

A View From Redwood Creek: Learning By Doing

By Robert Belous

A discrete blend of summer fog, soil chemistry, mild maritime climate, and drenching winter rains has provided stable environs for California's coastal redwood forests for upwards of 20 million years, according to fossil evidence. But heavy timber harvests have destabilized a substantial portion of this landscape. Steep timbered slopes have been turned into oozing slides of top soil. And sediment-loaded streams now threaten remaining stands of old growth redwoods as well as spawning runs of salmon and steelhead trout. Today, side-by-side examples of eroding clearcuts and pristine redwood groves within Redwood National Park (RNP) serve as a proving ground for resource management techniques that could be of interest to troubled parklands nationwide, and beyond.

When Congress passed legislation in 1978 (P.L. 95-250) adding 48,000 acres of Redwood Creek basin to Redwood National Park, it included some of the tallest remaining trees, giants ranging from 400 to 800 years of age and rivaling our nation's capitol in height. The conservation goal, in part, was to add to the park as much of Redwood Creek watershed as a complete ecological unit as was attainable. But attainment fell short of aspiration.

The upper two-thirds of the watershed remained outside of park boundaries – and thus available for logging by private interests. Erosional outflow from these upstream lands now comprises the major source of impact to the park's redwood groves. And of the 48,000 acres added to the park, about 36,000 acres had been logged. Cutover lands included stark examples of unrestrained harvest practices (e.g., unlimited acreage cuts; no buffer strips; stream dumping of slash and soil) later corrected under California's exemplary Forest Practices Act of 1973. Results of old logging methods were brought into sharp focus by unusually severe storms in 1972 and 1975. Much of the raw landscape still has the look of an active war zone.

Today, where untreated, ditch-lined logging roads on steep, unstable slopes collect heavy surface runoff from the 80- to 100-inch winter rains. Chutes of water flow onto cutover slopes where average grades are 30 to 50 percent, and can exceed 70 percent. Deep gullies form and slopes fail. Earthflows, present under natural conditions, accelerate sharply. The active biotic layer of 10 to 20 inches in depth washes directly into streams. The basin's substrata of schist, sandstone and shale is often laid bare.

In Redwood Creek basin the annual erosion rate climbed to more than 8,000 tons of sediment per square mile by 1975 – up from an estimated natural annual erosion rate as low as 1,000 tons per square mile. Some tributaries carry 20 times their normal sediment load. Stream channels fill and force water flow over old banks, undermining streamside stands of Douglas fir in upstream areas, and threatening (by raising the water table) the downstream terraces where the world's tallest trees stand – presumed inviolate under NPS protection.

Yet the Congress's charge to the Park Service is clear: Rehabilitate clearcut areas within and upstream of the park, and reduce risk of damage to



An unearthed redwood stump, its 14-foot crown marking the level of an old logging road, is a measure of the recontouring needed to control erosion and stabilize a scarred landscape in Redwood Creek watershed. Park geologist Terry Spreiter directs operations with an eye toward relocating original stream channels that may carry 20 times their normal sediment load.

streamside areas adjacent to Redwood Creek. An appropriation of \$33 million was authorized for the program, this to be expended over a 10-year period. Now nearing its midpoint, how has the program fared? To what degree will it succeed? Are mid-course adjustments planned? And when and how will the program phase down? Or, phase over?

While a watershed "rehab" plan was being designed (published April '81), a cadre of some 70 professionals, technicians and administrators was assembled. Immediate attention turned to accurate mapping and identifying hot spots where heavy erosional losses were imminent. From the outset it was damage control unadorned. "Proximity to the stream channels has been and is the alarm bell for stabilization control," according to Bill Weaver, the team's engineering geologist at the park's Arcata office. Steepness of terrain and soil types, Weaver points out, are also parallel considerations before committing money, manpower and machines to stem a mass wastage of soil.

Given the incremental nature of annual funding, only a limited number of actions are possible each year. And there are a bevy of efforts to keep in motion: e.g., stabilizing the worst of some 200-plus miles of logging roads; core drilling for landslide analysis; straw mulching for stabilization and regrowth;

monitoring for results; experimental compost production; and review of timber harvest plans in the privately-owned 30,000-acre Park Protection Zone (PPZ) established by Congress upstream of the park's Redwood Creek boundary.

As the rehab program took shape it sorted out into three distinct efforts. One-fourth of the job relates to reviewing plans for timber harvest outside the park with an eye to sediment loads entering Redwood Creek. A second 25 percent of the team's effort is applied to refining the sediment budget equation for the watershed (a kind of pulsating model of inflow and outflow and storage cells that is tied to old logging outwash, vegetation recovery and the size and ferocity of winter rain storms). The last half of the job relates directly to erosion control, recontouring road scars, revegetation, mapping, monitoring; simply, keeping the soil on the slopes.

Aside from emergency actions, the top of the program's hit list has been the determination of the entire watershed's sediment budget. The effort is aimed at an area of 280 square miles surrounding Redwood Creek's 55 miles of mainstream flow. Geologist Mary Ann Madej (appropriately pronounced "May-Day") is responsible for coordinating this new technique for assessing how long the park's portion of the watershed will remain in an aggraded, or sediment-



Aerial View of Clear-Cut and Old Growth Redwood Forest Included in 1978 Park Expansion Area. Bulldozers, zig-zagging across hillslopes and stream channels on the former forest floor, created a "web" of trails as they skidded logs down to the lower road. The area was logged and burned in 1975-76. The area near the top of the photo was logged 10 years earlier and displays some revegetation. Post harvest erosion from such steep, highly disturbed logged lands in the park is being addressed by a unique watershed rehabilitation program. By 1983, all the logging roads in this area of the Bond Creek basin, as well as in many other regions of the park will have been obliterated and adjacent clear cuts treated to control or prevent erosion.

swollen, state. Harvey Kelsey, a research geologist, uses comparative aerial photographs to ascertain the year in which landslides occurred and the nature of ground conditions at critical transition phases. Kelsey's original design for the project emerged from expertise gained through a doctoral research program in California's Van Duzen River watershed.

By applying the concept of compartments, and measuring streambed profiles at discrete locations, a predictive model has emerged. It describes for the first time the dimension and dynamics of the great glut of gravel associated with years of logging outwash that is now trying to work its way down Redwood Creek in annual rain-driven pulses. The material – unconsolidated Franciscan geology ranging from fine alluvial silt to cobbles the size of bowling balls – becomes lodged in varying compartments along the waterway.

Material in the active stream load can pass through the park in 10 years. Gravel bars and other semi-active loads (not mobilized with every rain storm) can take upwards of 15 years. Inactive sediment found in areas of 20 year old alder growth need major storm events to mobilize and thus can take over 100 years to pass through the park. Finally, sediments that have been lifted by extreme storm events onto alluvial terraces among old growth redwoods may remain in place for thousands of years. Meanwhile, new sediment continues to work its way into the system, though at a reduced rate. The sediment budget equation is complex and difficult to measure, but is now a working tool. For outflow data, the Redwood team contracts with U.S. Geological Survey. Their stream gaging techniques show amounts of material leaving the system in terms of bedload, plus suspended sediments that are flushed out to sea.

The famous Tall Trees Grove stands near the mouth of Tom McDonald Creek, a tributary of Redwood Creek. Five feet of aggraded material has built up there since 1964. The grove is now only about 15 feet above the stream bed instead of the 20 feet elevation of safety its trees once enjoyed. Redwood roots are comparatively shallow, from 5 to 8 feet deep, and any more sediment build-up could pose a threat to the big trees' root system. The unspoken question: Can the Tall Trees be saved? No answer yet.

The land use history of the entire basin has now been documented. "One thing we found," Madej said, "was that once the sediment gets into the creeks, it's basically a lost cause. It's too difficult and expensive to remove the excess material. The only effective remedy is to prevent more sediment from washing into the creek."

The exceedingly diverse character of the scarred landscape is beginning to emerge. "We now know how much sediment each type of erosion problem is contributing," Madej said. "We're ready to move into the predictive stage." During the November through March storm season NPS and USGS people go to the gaging stations and measure sediment flow during storm events. With these data a determination can be made as to which points of the basin are producing the most sediment and how quickly it's transported under various conditions of rainfall and stream flow. "Once we define the sediment transport relationship," Madej points out, "we can say with relative confidence that given these conditions, this will happen."

Field techniques also are evolving that spot serious transient conditions; say, a stream crossing or road with a high potential for washout; or worse, landslide. The locale is carefully mapped and a corrective pre-

scription proposed. Review is done by an interdisciplinary team from the park's Resource Management and Technical Services divisions. A clearance survey for endangered species and cultural resources also is set in motion. The team closely screens the plan for the level of severity involved, efficient sequencing and proper engineering methods, achievability, and cost effectiveness. Given daily costs of \$350 to \$1,000 for earthmoving machinery on location, budget estimates are given monastic scrutiny.

If the plan passes muster, trucks, bulldozers and rehab teams move out to begin road fill removal, surface decompaction and, in sensitive areas, careful recontouring of slope profile. Straw mulch at 6,000 pounds per acre is distributed. Fir and redwood are planted along road alignments. In the case of stream-sides, shrubs and trees are added – fast growing red alder (*Alnus rubra*) on the moist side of the drainage and coyote brush (*Baccharis pilularis*) on the dry side, these to stabilize soil and hasten recovery. Streams diverted years ago by road building are rerouted to natural channels. The treated area is then monitored for rehab success, and the results are used to streamline the next project. The program is self-correcting.

Monitoring already has resulted in beneficial adjustments in methodology. "In the early stages of erosion control our field efforts were predominantly labor intensive," recalls Lee Purkerson, Technical Services Chief. "And that's just what Congress intended as a step toward reemployment for timber industry personnel displaced from jobs when the park was expanded in 1978." But soon two problems were noted. Aside from mulching and planting, hand labor could never accomplish the major tasks. Sheer volume of soil and debris called for earthmoving strategies that far surpassed anything attainable by a hands-on labor force. Secondly, creating such a labor force did not prove a direct benefit to former timber workers with machine and mill operating skills. "The major emphasis was shifted from labor intensive to a mechanized operation," Purkerson said. "It's getting the job done and we're now employing more of the people Congress intended to reach in the first place."

Control of potentially injurious logging practices in the PPZ upstream of the park boundary is critical to protection of the park's aquatic and riparian resources along Redwood Creek. Geologist Danny Haggans and Bill Weaver are the key men for dealing with upstream land use activities. Although enforcement of state regulations and surveillance lies with the California Department of Forestry, the federal statutes of 1968 and 1978 establishing and expanding the park contain provisions for NPS involvement with upstream studies and review of proposed timber harvest plans. Congress recognized that continued monitoring of land-use practices upstream from the park was essential to provide adequate protection to park resources lower in the watershed.

"We've reviewed nearly 90 timber harvesting plans for the PPZ since 1978," Weaver said. "And above the PPZ we have reviewed about 30 plans that looked critical, ones that were along Redwood Creek stream banks, ones with known landslides, or ones involving new road construction." In all, about 10,000 acres adjacent to the park have been inspected for conformance.

Within park boundaries, estimates to date indicate that about 70-plus miles (out of over 200) of logging roads have been treated for stabilization. The rate of advance, though varying with problems en-

countered, averages 15 miles per year. Costs for worst-case road rehab can reach \$40,000 per mile; average conditions yield costs of \$25,000 down to \$8,000 per mile. Most logging roads present a mix of conditions and costs. Generally, the approach is still on a "worst first" basis. Ridgeline roads, by contrast, pose little or no threat for erosion and so remain low in priority. In the interim, such roads can be utilized for fire suppression, rehab monitoring, and other management needs. Where natural recovery is feasible, the cost is zero.

The scheme is working, measurably. At the close of the 1983 season, approximately 32 percent, or 11,500 acres have been treated for rehab and stabilization, out of 36,000 acres of original clearcut. It also has been estimated that by 1983 erosion control efforts saved over 6 million cubic feet of sediment from washout — despite early stages of the program given to initial gearing up, adjustment of methods, team coordination. The volume of material is noteworthy. If spread 1½ feet deep over the bed of Redwood Creek, it would run for five miles; it would fill a procession of dump trucks lined end to end, stretching 150 miles.

In contrast to annual funding rates, progress in rehab of the park's redwood environment is not simply linear with time. New ground is being covered with each step. Case by case crises inevitably will alter schedules. And people with built-in experience in landslide control in 50 percent grade redwood terrain are not instantly hireable off the street. Today's experts did not begin as experts; there is a disproportionate time and funding nature to the program that is heavily front-end loaded.

Problems also have been increased in complexity by new insights into long-term weather patterns. Early stages of erosion control, for example, occurred during a long and unusual period of relative drought in redwood country. "There was a substantial gap in major storm events between 1975 and 1981," points out geologist Ron Sonnevil. Later storms of a 5-year-cycle proportion occurred during the winters of 1982 and 1983, causing slides and erosions at several road locations previously treated for rehab. Reworking those sites became necessary if future washouts were to be avoided. It was learn-by-doing. But the experience also evolved an improved technique and a better chance that a 20-year storm event (the last one occurred in 1975) can be weathered with little more than natural levels of sediment loss from treated sites. Rain events, their history and character, are now part of the lexicon for redwood rehab.

The program is recognized as one-of-a-kind. A symposium was held on redwood rehabilitation at Humboldt State University in California during August 1981, and attracted a wide array of participants from western states. Rehab sites have drawn visits by members of the Norwegian Parliament, and interest in the program has been expressed by forestry managers from Holland.

Importantly, the program evolves daily toward a permanent resource management scheme for the park. In a kind of inverse proportionality, the pure science and technical aspects transmute with time and experience into applied resource management functions. Despite setbacks and course corrections, the rehab progress curve since Congress's 1978 dictum is rising exponentially. More ground will be covered (literally) in less time as the last half of the program unfolds.

Also, spinoff benefits accrue whenever highly moti-

vated teams of technical services and resource management people splice their various skills. For example, a plan is now underway for monitoring of air quality and pollution-sensitive lichen growth along the park's north boundary. Baseline data will indicate any intrusion on park environs by sulphur dioxide and other outfall associated with a proposed mining operation nearby and its burning of high sulphur coal.

Yet the sheer magnitude of the program and its ticking legislative clock calls for special management

considerations. On the one hand, how to ensure within a shrinking time frame the goal of permanently curing man-caused erosion and restoring the cutover lands to a self-sustaining redwood forest ecosystem. And on the other hand, how to reasonably and efficiently evolve a highly specialized task force operation — with a once-in-an-era mission — into a basic part of the park's resource management scheme by the time the program winds down.

Supt. Douglas Warnock, a biologist by training



1(A) Before: Sept., 1980

Removal of the W-line logging road across Dolason Prairie Before/After

Complete recontouring of old logging roads is done only in areas where future visitor use is anticipated to be heavy or where park vistas would otherwise be impaired. Rehabilitation of 3,000 acres of prairie grasslands acquired in the 1978 expansion includes total outcropping of the roads, gully reshaping, protection of bare soils with straw mulch and revegetation with native grasses. Before (A) and after (B) photos show the dramatic results of restoration of the Dolason Prairie (photos taken in June, 1980 and June, 1981).

2(B) After: Oct. 1980



and a veteran of complex resource problems during his tenure in the Alaska Region, is keenly sensitive to the management value of scientific expertise and data. "The intense work during the past five years on this park's primary resource — the redwoods — has given us an in-depth information base that well could be the envy of any park in the system," he said. "It's given us the capacity to gage even the subtlest differences between an undisturbed redwood forest and those heavily impacted areas Congress has told us to restore. And it's providing ways to close that environment gap."

Yet it is vitally important, Warnock points out, that we keep in clear focus the mission and nature of the rehab program. The landscape and habitat manipulations inherent to this program comprise a radical departure from the basic preservation and protection mission of the Park Service. To be sure, such a departure is justifiable by its final goal of restoring to the greatest degree possible a self-sustaining redwood forest within a national park. But as the program succeeds, emphasis and organization must inevitably shift.

"I've called for an assessment of all that has been accomplished thus far, so we can plot the most productive course over the next five years," Warnock said. "We're faced with very real limits of time and money, and we certainly don't want to discover down the road that a key link has somehow been left out of the effort. Ideally, as we erase man's impact on the redwoods we also reorient the park staff from one geared to rehabilitation to one able properly to manage and protect the renewing forest when the time and money run out. If we do it right, stage by stage, there should be no great or abrupt change on the last day of the last year."

Belous is Management Assistant at Redwood NP. The final installment of this article will appear in the SPRING issue.