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Environmental Tradeoffs in Management Decisions

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Introduction

Redwood National Park in northwestern California was established in 1968 to preserve significant examples of primeval coastal redwood forests and the streams and seashores with which they are associated. The park was expanded in 1978 by almost 50,000 acres to protect park resources from damaging upslope and upstream land uses. Much of the land in the expansion area had been logged, and the existence of over 380 miles of truck roads and 3,500 miles of tractor trails created severe erosion problems on park lands. The construction of logging roads on steep slopes frequently resulted in massive slope failures and gullies, causing sediment to be delivered directly into stream channels. Timber harvest and abandoned logging roads cause many problems: 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. Problems may be propagated off-site and downstream from the cut-over lands, and include aggradation of stream beds, the loss of anadromous fish-spawning and -rearing habitat, increased streamside slope failures, greater bank erosion, loss of streamside vegetation, higher winter stream discharge, lower summer discharge, higher water temperatures, and altered flow patterns and sediment quantities in the estuary (Redwood National Park 1981).

To address the many resource threats posed by abandoned logging roads within Redwood National Park, Congress directed the National Park Service to initiate a watershed rehabilitation program in 1978. Between 1978 and 1996, about 180 miles of abandoned logging roads were treated by removing culverts, pulling back unstable road fill, decompacting the road surface, and revegetating the road corridor. In 1995, remaining roads were inventoried by park staff (Spreiter 1996) to assess their erosion potential and to help prioritize the roads for removal. Less than five miles of road are currently treated each year, so park managers need to weigh the environmental tradeoffs of leaving certain segments of roads on the landscape for the next few decades.

Objectives

The objectives of this paper are to describe how a multi-disciplinary team evaluated resource values and risks on lands within Redwood National and state parks and weighed their relative importance in making management decisions. The multidisciplinary team consisted of representatives from the maintenance, protection, fish and wildlife, vegetation, geology, cultural resources, interpretation, and administration branches of the park. The tasks of the team were to:

- Identify a long-term road network on park lands in the Redwood Creek watershed that optimizes protection of park resources and the visitor experience, and provide administrative access to park lands over the next 20 years; and
- Develop a strategy to both incorporate multi-disciplinary information to weigh tradeoffs in management decisions and provide an interdisciplinary forum allowing resource professionals and the management team participation in the decision-making process.

Study Area

Redwood Creek drains a 280-square-mile watershed in northern coastal California. The creek begins near an elevation of 5,000 feet and flows northwest for 55 miles until it empties

into Humboldt Bay at the ocean. The annual rainfall of about 80 inches usually occurs between October and April. The park is located at the downstream third of the watershed, and the upstream two-thirds is mostly privately owned and is managed primarily for timber harvest (Figure 1).

Analysis of Flood Risks to Park Resources

Floods are an integral part of the disturbance regime in northwestern California. Periodic large floods cause streamside landsliding and flood plain modification. Timber harvest activities and road construction have made the landscape more susceptible to flood damage, especially through road-related erosion problems. Storms and floods are the primary agent of geomorphic change in this region and are responsible for large-scale changes on hillslopes and channels. Past studies have shown most erosion from roads (road failures, gullies, landslides) occur during large storms, resulting in considerable long-term damage to critical riparian and aquatic habitat.

Because the most severe erosional damage in northwestern California occurs during large floods, it is imperative to include the risk of floods in an assessment of environmental threats. Since the beginning of the watershed rehabilitation program in 1978, storm intensity and flood magnitude in the Redwood Creek basin have been much lower than during the previous three decades. However, large storms are a persistent part of the climatic pattern in this area (Coghlan 1984). Existing funding is not sufficient to remove all logging roads in Redwood within the next 10 to 20 years. Before the rehabilitation program is complete, the likelihood of a large flood that can cause widespread damage to park resources is very high. For example, although the chance of a 25-year flood occurring in a given year is only one out of 25 (4%), within any 10-year period it is 34%, and within any 20-year period, the probability is 56%. The most recent 25-year flood in Redwood Creek was in 1975. This means that for Redwood Creek there is a 72% probability of experiencing a large (25-year) flood by the year 2006. This high probability of a damaging flood within the next 10 years should be considered in choosing among road access and road removal strategies.

Road Network

There are presently about 225 miles of abandoned logging roads on park lands in the lower Redwood Creek basin. Redwood National Park now has the challenge and opportunity to direct restoration and maintenance resources in a manner that provides both the best long-term protection to park resources while maximizing access for on-going management support, administrative programs, and research and monitoring. By identifying long-term (20-year) road access, the park is not committing to a permanent road network, rather one which optimizes protection to resources, visitor experience, and interim access for short-term resource management activities until the roads are treated under the Redwood rehabilitation plan.

Upstream of park boundaries there are 1100 miles of unpaved logging and ranch roads, which pose a serious threat to aquatic and riparian resources in Redwood (Figure 1). Concurrent with the rehabilitation program on park lands, Redwood is working with upper basin landowners to reduce erosion and to maintain logging haul roads on private lands (Hofstra, Bundros, and Hill, this volume).

Decision Process

This project began in August 1995, when park staff initially evaluated Redwood's road network. At that time, the use and relative importance of roads to different resource groups was not well-documented. In addition, most staff had considerable knowledge of the Redwood's natural and cultural resources that went beyond any recorded or formally documented process. Park staff were asked to evaluate the existing road network based upon

EXISTING ROADS IN THE REDWOOD CREEK WATERSHED (1992)

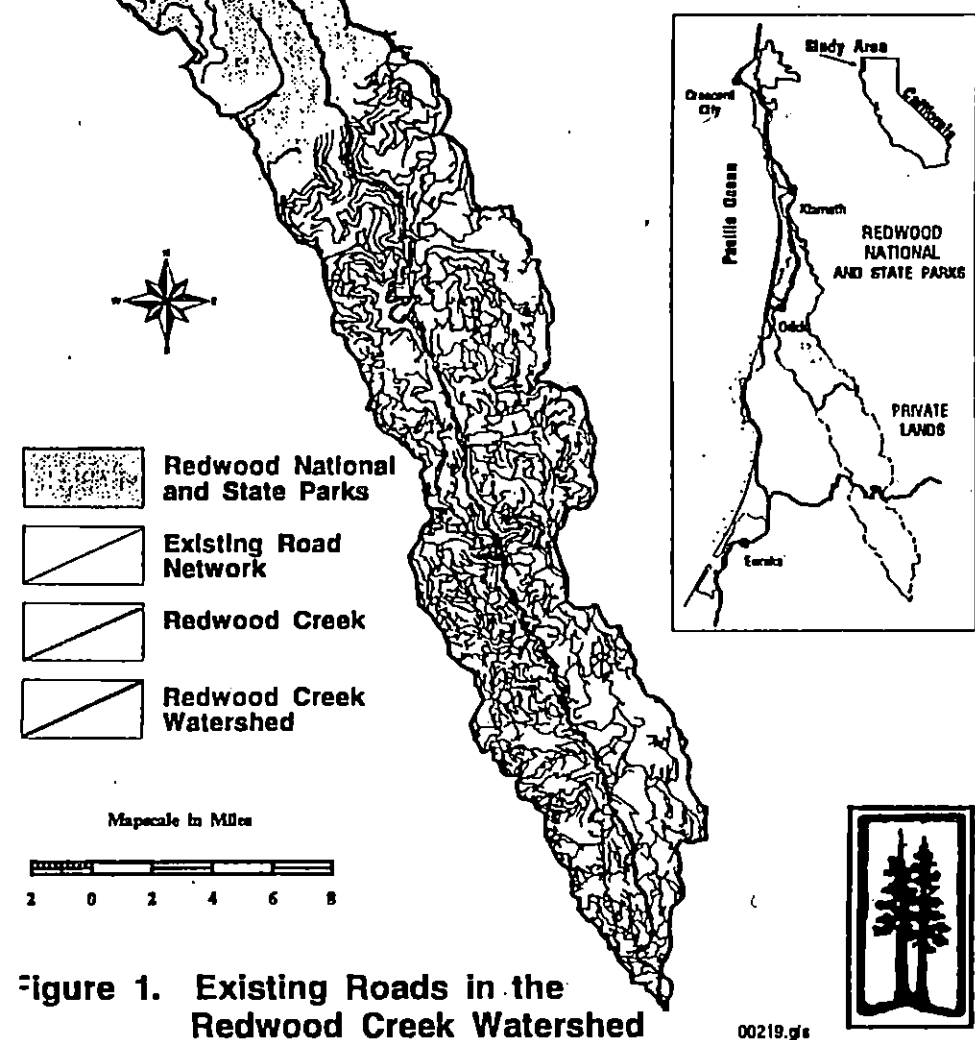


Figure 1. Existing Roads in the Redwood Creek Watershed

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their unique professional perspective. Participants were provided a set of maps showing (1) roads and trails in relationship to vegetation, (2) topography, and (3) location of old-growth forests and timber harvest history. Resource professionals identified roads which: (1) supported park operations and programs, (2) should be removed, (3) were of no special interest to the group, or (4) should be left undisturbed or abandoned, or some "other" action. Information was summarized in map and table form. Areas of common concern and divergent opinion regarding parts of the road network were identified.

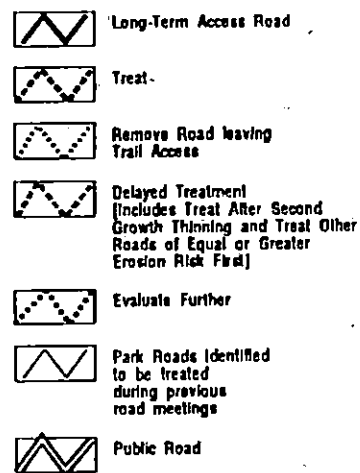
Next, a multi-disciplinary group of resource professionals and managers made a preliminary determination of road access on park lands in Redwood Creek. Decisions were based on long-term access needs identified by resource groups with an emphasis on administrative convenience without information on resources at risk or the relative sediment threat from roads (Ozaki 1995). The group agreed that about 43% of the existing road mileage was to be considered for treatment. For the remaining 57% of the existing road mileage, park staff had identified roads for access routes or were in disagreement on whether to retain or remove the road. These roads needed further evaluation to determine whether the roads should be treated or retained for long-term access.

To accomplish this, the group agreed upon the type of additional information needed to decide on the road network. These data included the relative value of the park's natural and cultural resources and the sediment threat posed by roads, as well as the nature and extent of road usage for current and proposed projects. Subsequent meetings collected and compiled this information into the GIS, which formed the basis of the group's decisions.

The final information used to support road decisions included:

- **Resources at risk.** The team identified and evaluated eight primary park resources from a natural and cultural perspective: old-growth alluvial groves, old-growth forests, second-growth forests, tributary fisheries, terrestrial wildlife, estuary, prairie, and oak woodlands. Each resource was evaluated independently and stratified into relative values of high, medium, and low. Using these data, the team developed a strategy to stratify the relative resource values and determine areas in the watershed of high value which were threatened by roads. Unfortunately, no simple approach to combine all resource values emerged from the discussions, since many of the identified resources were affected by roads on only a site-specific scale. The focus of determining resources at risk shifted to identifying which resources were directly impacted by roads. Sediment from road failures primarily poses a direct threat to downstream aquatic and riparian resources. As a result, tributary fisheries became a driver for determining resources at risk from roads. Seven tributaries were identified as having the highest fishery values and were ranked in numerical order of importance based on specific criteria that included potential sediment contribution from roads, existing habitat values, fish diversity, and unique and irreplaceable fish populations. The final tributary ranking was: (1) Lost Man Creek, (2) Forty-Four Creek, (3) Tom McDonald Creek, (4) Elam Creek, (5) Bond Creek, (6) Lower Prairie Creek, and (7) Bridge Creek.
- **Levels of use.** For each road under consideration for retaining or treating, the team identified the number of person-days per year for existing and proposed projects, and projects and park groups which the access supported. Additional information was gathered on (1) seasons of use, (2) whether the road was used a route or as a destination, (3) length of time access was needed, and (4) types of vehicles and equipment used on the road.
- **Sediment risk from roads.** A road inventory database (Spreiter 1996) listed the erosion potential posed by a given road. Erosion potential is the estimated volume of sediment that is expected to erode from the road during the next large storm.

Final Road Decisions



Final Road Decisions

As a final step, the team weighted information about resources at risk, relative sediment threat, and levels of use. The group chose a road network which provided both acceptable access while reducing erosion threats to high-quality fishery habitat in tributary watersheds.

Final road decisions were grouped into three main categories (Figure 2): (1) roads to provide access, (2) roads to be treated, and (3) roads with alternative considerations.

Roads to provide long-term access will be maintained at some level and comprise about 80 miles of road. The levels of maintenance will be discussed in the erosion control and disturbed land restoration (EC&DLR) plan currently being revised by Redwood.

Roads to be considered for treatment (45 miles) include a subset of roads (20 miles) which were identified as "to be removed," but after which a bench or trail access will be left. The trail standard (hiking, all-terrain vehicle, etc.) will be determined on a project-clearance level as the road comes up for treatment. Alternative treatment styles for roads on Redwood lands will also be addressed in the EC&DLR plan.

Roads with alternative considerations included three alternatives: (1) Roads to be treated after second-growth thinning (delayed removal, 8 miles), (2) Roads to provide access as long as possible by treating other roads of equal or greater erosion risk first (delayed removal, 5 miles), and (3) Roads that need further evaluation (11 miles), which will be addressed in the Redwood EC&DLR plan.

Summary

Road access is a highly controversial issue in Redwood. Previous attempts had been made to make these decisions, but had failed because consensus could not be reached. This process provided an objective resource-based framework for decision-making. Resource professionals worked closely with park managers to determine the environmental tradeoffs in management decisions. As a result, a long-term road access network has been determined for retaining or removing abandoned logging roads within park boundaries.

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Mapscale in Miles

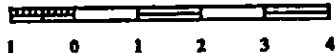


Figure 2. Final Road Decisions