementation of the selected action is not likely to jeopardize the continued existence of the three fish species, and is not likely to destroy or adversely modify designated critical habitat of these species.

The No Action alternative (Alternative 1) is not the environmentally preferred alternative because the roads would continue to erode gradually or eventually fail massively in a storm. Sediment would be delivered into streams either slowly through gradual erosion or in massive slope and stream-crossing failures. On road segments high above streams or in between stream crossings, the risk of road-related landslides that destroy vegetation would increase. The sediment delivered into streams would move downstream and further degrade the quality of spawning habitat for threatened coho and chinook salmon and steelhead trout.

Alternative 3: Full Restoration is not the environmentally preferred alternative because it has greater short-term impacts on threatened birds from removal of more vegetation, which reduces cover for these birds, and increases the area of exposed soils susceptible to invasive exotic plants that are food sources for avian nest predators.

Public Involvement

Watershed restoration was a major topic in the 1999 GMP/EIS, which received full public review beginning with scoping in 1996 and continuing through 2000, when the signed Record of Decision was distributed to everyone who commented on the draft EIS.

The NPS began public scoping for the selected action in April 2004, and sent letters to 141 agencies, organizations, and individuals in April 2004, soliciting comments on the project. Seven people attended a public field trip on September 25, 2004. A presentation about the project was made on October 5, 2004 to the Strategic Partnership Coalition, a group of council members from local Tribes and representatives of state and federal agencies who meet to share information on environmental issues and concerns. NPS and CDPR sent letters on November 3, 2004 to Yurok Tribe representatives, Trinidad Rancheria representatives, Big Lagoon Rancheria representatives, Resighini Rancheria representatives and the California State Office of Historic Preservation

(SHPO) requesting comments, issues or concerns regarding the project. The NPS met regularly with the USFWS and NMFS to incorporate threatened and endangered species protection measures as the project was developed.

The Lost Man Creek watershed restoration EA was made available for public review and comment on June 28, 2006 for a 31-day period ending July 28, 2006. Seventy-eight copies of the EA were distributed via U.S. Mail to elected officials; federal, state and local agencies; federally recognized American Indian tribes; organizations; local businesses; and the general public. Copies of the document were also available at local libraries in Crescent City, Arcata, and Eureka, and at park offices in Crescent City and Orick.

The NPS issued a press release to the standard RNSP mailing list of 33 print, television, and radio media on June 27, 2006, announcing the availability of the EA for public comment. Copies of the EA were provided to the local newspapers in Eureka, Arcata, McKinleyville (all serving Humboldt County where the project will take place), and Crescent City (Del Norte County where park headquarters is located.) The *Eureka Times-Standard* and the *McKinleyville Press* published short outlines of the proposal and provided information on how to comment.

The NPS received four letters and one electronic mail message commenting on the project. There were no substantive comments that raised new issues or concerns. Four comments expressed support for watershed restoration as described in the EA, for the purpose of reducing sediment threats to improve water quality and habitat for endangered species, especially salmonids. One comment supported watershed restoration while expressing a belief that restoration could be accomplished in a manner that included development of trails for hiking, equestrian, and bicycle use. One of the letters of support from a biologist at the California Department of Fish and Game Eureka office also provided recent data to update and refine descriptions in the Affected Environment of salmonid life histories and habitat in the mainstem of Redwood Creek. The Affected Environment section was based on data obtained from studies conducted in the park over the past 20 years. The new data are relevant to the mainstem of Redwood Creek outside the Lost Man Creek project area, and do not alter any of the statements regarding fish populations in the project area nor any of the conclusions on the effects of the project on fish.

Endangered Species Consultations

The NPS initiated informal consultation with USFWS and NMFS in 2004 under Section 7(a)(2) of the Endangered Species Act of 1973, as amended, for the purpose of determining whether any federally listed or proposed threatened or endangered, or candidate, plants or animals would be affected by this project. Informal consultation on this project began during an Interagency Consultation Team (ICT) field trip on July 14, 2004 to view on of the project sites and the various problems associated with erosion. Based on discussions at three meetings in February and March 2005, the ICT determined that potential impacts of the proposal to listed terrestrial and aquatic species warranted formal consultations with both USFWS and NMFS. Two additional field reviews were conducted in March and April, 2005.

The NPS submitted a final biological assessment to the USFWS on March 10, 2006 that described the project, potential effects of the project on northern spotted owls and marbled murrelets, and measures to minimize adverse effects on these two species. The USFWS issued a Biological Opinion file number 8-14-2006-2836 which concurred with the NPS determination that the project may affect but is not likely to adversely affect the northern spotted owl and that

the project may affect and is likely to adversely affect the marbled murrelet. The NPS requested, and the USFWS authorized, incidental take of marbled murrelets expected from harassment of nesting birds due to operation of heavy equipment in 2 acres of occupied nesting habitat during the breeding season; harm of murrelets due with an increased risk of corvid predation on 66 acres of nesting habitat; and harm of murrelets associated with 7 acres of nesting habitat due to habitat degradation. The biological opinion concluded that the level of anticipated take from this project is not likely to result in jeopardy to the marbled murrelet, or destruction or adverse modification of critical habitat for the marbled murrelet.

The NPS submitted a biological assessment to NMFS in April 2006 that described the project, potential effects of the project on SONCC coho salmon, CC chinook salmon, and NC steelhead trout; and measures to avoid or minimize adverse effects on these species, and designated critical habitat for these species. NMFS issued Biological Opinion SWR/2004/02180 that concurs with the NPS determination that the project may affect and is likely to adversely affect the three listed fish species, and requires monitoring of sediment input as a term and condition to minimize adverse effects on these listed species and their designated critical habitat. The NPS requested, and the NMFS authorized, incidental take for an unspecified number of juvenile fish in an unspecified length of stream due to increased turbidity in the first rainy season after excavation. 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 Lost Man Creek restoration project, and the cumulative effects, NMFS concluded that that the implementation of the Lost Man Creek restoration project, 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. Mitigation measures associated with the species and their habitat would also protect Essential Fish Habitat.

Cultural Resource Consultations

The NPS initiated government-to-government consultations on the plan in November 2004 with the Big Lagoon Rancheria, Elk Valley Rancheria, Hoopa Valley Tribe, Resighini Rancheria, Smith River Rancheria, Tolowa Nation, Trinidad Rancheria, and the Yurok Tribe via a letter informing each group of the proposed project and requesting information about cultural resources that might be affected by the proposal. No comments from any of these groups were received on the proposal.

Ethnographic interviews conducted in 2000 provided information about the project area being used for resource procurement and fishing along the lower reaches of the Lost Man Creek watershed. Consultation with the Yurok Tribe Culture Committee occurred on August 26, 2005 and November 18, 2005 in the Klamath tribal office. The initial consultation with the Yurok Tribe Culture Committee resulted in the recommendation to speak in detail with a Yurok elder who has knowledge of the history of trails and logging history of the area and a traditional Yurok basket maker with resource knowledge of the area, particularly a bear grass area close to the coast used by Yurok basket makers.

A post-survey consultation on the survey findings was conducted with the Yurok Tribe Culture Committee on November 18, 2005. The location of the bear grass site on Holter Ridge Road was shared with the committee and recommendations were sought for future management. The Yurok

Tribe Culture Committee recommended that the bear grass site be protected from impact by the project, and for future management to enhance and improve the health of this site.

The NPS consulted on the plan with the SHPO under Section 106 of the National Historic Preservation Act (35 CFR 800) and under the 1995 Programmatic Agreement Among the NPS, the Advisory Council on Historic Preservation, and the National Conference of State Historic Preservation Officers, Section V (1995 PA). The NPS notified the SHPO in November 2004 that an environmental assessment was being prepared and outlined the project. The NPS sent a subsequent letter to the SHPO in March 2006 seeking concurrence with the preliminary findings and recommendations for protecting historic properties in the project area, including two sites on Holter Ridge. The SHPO responded in April 2006 with concurrence that a finding of No Adverse Effect with conditions outlined in the NPS recommendations was appropriate for this project.

Why This Project Will Not Have a Significant Effect on the Environment

This section summarizes effects on resources in the context of the project area, Lost Man Creek downstream of the project area, Redwood Creek within the park, and the parks as a whole, and documents that none of these effects is significant, highly controversial or uncertain, nor will the selected action adversely affect public health and safety. Further, the selected action is not part of a larger action and will not establish a precedent for future actions.

The EA contains descriptions of the mitigation and best management practices to protect resources including water quality, riparian wetlands, and threatened bird and fish species that are known to be present and might be affected by the project. Additional descriptions of mitigation measures to protect federally-listed threatened birds that might be affected by the project and fish species that occur downstream of the project area are contained in the USFWS Biological Opinion file number 8-14-2006-2836 and the Terms and Conditions portion of the NMFS Biological Opinion SWR/2004/02180, respectively.

Potential effects to other resources have been determined to be negligible or minor and will not require mitigation on the part of the NPS to avoid or reduce the effects discussed below.

Air Quality—The selected action will have short-term localized adverse effects on air quality from vehicle emissions and fugitive dust from excavation of road fill while heavy equipment is working. Dust suppression equipment and clean water will be used to reduce excess airborne particulates from exposed soils in active construction areas. Heavy equipment is licensed under state regulations to meet state air quality standards for vehicle emissions. Air quality will quickly return to very good to excellent when excavation is completed and vehicles no longer access the project area. The long-term adverse effect on air quality will be negligible.

Cumulative Effects on Air Quality—Air quality in the parks and the region will continue to be very good to excellent over the long-term. The only potentially significant source of air pollution is from wildfires, which could have significant adverse effects on air quality for the duration of a fire. Potential adverse effects on air quality from planned fire ignitions are negligible to moderate. The North Coast Air Quality Management District coordinates planned ignitions in Humboldt, Del Norte, and Trinity Counties to minimize cumulative adverse smoke effects on sensitive areas (local communities and highways). The cumulative effect on air quality in the parks from prescribed fires conducted on adjacent private timber lands to reduce logging slash

will be short-term, adverse, localized and could range from negligible to moderate depending on wind conditions and how close the prescribed fires are to park boundaries.

Effects on Soils and Topography—Under the selected action, about 545,000 cy of soil will be excavated over an area of 216 acres to remove about 28 miles of abandoned logging roads throughout 5,804 acres in the project area. All soils affected by the project are previously disturbed from original road construction and logging. Soil horizons will be restored to more or less their original position, with topsoil uncovered and repositioned on top rather than buried beneath fill. Excavated areas will be covered with mulch to reduce erosion until vegetation regrows from the seed bank in the repositioned topsoil. The selected action will reduce the potential for landslides caused by failing roads by excavating unstable road fill and moving it to more stable locations, and reshaping landforms to resemble original topography as closely as possible. The selected action will have a minor to moderate benefit to soils and topography in the project area from moving soils to more stable locations, repositioning top soil, restoring landforms, and reducing the potential for land slides and erosion by completely removing 12.6 miles and partially removing 11.1 miles of roads between stream crossings and completely removing 4.2 miles of stream crossings.

Cumulative Effects on Soils and Topography—The selected action will reduce soil erosion by removing and stabilizing road fills and increase the acreage of landforms restored in the Lost Man Creek watershed by removing or treating 28 miles of roads, bringing the total mileage of roads treated to about 53 miles. The selected action will have a minor cumulative benefit to soils and topography in the Lost Man Creek watershed, and no effect on soils or topography in other watersheds.

Effects on Hydrology and Water Quality—Water quality at project sites, particularly stream crossings, will be protected during excavation through best management practices (BMPs) to reduce soil erosion at excavation sites and prevent petrochemical or other contaminant spills. A spill prevention plan will be prepared.

The selected action will have short-term adverse effects on water quality from increased turbidity in Lost Man Creek and its tributaries for several years following excavation as any remaining fill material is flushed out during winter storms as the stream channels readjust to the restored configuration. Turbidity is highest in the first storm after excavation and declines with each successive storm. The short-term adverse effects from increased turbidity are outweighed by the long-term benefits to hydrology from restoring drainage patterns and benefits to water quality from removing 146,900 cubic yards of fill from 163 stream channels and reducing erosion potential from about 560,000 cubic yards that could enter streams or damage aquatic habitat as road fill erodes and roads fail.

Following the completion of the project, some untreated segments of roads and skid roads will be inaccessible to heavy equipment used to remove roads. These untreated roads do not have the potential to deliver sediment to streams or damage important terrestrial habitat and do not pose a significant erosional threat.

Thus, the selected action will have negligible short-term adverse effects on water quality and minor to moderate long-term benefits to hydrology and water quality from restoring drainage patterns and reducing potential for road failures that introduce sediment into streams.

Cumulative Effects on Hydrology and Water Quality—Redwood Creek has been identified as a sediment-impaired and temperature-impaired stream by the U.S. Environmental Protection Agency (EPA) and as water-quality limited due to clean sediment loading by the North Coast Regional Water Quality Control Board. The EPA established a Total Maximum Daily Load (TMDL) for sediment for Redwood Creek under Section 303(d) (1) (A) of the Clean Water Act.

The Redwood Creek TMDL is used as a reference to ensure that watershed restoration in Lost Man Creek is consistent with the recommendations of the TMDL to protect the beneficial uses of Redwood Creek, particularly the cold water fishery. The Redwood Creek TMDL is primarily concerned with the conditions on the mainstem of Redwood Creek that result from the effects of land use and natural conditions on the mainstem and all the tributaries. Redwood Creek TMDL hillslope targets will be met or exceeded under the proposed action but water quality of Redwood Creek within the park will not improve significantly because the confluence of Redwood Creek with Lost Man Creek /Prairie Creek is downstream of the park. Sediment that might be delivered to the Redwood Creek estuary (which is located within the park) will be reduced but water quality in Redwood Creek within the park will continue to be adversely affected by logging roads on unstable slopes upstream of the park and abandoned failing roads within other Redwood Creek subwatersheds in the park. The erosion potential for Redwood Creek upstream of the confluence of Lost Man Creek/Prairie Creek would remain at about 5 million cubic yards. As this sediment erodes, it will continue to adversely affect hydrology and water quality within the park.

Effects on Floodplains and Wetlands—There are no well-developed floodplains in the project area because of steep slopes and confined stream channels. Floodplains are present lower in the drainage, the mainstem of Lost Man Creek, and along Prairie Creek. The selected action will have a negligible indirect long-term benefit to the floodplain of Lost Man Creek downstream of the project area from restoration of hydrology and from reducing the threat of erosion upstream if a major road failure deposited large quantities of sediment into stream channels.

Wetlands in the project area consist primarily of riparian areas along the stream channels, puddles formed in depressions and slumps caused by road failures, and temporary wetlands formed in road ditches. The primary wetland values are small patches of amphibian breeding habitat in the ditches and slumps. The selected action will have a minor adverse effect on wetlands from draining the ditches and removal of slumps in failed roadbeds and indirect long-term benefits to riparian wetlands from restoring drainage patterns. The overall effects on riparian wetlands from the selected action will be negligible to minor, short-term, and adverse from disturbance to the streambanks and removal of riparian vegetation along flowing streams. The wetlands created by road failures and those in ditches will be removed but the adverse effect on amphibians from removal of small puddles will be outweighed by the long-term benefit from reducing the threat of road failures that result in loss of larger amounts of riparian habitat.

Effects on Vegetation—Approximately 216 acres of vegetation will be removed to excavate road fill, although not all of the roads or stream crossings are heavily vegetated. The vegetation that will be removed has all regrown following logging, and is primarily small alders and Douglas-fir. No large residual old-growth will be removed. Trees larger than 18 inches diameter at breast height will be removed only if necessary to achieve rehabilitation objectives. The effects on vegetation are short-term, adverse, and negligible, because all vegetation to be removed has regrown after logging.

Cumulative Effects on Vegetation—Cumulative adverse effects on vegetation in the parks and the surrounding region result from logging and associated road construction, and residential, commercial, industrial, agricultural, and transportation development and use. The most significant cumulative effect on vegetation in the parks occurred prior to park establishment and expansion from the logging of about 50,000 acres of original coniferous forest, mostly in the Redwood Creek watershed. Park projects that remove vegetation include other watershed restoration projects, maintenance of roads and trails, and restoration of the Bald Hills grasslands and oak woodlands through removal of encroaching Douglas-fir. Areas of the park with Port-Orford-cedar are being managed to reduce the spread of Port-Orford-cedar root disease, in cooperation with the U.S. Forest Service and the Bureau of Land Management over the range of Port-Orford-cedar. Sudden Oak Death, caused by a pathogen closely related to the root disease agent, is also expected to adversely affect park vegetation but the degree of effect is not yet known.

Effects on Wildlife—There will be short-term localized adverse effects on wildlife from noise, disturbance, and loss of 216 acres of vegetation that provides wildlife habitat. Individuals of small sedentary species will be killed or displaced by excavation and vegetation removal. Mulching of newly excavated areas will provide immediate shelter for small animals. The effect on wildlife will be negligible over the long-term because wildlife species that are present have been affected by the high degree of disturbance that has occurred on site and will recolonize newly excavated areas as vegetation regrows in 4-10 years.

Cumulative Effects on Wildlife—Cumulative adverse effects on wildlife in the parks relate primarily to activities outside the parks including loss or conversion of habitat for agricultural, residential, commercial, and transportation development; mortality from vehicle collisions along U.S. Highway 101; and illegal poaching of elk and deer. These effects are negligible to significant, depending on the species and its degree of mobility and tolerance of human presence and disturbance. Some individual animals benefit in the short-term from the presence of humans who leave trash that serves as a food source, and from disturbance due to logging, which increases forage for some species as vegetation regrows. However, in the long-term, human food sources have a moderate to significant adverse effect on individual animals that become accustomed to unhealthy food sources or are killed if they become a nuisance or cross highways to get to food sources. Other park actions that affect wildlife include second growth forest management, control of non-native plants, and maintenance of facilities. The cumulative effects on wildlife from park actions in the short-term will be adverse, localized, and negligible. Park resource management projects have long-term minor to moderate benefits on wildlife species from restoration of habitat and because the parks serve as a refugium from disturbance.

Effects on Rare, Sensitive, Threatened, and Endangered Species—USFWS Biological Opinion 8-14-2006-2836 concurs with the NPS determination that the project may affect but is not likely to adversely affect the northern spotted owl and that the project may affect and is likely to adversely affect the marbled murrelet. The NPS requested, and the USFWS authorized, incidental take of marbled murrelets expected from harassment of nesting birds due to operation of heavy equipment in 2 acres of occupied nesting habitat during the breeding season; harm of murrelets due with an increased risk of corvid predation on 66 acres of nesting habitat; and harm of murrelets associated with 7 acres of nesting habitat due to habitat degradation. The biological opinion concluded that the level of anticipated take from this project is not likely to result in jeopardy to the marbled murrelet, or destruction or adverse modification of critical habitat for the marbled murrelet.

NMFS Biological Opinion SWR/2004/02180 concurs with the NPS determination that the project may affect and is likely to adversely affect SONCC coho salmon, CC chinook salmon, and NC steelhead trout, and requires monitoring of sediment input as a term and condition to minimize adverse effects on these listed species and their designated critical habitat. The NPS requested, and the NMFS authorized, incidental take for an unspecified number of juvenile fish in an unspecified length of stream due to increased turbidity in the first rainy season after excavation. 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 Lost Man Creek restoration project, and the cumulative effects, NMFS concluded that the implementation of the Lost Man Creek restoration project 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 for these species. Mitigation measures associated with the species and their habitat would also protect Essential Fish Habitat.

For threatened fish and birds, the effect of the selected action will be adverse, short-term, and negligible (owls) or minor (fish, murrelets). For threatened birds species, there will be a negligible benefit over the very long-term as vegetation that is removed on 216 acres eventually reattains forest characteristics suitable for foraging (owls) or nesting (owls, murrelets). For threatened fish, there will be short-term minor adverse impacts to juvenile fish from increased turbidity from minor erosion of newly excavated streams crossings for the first rainy season following excavation, and a minor to moderate long-term indirect benefit from reducing the potential for erosion that can lead to sedimentation of spawning habitat in Lost Man Creek downstream of the project area.

Cumulative Effects on Rare, Sensitive, Threatened, and Endangered Species — Almost all activities in RNSP affect federally listed threatened species because the forests and streams in the parks are occupied by northern spotted owls or marbled murrelets, and coho and chinook salmon, and steelhead trout. Fire management through out the parks will have minor long-term benefits to sensitive species from reduction in fuel levels that reduce the potential for catastrophic wildfires. Management of second growth forests in RNSP will have minor to moderate benefits as forests regain characteristics more typical of old growth forest and the habitat for forest-dwelling bird species improves. On-going and planned projects and activities for which the NPS consults with either USFWS or NMFS for potential effects on listed, proposed, and candidate species include road, trail and facility maintenance and construction; non-native plant management; helicopter and off-road vehicle use; and beach management. The NPS has been authorized incidental take of listed species, primarily northern spotted owls, marbled murrelets, and juvenile anadromous salmonids, by the USFWS and/or NMFS for some of these activities. On-going and reasonably foreseeable NPS actions will not jeopardize the continued survival of any listed threatened species.

Outside the parks, the primary activities that affect listed threatened and endangered species are loss of habitat from logging, residential, industrial, and agricultural development; dams for power development, flood control, and water supply for domestic, industrial, and agricultural activities; and residential, commercial, industrial, agricultural, and recreational development projects that reduce the quality of habitat or decrease the quantity of habitat. For anadromous fish, sport and commercial fishing also affect fish populations over both the short- and long-term. The

cumulative effects on some species and their habitat are widespread, adverse, long-term, and significant, and have resulted in the listing of these species as threatened.

Effects on Cultural Resources—No historic resources listed or eligible for listing on the National Register of Historic Places will be adversely affected by the selected action either by road maintenance and upgrading for access to work sites followed by removal of these roads, or maintenance of approximately 12 miles of roads for administrative and recreational access.

Cumulative Effects on Cultural Resources—Other on-going and proposed activities in the parks include fire management, watershed restoration, management of second growth forests and non-native plants, and maintenance and construction of trails and other facilities. The cultural sensitivity of the coniferous forest where watershed restoration and second growth forest management will occur is very low because these areas were logged or affected by road construction, which very likely damaged or destroyed any cultural resources originally present. Invasive non-native plants occur primarily in areas affected by recent human disturbance.

Cultural resource surveys are conducted prior to any work involving ground disturbance. Cultural resources in areas of known cultural sensitivity are protected by avoiding or minimizing ground disturbance. The NPS consults with affiliated American Indian groups and/or the SHPO/YTHPO as required under the 1995 PA on all projects that have the potential to affect cultural resources. No significant adverse effects to cultural resources are anticipated from any reasonably foreseeable park actions.

Effects on Visitor Experience and Visual Quality—There are no visitor facilities that will be affected by the selected action. The effect on visitor experience and visual quality from the selected action will be negligible.

Cumulative Effects on Visitor Experience and Visual Quality—Opportunities for hiking, mountain biking, equestrian use, and primitive camping are being proposed as part of a comprehensive trail plan for RNSP. Other recreational opportunities in the vicinity include sport fishing in the Smith and Klamath Rivers and the ocean; sea kayaking and surfing; whitewater boating on the Smith River; the Smith River Rancheria casino on Highway 101 north of Crescent City; the Gold Bear Casino on the Resighini Rancheria at Klamath; and the Elk Valley Rancheria Casino on Howland Hill Road that would be replaced by a proposed casino resort along Highway 101 south of Crescent City; camping and hiking in RNSP, Six Rivers National Forest, and the Smith River National Recreation Area (NRA); scenery and wildlife viewing and photography in RNSP, Tolowa Dunes State Park, the national forest, the NRA, and Pelican Bay State Beach and other beaches in Del Norte County; and many additional recreational activities available in Crescent City, Del Norte County, and southern Oregon.

Effects on Adjacent Communities—Under the selected action, the NPS will contract with heavy equipment operators to remove roads. Previous watershed restoration contracts have been awarded to operators from nearby communities. Should the contract for the selected action be awarded to local contractors, there will be an economic benefit that is likely to contribute to the local economy.

Cumulative Impacts on Adjacent Communities—It is not possible to describe all the past, present, and reasonably foreseeable actions that have affected or might affect communities adjacent to the parks, particularly the community of Orick. The most significant factor in the economy of Orick

is the decline of timber-based economy following the establishment and expansion of Redwood National Park, gradual decrease in timber supply available to local mills, and increased regulation of timber operations to protect watersheds and endangered species. The NPS is providing technical assistance to the community of Orick, and participating with other public and private entities for planning for watershed protection for Redwood Creek, including development of a community wastewater system.

Conclusion—As summarized above, the effects of the selected action have been considered and determined to be less than significant. These effects have also been considered under the criteria for significance listed in the Council on Environmental Quality regulations (40 CFR 1508.27) and found to be less than significant. Actions for which mitigation can be prescribed, the prescribed mitigation, and the responsible party are summarized in the following table.

Summary of Effects and Mitigation for Lost Man Creek Watershed Restoration

<i>Resource & Effect</i>	<i>Mitigation</i>	<i>Responsible Party</i>
Air Quality: short term adverse effects from construction dust, vehicle emissions	Water trucks for dust abatement; vehicle emissions regulated to state standards	Contractor—dust control & vehicle maintenance; NPS, CDPR—park vehicle maintenance
Soils, Geological Resources, & Geological Hazards: 216 acres disturbed by restoration	All soils previously disturbed by logging and road construction	Contractor—excavation, restoration of landforms, and mulching for erosion control
Hydrology & Water Quality: erosion of bare soils in stream channels following excavation	BMPs to protect fish-bearing streams will avoid or minimize run-off into stream during & after excavation; spill prevention plan (SPP) required	NPS—develop BMPs , spill prevention plan; Contractor—BMPs implemented during construction, comply with SPP
Floodplains & Wetlands: short-term adverse effects from removal of riparian vegetation where stream channels are excavated	Adverse effects to riparian wetlands from removal of vegetation adjacent to culverts and fill from stream channels; long-term minor to moderate benefit to floodplain & riparian wetlands from restoring hydrological regime to more closely resemble original hydrology	Contractor—implement BMPs during operations, comply with SPP
Vegetation: vegetation on 216 acres of old roads	Vegetation previously removed by logging; mulching and replacement of topsoil speeds natural revegetation	Contractor—apply mulch under direction of COTR
Wildlife: day-time disturbance from equipment and personnel for several weeks between June and mid-October ;	No mitigation prescribed for disturbance to species tolerant of on-going human disturbance; remove all food scraps and trash to avoid attracting scavengers and habituating wildlife to people and human food	NPS, contractors

<i>Resource & Effect</i>	<i>Mitigation</i>	<i>Responsible Party</i>
Short-term loss of habitat on 216 acres	sources	
Sensitive Species: no sensitive plants; three anadromous fish species; marbled murrelets	BMPs required during construction to protect fish from erosion into stream; long-term benefit restoring drainage and reducing erosion potential; daily limited operating periods (DLOP) to protect murrelets	NPS—monitor BMPs to be implemented by contractor during construction; Contractors: observe DLOPs
Cultural Resources: no National Register-eligible resources affected	All ground-disturbing activities monitored; work will cease & the NPS will consult with the SHPO or Yurok Tribe, as required under the 1995 PA if resources encountered	NPS, contractors
Visitor Experience: no visitor facilities in project area	No direct effect on visitors because no existing visitor facilities in project area; locked gates prevent unauthorized vehicle access; signs requiring hard hats in heavy equipment operations areas	NPS, contractors

Non-Impairment of Park Resources and Values

Non-Impairment of Air Quality—Air quality will be adversely affected primarily by dust raised from excavation with negligible effects from vehicle emissions. Dust will be controlled by sprinkling water from water trucks. Vehicles will be licensed under California and federal emission standards. Air quality in the parks will return to very good to excellent condition after ground disturbance ceases to generate dust and equipment operations cease. The long-term effect of vehicle emissions associated with park maintenance operations on Geneva, Holter Ridge, and B-Line roads is negligible. Therefore, the selected action will not impair air quality or air quality related values in the parks.

Non-Impairment of Soils and Topography—Approximately 216 acres of soils will be affected by excavation of roads and stream crossings. These soils were previously disturbed by the original road construction and by logging. The selected action will protect soils from further disturbance caused by erosion and failure of untreated logging roads and will uncover and return topsoil to more or less its original position. The original topography of hillslopes and stream crossings will be fully restored along 12.55 miles and partially restored along 11.14 miles, with 163 stream crossings excavated to original channel shape and depth. Therefore, the selected action will not impair soils or topography in the parks and will eliminate or reduce impairment to soils and topography in the project area that resulted from construction and subsequent failure of logging roads.

Non-Impairment of Hydrology and Water Quality—Lost Man Creek is a major tributary of Prairie Creek. Prairie Creek is one of the largest tributaries of Redwood Creek and the last major tributary to join Redwood Creek at the confluence about four miles upstream of the Pacific Ocean. Redwood Creek has been identified as a sediment-impaired and temperature-impaired stream by EPA and as water-quality limited due to clean sediment loading by the North Coast

Regional Water Quality Control Board. The Redwood Creek TMDL for sediment established by the EPA is used as a reference to ensure that watershed restoration in Lost Man Creek is consistent with the TMDL recommendations to protect the beneficial uses of Redwood Creek, particularly the cold water fishery. The Redwood Creek TMDL is primarily concerned with the conditions on the mainstem of Redwood Creek that result from the effects of land use and natural conditions on the mainstem and all the tributaries. The position of Lost Man Creek/Prairie Creek low in the Redwood Creek watershed means that restoration in Lost Man Creek contributes less to the reduction of sediment in the mainstem of Redwood Creek than restoration of other tributaries higher in the drainage. However, Lost Man Creek has been judged by the NPS to be proportionately more ecologically valuable than other tributaries in the parks because Lost Man Creek still contains intact streamside old growth redwoods, high quality fish spawning habitat, and viable fish populations. The proposed restoration work in Lost Man Creek is fully consistent with the recommendations in the Redwood Creek TMDL for improving water quality through reduction of sediment related to human activities.

Potential adverse effects on water quality during excavation of stream crossings will be avoided through BMPs prescribed in the NPS/NMFS Biological Assessment/Biological Opinion. The selected action will result in short-term adverse effects on water quality from increased turbidity in first few years following excavation of stream channels as small quantities of sediment remaining after excavation are flushed out in storm events. In the long-term, restoration will protect and improve water quality from removing erodible road fill from stream channels and moving unstable fill to locations where it will not erode into streams.

The selected action will restore hydrological patterns that existed prior to the construction of the road network by excavating stream channels and restoring the natural topography by removing roads. The project area will be considered “hydrologically transparent” following the excavation of road fill from stream channels and restoration of topography that will restore original drainage patterns. Therefore, the selected action will not impair hydrology or water quality in Lost Man Creek and will reduce the sediment impairment in Redwood Creek. The selected action will eliminate the impairment to hydrology in the project area created by the alteration of topography from roads on slopes and across stream channels.

Non-Impairment of Floodplains and Riparian Wetlands—The steep, narrow stream channels in the project area do not have well-developed floodplains. The selected action will benefit the floodplain of Lost Man Creek downstream of the project area by restoring hydrological patterns upstream and reducing the potential for road failures that could deliver large quantities of sediment into the floodplain in major storms.

Small areas of riparian wetlands along permanent streams will be adversely affected during excavation of stream crossings. Riparian vegetation will regrow along streams within a few years after excavation. Removal of fill from stream channels and restoration of drainage patterns by restoring topography will improve the hydrological functioning of the stream channels, which will benefit the riparian zones of larger sections of the streams, including the mainstem of Lost Man Creek downstream of the project area. Therefore, the selected action will not impair floodplains or wetlands.

Non-Impairment of Vegetation Resources—The project area was logged between the 1950s and the mid-1970s. The original vegetation community was impaired by logging. The existing vegetation is second-growth forest and shrubs that have regrown following logging, with

scattered individual residual trees that were not cut. The selected action will redisturb the second-growth vegetation on landings and in corridors along logging roads on 216 acres of the 5804-acre project area. No trees larger than 24" diameter at breast height will be removed. The seedbank in topsoil that was buried beneath road fill will be exposed in repositioned topsoil and will speed revegetation with local species. Native shrubs, alder, and Douglas-fir will re-establish on excavated areas in several years.

Therefore, the selected action will not cause further impairment to park plant communities or vegetation but it will not eliminate or reduce the impairment to the original plant communities caused by logging in the project area and other areas of the park prior to park establishment.

Non-Impairment of Wildlife Resources—Some wildlife species that occur in the project area will be adversely affected by noise and disturbance at work sites during heavy equipment operations, or loss of habitat from removal of vegetation. On-site vegetation removed by excavation will be used for mulch and will provide immediate shelter for small animals. Contractors and park employees will remove all trash and human food from worksites daily to avoid habituating park wildlife to human food sources. Loss of habitat from vegetation removal will be a short-term adverse effect on small sedentary animals that cannot move out of work sites but the selected action will not affect any populations of wildlife or the long-term persistence of any wildlife species. Therefore, the selected action will not impair wildlife resources.

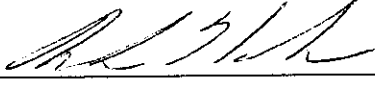
Non-Impairment of Rare, Sensitive, Threatened, and Endangered Species—The USFWS concurred with the NPS determination that the selected action may affect but is not likely to adversely affect northern spotted owls, and may affect and is likely to adversely affect marbled murrelets in 66 acres of occupied or potentially occupied nesting habitat from increased threat of corvid predation, habitat degradation on 7 acres, and noise disturbance in 2 acres. However, the USFWS determined that the selected action is not likely to jeopardize the continued existence of marbled murrelets, or result in destruction or modification of critical habitat. NMFS concurred with the NPS determination that the project may affect and is likely to adversely affect SONCC coho salmon, CC Chinook salmon, NC steelhead, their habitat, and Essential Fish Habitat, and authorized incidental take for an unspecified number of juvenile fish in an unspecified length of stream due to increased turbidity in the first rainy season after excavation. NMFS concluded that the implementation of selected action 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 these species. Therefore, the selected action will not cause impairment to threatened or endangered species.

Non-Impairment of Cultural Resources—There are no historic properties that will be affected by the selected action. Therefore, the selected action will not impair cultural resources.

Basis for Decision

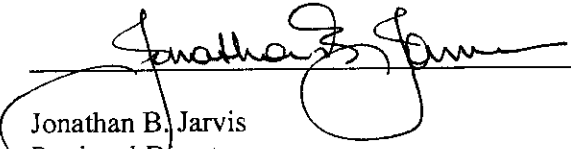
Based on the environmental assessment, analyses of issues and alternatives, together with consideration of public interest and the relation between public interest and laws, statutes, and regulations for managing NPS units, the ability of the mitigation measures to reduce or eliminate adverse impacts, and the concurrence of agencies and affiliated American Indian tribes that were consulted, the NPS is selecting to implement as its selected action the action described in the *Lost Man Creek Watershed Restoration Plan and Environmental Assessment* dated June 2006, as Alternative 2: Partial Restoration.

It is the determination of the National Park Service that the selected action in Redwood National and State Parks for watershed restoration through removal of abandoned logging roads in 5800 acres of Lost Man Creek does not constitute a major federal action significantly affecting the quality of the human environment, nor is this project without precedent or similar to ones that normally require an environmental impact statement. Therefore, in compliance with the National Environmental Policy Act, the National Park Service will not prepare an environmental impact statement, and will proceed with implementation of the program as soon as practicable.

Recommended:  8/23/06

Rick Nolan
Acting Superintendent
Redwood National Park

Date

Approved:  9/6/06

Jonathan B. Jarvis
Regional Director
Pacific-West Region

Date