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Cover Photo:

Fishery Biologist Jim Harrington holds a juvenile steelhead trout for dye marking of its fins, at Redwood Creek estuary.

Reviving Redwoods

(Part II)

By Robert Belous

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Erosion control efforts during the past five years in Redwood NP have brought a measurable degree of stability to a landscape otherwise beleaguered by aftereffects of clearcut logging. (See "View From Redwood Creek", Winter 1984 issue) But stabilized slopes alone do not a redwood forest make, or remake. Several parallel programs in resource management and applied science add important aspects to the park's rehabilitation efforts that will help assure the return of a self-sustaining ecosystem from crowning redwoods to critters of the forest floor, and provide a sound data base for future management needs.

A comprehensive soils mapping regime is being conducted across 51,000 acres of the Redwood Creek watershed. The terrain ranges in elevation from near sea level to the park's highest ground at 3,097 feet and includes the 36,000 acres of logged lands added to the park in 1978. Soil mapping of the watershed is being conducted in conjunction with the Soil Conservation Service and is slated to continue through December 1985. Field investigations and ground truthing of soil horizons are aimed at detecting areas down to 10 acres in size that require specialized techniques for watershed rehabilitation, erosion control and fire management.

Levels of mapping detail for rehabilitation zones are refined to 1:6,000 scale linear transects. Each transect segment is 100 feet or longer and corresponds to minimum delineated areas of about 0.25 acres. Such zones also are mapped at 1:12,000 scale using black and white aerial photographs with maximum size contrasting inclusion of 10 acres. Coverage for additional logged lands and adjoining prairies and oak woodlands include color infrared imagery to delineate special vegetation patterns associated with wet terrain and slopes susceptible to mass movement.

Ten major soil types have been identified thus far, where they occur in areas of 2,000 acres or more. A series of descriptions and names for these soil classifications has been proposed and submitted to the Soil Conservation Service for possible adoption into standard usage. If accepted, the lexicon of soil science would be expanded by such local sobriquets as *Ahpah* and *Devils Creek*, both depicting examples of *Inceptisol* soil found on relatively young geomorphic surfaces of late Pleistocene or Holocene age. The *inceptisols* are the dominant soils order of the park's mountain slopes. Other orders treated in the mapping regime are *Alfisols* (found in wet places underlain by clay-rich colluvium and subject to mass movement); *Entisols* (dominant mineral soil content and lack of distinct soil horizons, found on streamside alluvial flats); and *Ultisols* (a reddish soil occurring on well-drained, older geomorphic surfaces and with signs of intense mineral leaching). Thus the subtle chemistry of Redwood Creek's panoply of basic soils emerges for the first time.

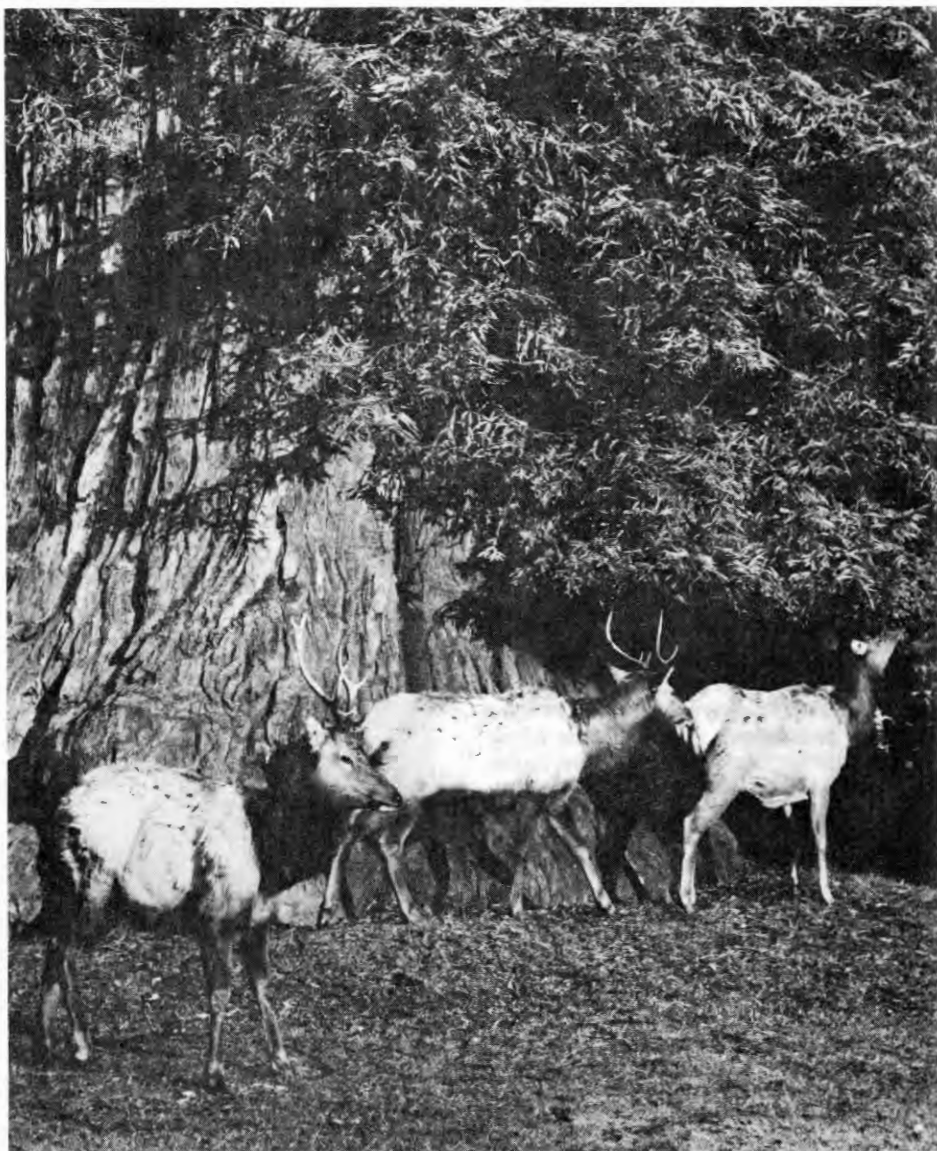
Methods of revegetation for rehabilitation sites have undergone considerable refinement over the first few years of the program. Initial techniques, for example, included use of "willow wattles" along terraced slopes. These bundles of woody branches were partially

buried in contour trenches and produced the first sprouts of soil-firming vegetation. Wattles comprised an effective barrier to raveling of soils on steep inclines and also helped prevent the formation of rills – the tiny rivulet precursors of erosional gullies – with the onset of winter rains. But comparative costs per linear foot were high. And summer drought conditions along many exposed rehabilitation sites took a heavy toll on young willow sprouts. Another disadvantage was the often intense impact of browsing. California blacktail deer display a notable fondness for tender willow shoots. Wattling was discontinued in 1980.

Early revegetation methods also utilized transplanted stock, stem cuttings and wood chips. Dairy barn by-products were tried, but with little success. Even planting of grasses proved counterproductive.

Grasses in redwood environs tended to inhibit reestablishment of such beneficial shrubs as coyote brush and salmonberry, which are successional shrub species whose root systems aid in stabilizing clearcut hillsides. This new insight was not without some spinoff benefit. While use of grasses was largely discontinued for redwood environs in the park, the practice proved cost-effective at nearby Siskiyou National Forest. Suppression of shrub growth by competing grasses on commercially harvested timber lands diminished the need for chemical defoliant otherwise used to speed timber regeneration.

Current restoration practice in the Redwood Creek watershed places major emphasis on site preparation; that is, decompaction of old road surfaces and accurate recontouring of original stream channels



Roosevelt elk at the base of a mature redwood tree. Elk herds of Redwood National Park are the subject of a research program to determine carrying capacity and choice of seasonal habitats, as well as the make-up and distribution of the herds.

and surrounding terrain. Any portion of the original A-horizon, or topsoil, that can be salvaged is carefully replaced. It has been shown that a higher degree of restorative success is attained by use of the original topsoil than by attempting to upgrade a C-horizon (mineral soil) with costly infusions of fertilizer.

Newly prepared sites are spread with straw mulch. This practice replaces the formerly used method of planting nitrogen-fixing legumes, such as subclover (*Trifolium sp.*). Monitoring of treated sites has shown that subclover competes for scarce water during summer dry periods with seedling root stock of redwood and Douglas fir. Typical restoration sites will be planted at 6 to 8 foot intervals with redwood and Douglas fir root stock. And fast-growing red alder often is used along stream channels and erodible banksides. Thus far, survival rates for vegetation run between 50 and 80 percent. Where substantial losses have occurred, the problem usually is related to fungus infection of the root stock and, in some cases, heavy browsing by elk and deer.

Upslope and along the eastern ridgeline of Redwood Creek are adjoining prairies where revegetation of road scars has involved a compromise with non-native species. Prior to the turn of the century, these rolling grasslands were covered predominantly with California oatgrass (*Danthonia californica*) and blue wild rye (*Elymus glaucus*). Since the 1850s, however, the area has been invaded by numerous exotics, such as soft chess (*Bromus mollis*) and subclover. Given the present mix of about 50/50, native to non-native, the occurrence of well-established exotics at rehabilitation sites has become a working compromise beyond reasonable remedy.

Historical evidence shows that the park's prairies were to a measurable degree dependent upon and a product of human activity. Periodic burning by aboriginal Indian people helped renew stocks of harvestable plants, such as Indian potato (*Brodiaea sp.*) and certain shrubs used in weaving basketry. The burning also created forage attractive to elk and deer, which in turn were harvested for food. Since the 1850s, when the practice of burning was abandoned, the prairies have lost more than 30 percent of their acreage to encroaching forest. As a step toward maintaining the prairie grassland environs, a regimen for periodic controlled burning is being considered as part of the park's fire management plan.

Fish and wildlife of the Redwood Creek watershed have undergone a varying range of impacts through habitat destruction from logging and forest renewal. Black bear, Roosevelt elk and blacktail deer now are enjoying a dramatic expansion of habitat amid the shrub-rich second growth forest that follows logging of some 36,000 acres of redwood trees. This sudden supermarket of edible plantlife has resulted in an increase of population, though exact comparisons cannot be made due to a lack of pre-logging data. What is clearly predictable, however, is that a downward adjustment of animal numbers eventually must occur, as surely as the tall trees regain their dominance and lush undergrowth habitat shrinks. In some locales, exceedingly thick stands of Douglas fir – referred to as "dog hair" forest – already appear rich and green but are almost devoid of sustaining habitat for deer, black bear and elk. In the case of black bear, an elevated population and a diminishing habitat, viewed against potential bear interaction with park visitors, suggests a serious and timely warning.

To better gauge trendlines between wildlife and the changing carrying capacity of a recovering redwood forest, several studies have been undertaken. A series of black bears have been fitted with radio



Biologist Mark Schroeder checks the condition of a radio-collared black bear that has been immobilized with a tranquilizing drug.

collars and have been monitored for movement, choice of habitats, and denning sites and duration. The collars are sensitive to motion and the angle of the animal's head, and thus provide a measure of daily activity as well as location.

Periodic trapping of bears also offers an indication of an individual specimen's vigor in relation to its age and habitats used. Preliminary findings show that bears inhabiting cutover areas of generally homogeneous age and vegetation type show a relatively poor weight-to-bone frame ratio, or a kind of "compromise physiology." Although the exact causes for such discernible differences in bodily condition are not yet fully understood, at least some of the data and observations suggest that habitat variety is an important

factor for bears in the redwood environment. Blood samples taken from trapped bears also yield insight into seasonal blood chemistry. Such factors as glucose levels and creatinine phosphates are considered a kind of bedrock measurement of an individual's physiological condition.

Combined with such resource information as regional soil characteristics and the prognosis for revegetation, an overall picture of the black bear's relationship to a changing habitat begins to emerge. The information allows for sound planning of visitor use areas and protection of critical habitats. An area known as Bridge Creek Ridge, for example, has been found to provide good year-round habitat of importance to bears. A relatively open forest canopy allows a diversity of such seasonal forage as salal berries, huckleberries, oak (acorns), forbes and grasses. These characteristics make the Bridge Creek area important for bears and also militate against development that would bring people and bears into direct (and needless) competition. A similar research effort relating to Roosevelt elk was initiated during the 1984 summer season.

As with any basic research program, certain unexpected benefits and insights have come from the black bear investigations. Blood samplings from live-trapped bears offered a chance to test for the occurrence of sylvatic plague – long surmised to be unrepresented in redwood environs. Of 42 bears sampled, one-third showed positive exposure to plague through presence of blood antigens. Further observations linked possible exposure to bear denning sites that were found associated with active wood rat nests. Subsequent tests of wood rats showed appreciable levels of antigen titers.

Sylvatic plague is a contagious disease caused by the bacterium *Yersinia pestis*, carried in the stomach of fleas. The disease can be transmitted to humans (as bubonic plague) through flea bite or directly (as pneumonic plague) from person to person. Field research on occurrence of sylvatic plague in Redwood NP is being conducted in conjunction with the California Department of Health Services.

The revival of Redwood Creek's aquatic habitat is



Two-year-old Douglas fir is planted by Technician Bonnie Griffith along a rehabilitation site on the eastern flank of Redwood Creek. Zones of clearcut logging can be seen in the distance, along with an old logging road slated for rehabilitation.

one of the notable rehabilitation achievements. Erosion control measures have stemmed the mass wastage of hillsides and old logging roads. And, though the creek bed has yet to undergo passage of many years' worth of logging-related sediment, stream disturbances have lessened to the point where fishery habitats are reforming. The modest-sized waters of Redwood Creek once supported a substantial fishery of steelhead trout, salmon and cutthroat trout. King salmon were known to run upwards of 50 pounds, and a commercial fishery operated during the 1920s for markets in Eureka, 30 miles south. Given the severity of logging impacts, it may require decades of recovery for the stream to approach its former stature as a fishery.

Loss of rearing habitat for juvenile fish appears to be the limiting factor in recovery. Only three holding pools have been found during a recent survey of the lower 18 miles of the stream. The sediment mass introduced by logging-related erosion has virtually eliminated the entire three- and four-year old age classes of steelhead trout. Yet a continuing program for trapping and marking down-migrating juvenile fish has shown a positive though modest increase in populations and growth rate for salmon and steelhead. Cyclic monitoring of water conditions (e.g., dissolved oxygen, temperature and aquatic invertebrate populations) also is performed, and this helps to match production of fish with habitat carrying capacity.

Biological survey efforts also have brought to light the occurrence along the creek's main stem of "cold pools," used by significant numbers of steelhead and

salmon. These pools are consistently 4° to 8°C lower in temperature than the 25°C of the creek's main stem. Fed by separate sources of groundwater, these cold pools may comprise important refugia for salmonids during critical periods of low water flow and high summer temperatures. This small but important habitat could help sustain the watershed's decimated fish stocks through the years needed to fully stabilize erosion and revive spawning and rearing habitats.

From the overall picture of the watershed and its fishery, the most serious bottleneck limiting full restoration lies in the creek's lower estuary and embayment. Construction of almost three miles of flood control levee following a local flood in 1964 has appreciably reduced juvenile rearing habitat at its final stage, the stage which prepares young smolt salmonids for survival in an ocean environment. In its present configuration, the estuary cannot accommodate full output from upstream spawning habitats as the positive effects of erosion control and rehabilitation continue to increase.

Park staff is currently consulting with the Army Corps of Engineers on methods of levee modification. The goal is to recover once-productive habitat while maintaining adequate flood protection for residents of the adjacent town of Orick. The effort is noteworthy, though the locale is miles removed from the park's stately redwood groves. Reestablishment of a thriving and healthy fishery in the Redwood Creek watershed may be the ultimate measure of success for a decade's worth of erosion control and rehabilitation.

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Juvenile salmon from Redwood Creek is weighed by Fishery Biologist Randy Brown. The fish is temporarily immobilized by use of a mild drug.