Envisioning Ways Jackson Forest Could Demonstrate How to Revitalize the Region's Depleted Biological Heritage and Timber Production Capacity[1]

Kathy Bailey[2]

Jackson Demonstration State Forest is a 48,652-acre forest near Ft. Bragg managed by the California Department of Forestry and Fire Protection (CDF). It is, by far, the largest publicly-owned forest in the redwood region between San Francisco and Humboldt County offering unique conservation, recreation, and forest management demonstration and research opportunities. Approximately 10,000 acres have not been logged since the initial harvest entry 80 to 120 years ago. An additional total of 459 acres of old growth redwood and Douglas fir are isolated in 11 groves. These older forest components are unusual assets in a region that has been heavily logged.

A recent court decision set aside Jackson's new management plan and required revision of its environmental impact report (EIR). Further, the court ruled that the California Board of Forestry is the lead agency rather than CDF, indicating the Board is responsible for management decisions that are to be implemented by CDF.

The poster will use maps and satellite imagery to visualize opportunities to re-orient Jackson Forest toward research and demonstrations that help re-vitalize both the region's environment and its timber production capacity by addressing restoration of biologically and economically depleted stands to productivity.

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Inner Gorge in Redwood Forests[1]

Julie A. Bawcom[2]

Coalescing landslide scars along eroding streams where the base level lowered, or a stream undercuts the toe of a deep-seated landslide form an inner gorge. Over-steep and undercut stream banks are susceptible to landslide failure by shallow debris sliding.

Inner gorge identification is important when planning timber harvest activities near watercourses. Aerial photo mapping of inner gorge in forested terrain is difficult due to tree cover. Anthropogenic alteration of the stream channels result in further complication. An inner gorge model of continuous symmetrical steep stream slopes is rarely found. Early logging that changed or significantly modified channel morphology produced inner gorge-like characteristics or obliterated inner gorge features altering many streams in the redwood region. Field mapping stream channels is the best method in determining the presence and historical alteration of an inner gorge.

Two field mapping terms are introduced, "Highly Modified Channel," and "Discontinuous Inner Gorge," which will aid in understanding and documenting the stability of slopes along redwood forest streams.

A highly modified channel (HMC) is defined as a channel changed by past in-stream logging that presently continues to erode exposing bare stream banks. Stream flow can intermittently be forced subsurface under buried logs. The stream channel is often "captured" within the old road fill and does not have the ability to undercut adjacent slopes. These modified channels are filled with legacy sediment from a previous era of logging practices.

A discontinuous inner gorge (DIG) occurs along a stream channel with intermittent sections exhibiting an inner gorge. It can be represented by an inactive inner gorge, or is often developed on only one side of the channel. This may be due to old railroad grades that break up the steep slope or to natural geomorphic irregularities. The one-sided inner gorge can be represented as a line with barbs pointing to the active side of the channel.

In both these specific geomorphic types the origin of shallow landsliding often originates upslope via slope creep, shallow soil slips or debris slides above the channels' influence. Management and stability considerations are different for a natural or continuous inner gorge.

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Research at Jackson Demonstration State Forest—Building Partnerships for a Better Understanding of the Forest Environment[1]

William Baxter[2]

Jackson Demonstration State Forest (JDSF) has conducted and facilitated research in the redwood region for over 50 years. JDSF's mission of research and demonstrations helps to increase our understanding of redwood forest ecology and improve our forest management methods. Examples of research projects are presented to gain a better understanding of the diversity of JDSF research and the network of partnerships representing universities, public agencies, and wildland management professionals.

A wide variety of research is conducted on the 48,650 acre JDSF with almost endless possibilities for researchers. The predominantly redwood and Douglas-fir forest encompasses approximately 90 miles of streams with fish habitat and a mixture of forest types, age classes and management methods. JDSF is the largest state forest in California conducting research and demonstrations of forest management and it provides a unique opportunity to investigate the interaction of forest management with forest ecology in a public setting that is also used for recreation. There is ample opportunity to study the ranges of conditions and treatments including unit or landscape level treatments, and sufficient area for replications and control area.

Forest research often takes many years to offer reliable conclusions. Many of the historical research projects at JDSF, such as the Caspar Watershed Project initiated in 1962, provide baseline data that may be used as a foundation for future research. Demonstrations and experiments are used to initiate improvements in management methods and also to test the effects of existing standards. JDSF is also used to study regulatory standards prior to implementation to increase their effectiveness and reliability. This helps policy makers determine the balance between scientific knowledge, landowner rights and desires, and legal constraints.

JDSF is an ideal location for tours with universities and colleges, resource professionals and the public. Approximately 26 percent of the presentations at the Redwood Region Forest Science Symposium contain research associated with JDSF. Some examples of the types of research associated with JDSF are:

Watersheds:

- Caspar Creek Watershed Study – 150 research papers prepared since initiation in 1962.

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- Sediment storage and transport on the Noyo River.
- Microclimate in riparian zones.

Forest Ecology:

- Fire history in coast redwood.
- Genetic study of clonal growth in coast redwood.
- Sudden Oak Death – Stand dynamics and spatial patterns of SOD symptoms.

Silviculture:

- Pre-commercial stocking control of coast redwood, 17 years of response.
- Commercial thinning growth and yield, 29 years of response.
- Variable retention modeling of management regimes in coast redwood.

Fisheries and Wildlife:

- Salmonid trends in Caspar Creek for 30 years.
- Large woody debris placement in Parlin, Caspar, and Hare Creek.
- Wildlife use of legacy trees in managed forests.

Erosion and physical processes:

- Landslide inventory of even-aged management.
- Erosion rates over millennial and decadal scales.
- Significance of suspended organic sediments.

Restoration and Monitoring:

- Road decommissioning: Demonstration of different methods.
- Exotic weed control – Participation in the International Broom Initiative.
- Road surface erosion measurements of course and fine sediment.

Research and demonstrations on JDSF improve our understanding of the forest environment and increase our ability to make informed management decisions. With an ever-increasing demand for the multitude of uses for forestland, information from research is more critical than ever. There is a history of success on JDSF that creates a foundation for the future. In-kind operational support is available through technical assistance and through housing at the Forest Learning Center with a goal of building partnerships for a better understanding of the forest environment.

Growth and Survival of Redwood and Douglas-Fir Seedlings Planted Under Different Overstory Removal Regimes[1]

William Bigg[2]

A twenty acre stand of mature second growth redwood was marked for selective thinning and clear cutting after an intensive cruise based on basal area. Four treatments: an uncut control, a clearcut, and 66 percent and 33 percent basal area thinning were done. In each treatment, four plots were planted with redwood seedlings and three with Douglas-fir seedlings. The growth and survival of these seedlings has been checked each year since planting in early 1997.

No Douglas-fir seedlings survived the first summer in the uncut area. After six years there was 79 percent, 68 percent and 47 percent survival in the clearcut, 66 percent removal and 33 percent removal areas respectively. After six years the average height of Douglas-fir seedlings was 231 cm, 150 cm and 120 cm in the clearcut, 66 percent removal and 33percent removal areas.

Thirty eight percent of the redwood seedlings survived to six years in the uncut area with survival continuing to decline over time. There was 78 percent, 97 percent and 83 percent survival in the clearcut, 66 percent removal and 33 percent removal areas respectively. Heights of seedlings in the uncut, clearcut, 66 percent removal and 33 percent removal areas were 84.7 cm, 100.1 cm, 112.5 cm and 146.8 cm after six years.

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Habitat Characteristics and Spatial Extent of Burrow Systems of Point Arena Mountain Beavers on Managed Timberlands[1]

Sarah C. Billig[2] and Robert B. Douglas[3]

The Point Arena mountain beaver (PAMB) *(Aplodontia rufa nigra)* is one of seven subspecies of mountain beaver and is restricted in range to a small coastal area in northern California 62 square kilometers in size. Its restricted range and the lack of information regarding the population prompted the United States Fish and Wildlife Service (USFWS) to list the PAMB as endangered in 1991. Mountain beavers are generally found in cool microclimates with good drainage (Beier 1989, Pfeiffer 1953) and in areas with a higher proportion of small downed wood and soft soil (Hacker and Coblentz 1993). Because most information on mountain beaver ecology comes from studies on other subspecies, less is known about the Point Arena subspecies. PAMB live in underground burrow systems in areas with dense perennial vegetation and have been associated with three major habitats on forestlands: fresh water seep, alder/herbaceous ground cover, and conifers/sword fern (USFWS 1998). A majority of managed timberlands within the Point Arena mountain beaver assessment area are known to contain these habitat types. Our reasons for initiating a Point Arena mountain beaver habitat and spatial extent study were to examine burrow system habitat with respect to availability, develop hypotheses for future testing and modeling, and determine spatial extent of existing Point Arena mountain beaver burrows. Eventually, we hope to define potential habitat for Point Arena mountain beaver within forested systems with more specifics for inclusion in a Habitat Conservation Plan (HCP). We will use the spatial extent of burrow systems as a baseline for measurement within the HCP, and will re-measure spatial extent of each burrow system throughout the term of the HCP (with measurements taken every five years) to determine whether Point Arena mountain beaver burrow systems are changing in size.

To make a better assessment of stand-level characteristics associated with PAMB burrow systems, we sampled 22 habitat characteristics within known burrow systems (n = 7) on Mendocino Redwood Company lands. Plot measurements were made within PAMB burrow systems and around a random point 100 meters away from the edge of burrow systems. Proportion of stinging nettle (P = 0.08), sword fern (P = 0.07), and sorrel (P = 0.08) was greater in burrow systems than random plots. A greater proportion of these plants may be more indicative of potential habitat than other herbaceous plants. Though total number of trees was not different between burrow and random sites, there were fewer Douglas-fir (P = 0.02) and grand-fir (P =

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0.06) at burrow sites than random sites, however. Canopy cover (P = 0.20 center and P = 0.47 boundary) was not different between burrow and random sites, which may be due to an overestimation of alder canopy cover (using a spherical densiometer). We suspect burrow systems were generally closer to water than random sites and our inability to detect a difference (P = 0.138) may have been due to small sample size. Our results suggest the proportion of specific herbaceous species such as sword fern and stinging nettle may be an important factor explaining the location of Point Arena mountain beaver burrow systems. In addition, we characterized the spatial extent of each burrow system. Area of burrow systems ranged from 226.7 m^2 to 2,319.9 m^2 and had a, mean area of 685.8 m^2 (SE = 200.1). Burrow systems had a clumped distribution throughout the landscape and all were less than one-acre in size. Given estimates of density and home range sizes from other subspecies (Lovejoy and Black 1979, Martin 1971), each identified burrow system may only be occupied by 1 to 2 individuals, with each cluster of burrow systems constituting a potential "population."

In the future, we will continue to collect spatial extent information to determine if known burrow systems are increasing or decreasing in size as vegetation around the burrow systems change, and survey potential PAMB habitat in and around timber harvest plans to monitor burrow system distribution over time. This information will be used in conservation of PAMB in managed timberlands and may assist the USFWS in future status reviews of the species.

Table 1—*Perimeter (m) and area (m^2 and acres) of PAMB burrows measured on MRC lands in Mendocino County, 2003.*

Burrow identification	Perimeter (m)	Area (m^2)	Area (acres)
Lower Alder Creek 1	133.9	360.1	0.09
Mills Creek 1	107.0	271.5	0.07
Mills Creek 2	79.6	280.0	0.07
Mallo Pass 1	123.6	385.4	0.10
Mallo Pass 2	343.8	1332.6	0.33
Mallo Pass 4	220.5	1227.2	0.30
Owl Creek 1	155.5	391.6	0.10
Owl Creek 2	305.8	2320.0	0.57
Owl Creek 3	121.2	378.9	0.09
Owl Creek 4	98.3	226.7	0.06
Owl Creek 5	119.4	370.7	0.09

References

Beier, P. 1989. **Use of habitat by mountain beaver in the Sierra Nevada.** Journal of Wildlife Management 53(3): 649-654.

Hacker, A. and B. Coblentz. 1993. Habitat **selection by mountain beavers recolonizing Oregon coast range clearcuts.** Journal of Wildlife Management 57(4): 847-853.

Lovejoy, B. and H. Black. 1979. **Population analysis of the mountain beaver, *Aplodontia rufa pacifica* in Western Oregon**. Northwest Science 53(2): 82-89.

Martin, P. 1971. **Movements and activities of the mountain beaver *(Aplodontia rufa)*.** Journal of Mammalogy 52(4): 717-723.

Pfeiffer, E. 1953. **Animals trapped in mountain beaver *(Aplodontia rufa)* runways, and the mountain beaver in captivity**. Journal of Mammalogy 34(3):396.

Riparian Flora Observed at Riparian Revegetation Projects in North Coastal California[1]

R. Katz,[2] M. Lennox,[2] D. Lewis, [2] R. Jackson,[3] J. Harper,[4] B. Allen-Diaz,[5] S. Larson,[2] and K. Tate[6]

The flora observed at revegetation sites is a management concern for many landowners and agency efforts involved in analyzing stream function, riparian restoration, native plant conservation, and natural resource management in California. There is the potential for competition from non-native species to displace individuals and populations of native riparian species. We have conducted a cross-sectional survey of 70 existing riparian revegetation projects in Marin, Sonoma and Mendocino Counties to document the resulting composition of flora. The project is a collaborative effort between the University of California Cooperative Extension, resource agencies, consultants, private landowners, and watershed groups, working in coastal California. Sites ranged from four to 39 years in project age and received treatments of exclusionary fencing and active planting or fencing alone. The poster will report and compare the presence of native and non-native plant species. In addition, we will share observations of species succession, as well as plot measurements of dominant species cover. This documentation is the first step in using the project database to inform effective design, installation, and maintenance of riparian revegetation projects.

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A Literature Review to Examine the Potential of Silviculture to Enhance the Formation of Old-Forest Characteristics in Coast Redwood Stands[1]

Christa M. Dagley[2] and Kevin L. O'Hara[2]

Restoration of old forests is an emerging forest management priority in the Pacific Northwest. A literature review was sponsored by Save-the-Redwoods League to identify and examine the potential of silviculture to enhance and accelerate the formation of old forest characteristics in coast redwood stands. This review focused on four questions: 1) What is the range of old forest characteristics for coast redwood? Can we quantify these characteristics and identify geographic differences in different populations? 2) How did old redwood forests develop? What are the roles of shrub and hardwood species, and fire? Do conifers typically grow at low densities throughout their development, or is there evidence of periods of intense competition and suppression? 3) What are the opportunities for silviculture to restore and maintain old forest characteristics? Potential management activities include regeneration, vegetation control, early or mid-rotation spacing treatments, pruning, fuel reduction, creation of wildlife habitat features, and prescribed fire. 4) There may be differences between socially preferred old forest characteristics and those characteristics supported by scientific data. Are there treatments that will be conducive to maintaining old forest health and integrity while meeting societal expectations? Key findings from past research and a list of research priorities are presented.

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Channel Incision and Suspended Sediment Delivery at Caspar Creek, Mendocino County, California[1]

Nicholas J. Dewey,[2] Thomas E. Lisle, and Leslie M. Reid

Tributary and headwater valleys in the Caspar Creek watershed, in coastal Mendocino County, California, show signs of incision along much of their lengths. Headcuts are numerous in each drainage. An episode of incision followed initial-entry logging which took place between 1860 and 1906. Another episode of incision cut into skid-trails created for second-entry logging in the 1970s. Gullies resulting from both of these episodes of incision are sensitive to hydrologic fluctuations and feature active headcuts, deepening plungepools, and unstable banks, which continue to contribute sediment to the Caspar Creek channel network.

Surveys indicate that bank retreat, plunge pool deepening, and headcut retreat all contributed sediment to the channels between 2000 and 2003. During the study period, bankwall retreat appears to be a more significant source of sediment than headwall retreat.

Stream gage records show that some channels consistently deliver higher levels of suspended sediment than others. On an annual to decadal time-scale, rates of suspended sediment delivery per unit area of catchment correlate better with gully length and exposed bank area, than with the volume of sediment delivered by landslide events, with total catchment area, or with peak storm flow per unit area.

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Landscape and Site-Level Habitat Characteristics Surrounding Accipiter Nests on Managed Timberlands in the Central Coast Redwood Region[1]

Robert B. Douglas,[2] John Nickerson,[3] A. Scott Webb,[4] and Sarah C. Billig[5]

Accipiters such as the Cooper's Hawk *(Accipiter cooperii)* and Sharp-shinned Hawk *(A. striatus)* commonly nest in managed timberlands in the redwood region. A few published accounts describe accipiter nest sites in the western U. S. (Asay 1987; Moore and Henny 1983, 1984; Reynolds and others 1982; Siders and Kennedy 1996), however none exist for managed timberlands in northwestern California. Additionally, these species are listed by the California Department of Fish and Game as a Species of Special Concern primarily because of a lack of demographic information and continued habitat loss. Logging has been identified as one of several threats to accipiters and is a common activity in the redwood region that alters forest structure and plant species composition, and hence, may influence accipiter nest-site selection.

Since accipiter nest-site selection is not well understood on managed timberlands within the redwood region, resource managers often have little information to use for making management decisions. In 2001, Mendocino Redwood Company (MRC) initiated a project to identify accipiter nest sites throughout its forestlands using broadcast surveys, stand searches, and incidental sightings. In an effort to better understand accipiter nest-site selection, a project was designed to examine forest attributes surrounding nest trees at several scales. Here, we report preliminary results for habitat characteristics surrounding Cooper's Hawk (n = 7) and Sharp-shinned Hawk (n = 1) nests at stand and landscape scales. At the stand scale, we measured vegetative characteristics around nest trees and random trees (located 125 m away) within 0.05, 0.01, and 0.2 hectare radius plots; and at the landscape scale, we calculated percent area of specific forest structure classes and vegetation types surrounding nest trees within 7, 29, 51, 203, and 458 hectare circles.

Site- and landscape-level results suggest that tanoak and large conifers are important elements at nest sites. All nests were located in tanoak trees in the upper size classes (>39. 37 cm dbh; *table 1*) and nest sites had higher mean hardwood basal

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area and higher mean hardwood tree density (1.23±0.09 m^2/plot, 22.14±3.24 trees/plot), primarily in small-to-medium sized tanoak, than random sites (0.93±0.19 m^2/plot, 14.57±3.88 trees/plot, respectively). Although mean conifer basal area and mean conifer tree density were lower at nest sites (0.96±0.54 m^2/plot, 4.00±1.60 trees/plot) than random sites (1.13±0.41 m^2/plot, 7.71±1.74 trees/plot), most nest sites contained a few large conifers that contributed to most of the conifer basal area. Accipiter nest sites contained relatively high densities of small and medium hardwoods and a low density of conifer in all size classes. Landscape analysis also showed that the mean percent area of mixed hardwood/conifer vegetation type was highest at the smallest spatial scale and declined with increasing area around nest sites, suggesting that accipiters may be selecting this habitat type at the nest-stand scale.

Historical records indicate that accipiters have nested in other tree species besides tanoak on MRC lands; however, the disproportionate discovery of nests in tanoak (and stands dominated by tanoak) since the inception of this study suggests that birds are cuing on tree and/or stand characteristics conducive for nesting. Moore and Henny (1983) found that Cooper's hawks in Oregon typically selected Douglas-fir, as opposed to six other species of conifer, to build nests because this species often contained mistletoe brooms which provide a solid substrate for nest building. Wiggers and Kritz (1991) also documented Cooper's hawks nesting primarily in deformed trees below canopy in Missouri. While accipiters on MRC timberlands may be selecting trees suitable for constructing nests, they may also be selecting stands with tanoak and a few emergent conifers because these stands may provide increased access to prey and/or have higher prey availability, as well as provide protection from potential predators.

Moreover, since these results are based on a small sample size, our interpretation of the data should be regarded as working hypotheses subject to change as more information is collected. We are continuing to survey for accipiters in timber harvest plans, provide protective buffers around nests, and measure nest-site characteristics. If our results do indeed represent a phenomenon common in the redwood region, then some level of hardwood and emergent conifer retention may be an important element in conserving accipiters on commercial timberlands in Mendocino County.

Table 1—*Summary statistics for eight accipiter nests found in tanoak on MRC lands in Mendocino County.*

Nest Tree	Mean	SE
Diameter at Breast Height (cm)	49.31	2.72
Tree Height (m)	22.42	1.99
Nest Height (m)	16.25	2.09
Height to Crown Base (m)	9.42	1.54
Elevation (m)	350.12	65.38
Distance to Watercourse (m)	136.68	29.27
Canopy Cover (percent)	93.55	0.94
Position on Slope (percent)	55.28	5.91

References

Asay, C. 1987. **Habitat and productivity of Cooper's Hawks nesting in California.** California Fish and Game 73(2): 80-87.

Moore, K.R.; Henny, C.J. 1983. **Nest site characteristics of three coexisting Accipiter hawks in northeastern Oregon.** Journal of Raptor Research 17(3): 65-76.

Moore, K.R.; Henny, C.J. 1984. **Age-specific productivity and nest site characteristics of Cooper's Hawks (*Accipiter cooperii*).** Northwest Science 58: 290-299.

Reynolds, R.T.; Meslow, E.C.; Wight, H.M. 1982. **Nesting habitat of coexisting accipiters in Oregon.** Journal of Wildlife Management 46: 124-138.

Siders, M.S.; Kennedy, P.L. 1996. **Forest structural characteristics of accipiter nesting habitat: is there an allometric relationship?** Condor 98(1): 123-132.

Wigger, E.P.; Kritz, K.J. 1991. **Comparison of nesting habitat of coexisting Sharp-shinned and Cooper's hawks in Missouri.** Wilson Bulletin 103(4): 568-577.

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Restoring Riparian Conditions Along Valley Floors Affected by Multiple Coarse-Grained Flood Deposits: An Approach from Bull Creek, Humboldt Redwoods State Park[1]

Rocco Fiori,[2] Ruth Goodfield,[3] and Patrick Vaughan[4]

Sedimentation from the 1955 and 1964 floods aggraded portions of the Bull Creek valley by several meters and widened the channel bed as much as 100 percent. Past efforts to restore riparian conditions, based largely on vegetative characteristics alone, have had limited success. Limiting factors include poor water holding capacity within expansive coarse deposits (d50 >10 mm), seasonal rainfall, continued flooding, high solar exposure and channel migration and sedimentation related to the legacy of poor land use in the upper watershed before acquisition by the park in the mid-1960s.

California State Parks and Cooperators are now beginning to restore riparian areas using a process based approach. These efforts follow watershed improvement projects, begun in 1997, that have greatly reduced the density of hydrologically linked roads in the upper watershed and are intended to decrease sediment production, attenuate flood peaks and reduce the zone of annually mobilized bed sediment.

In several opportunistic locations within affected floodplains and channel margins we have created planting islands. In these areas we have mechanically shifted the coarse deposits to a finer texture and increased the organic content to a depth approaching the summer low flow elevation. Preliminary results suggest that soil moisture and over summer survival is significantly greater for seedlings planted in islands compared to untreated deposits. By strategically locating planting islands, where fine sediments are accreting and other geomorphic indicators suggest conditions are favorable to longer-term riparian vegetation, naturally occurring riparian areas can be expanded and linked with other islands.

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Determining the Distribution of Three Amphibian "Species of Concern"[1]

Matthew O. Goldsworthy[2]

Currently the distribution of tailed frogs, red-legged frogs and southern torrent salamanders in Mendocino County is largely unknown. Baseline data on the distribution of these species was collected in 2003. Approximately 56,000 acres or 25 percent of Mendocino Redwood Company's (MRC) ownership was surveyed in 2003. The remainder of the MRC ownership will be surveyed during the next three years and monitored throughout the next 80 years.

Approximately 33 percent of the Calwater planning watersheds surveyed were determined to support red-legged frog reproduction. Fifteen documented breeding sites were located throughout five planning watersheds. The majority of breeding sites found contained little canopy cover (<40 percent) and were located within floodplains (57 percent). Many of the documented breeding sites were manmade (42 percent).

Tailed frog surveys were conducted at 148 sites, of which 24 sites yielded detections (16 percent). The species was detected within approximately 40 percent of the planning watersheds surveyed. The majority (96 percent) of detections were from watercourses which did not have southerly aspect.

Southern torrent salamander distribution surveys were conducted after the first few rains of 2003. There were 108 sites surveyed and eight sites (seven percent of sites) yielded detections of the species. The distribution of southern torrent salamanders does not appear to be as widespread as it is in Humboldt County.

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The Effect of Overstory Canopy Alterations on Air Temperature in a Managed Redwood Forest[1]

Elizabeth Wilson Hadley and William Bigg[2]

This study was conducted to determine if there is a relationship between air temperature and overstory canopy, if there is an effect on the air temperature at the center of the buffer strip with a 50-foot reduction in width, and with an overstory removal to bring the canopy down to 85 percent.

Following a control period, the canopy surrounding three circular study plots were cut first to create a 200-foot buffer from the center, second to bring the buffer width down to 150 feet, and third, to bring the overstory canopy to a level of 85 percent closure.

The daily mean, minimum, and maximum temperature difference between 52 sampling points and the center untouched 50-foot area of the buffer zone was found following every logging event. No significant changes in the air temperature at the center were found as a result of any of the harvests ($p < 0.001$). There was a strong relationship between the maximum daily air temperature differences and overstory canopy as measured by the solar pathfinder ($R2 = 0.66$).

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A Comparison of 10 Techniques Used to Estimate Canopy Interception[1]

Todd A. Hamilton and William Bigg[2]

An eighty-year coast redwood *(Sequoia sempervirens)* and Douglas-fir *(Psuedotsuga menziesii var. menziesii)* forest type was used to compare ten techniques of measuring canopy interception. Measurements for all techniques were taken in a series of four treatments: 1st) before operations, 2nd) after surrounding area was clearcut to retain 200-foot radial circles, 3rd) after surrounding area was clearcut to retain 150-foot radial circles, and 4th) after the 150-foot radial circles were thinned to retain 85 percent canopy interception.

Thinning 33 percent of the basal area changed canopy closure from 91 percent to 86 percent and canopy cover from 96 percent to 85 percent. Vertical sighting tube showed the greatest change in canopy interception after thinning, whereas gap fraction (5'175˚) showed the least change in canopy interception. The strongest correlation (r^2 = 0.96) was between hemispherical photographs with different view angles (15'75˚ and 15’175˚). Average change in canopy interception increased 12.7 percent from view angles of 5º to 175º (slope = 0.07). Stem structure remained about the same though the average number of trees per acre went from 202 to 150.

It is recommended that techniques of canopy cover are used in stands with interception less than 65 percent and techniques of canopy closure are used in stands with interception greater than 65 percent.

[1] This poster was presented at the Redwood Science Symposium: What does the future hold? March 15-17, 2004, Rohnert Park, California.

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Redwood and Douglas-Fir Stumpage Price Trends in Coastal California[1]

Richard B. Standiford[2]

The North Coast is California's largest timber harvesting area. Harvest in this area, stretching from Sonoma to Del Norte Counties, ranged from 1.4 billion board feet in 1978 to 520 million board feet in 2002. This represents approximately 30 percent of the state's timber harvest. Old growth percent has decreased from 70 percent in the mid-1970s to less than 10 percent currently.

Real prices for young growth redwood and Douglas-fir in the North Coast have shown an increasing trend since 1978. Annual real price increases over the past 14 years have averaged 5.3 percent for redwood, and 4.1 percent for Douglas-fir. Despite these trends, there have been tremendous annual price fluctuations, reflecting volatility and uncertainty for landowners. Over the past 14 years, changes from year to year varied from −40 percent to +74 percent.

The unique niche for redwood products and high consumer acceptance is expected to continue the strong price trends for this species. The Douglas-fir prices are expected to be more of a commodity, tied in closely with pine and Douglas-fir from other regions. This information will be useful in modeling anticipated affects of supply changes on product prices.

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Large Woody Debris and Pool Dynamics in the Caspar Creek Experimental Watershed, Northern California[1]

Sue Hilton[2] and Leslie Reid[2]

Although large woody debris (LWD) is now widely recognized as an important contributor to channel habitat, LWD dynamics are still poorly understood. This poster describes interim results of a study of inputs, breakage, transport, and decay of LWD in the mainstem channels in the two Caspar Creek Experimental Watersheds. LWD volumes and characteristics differ in the two reaches. Here we discuss possible causes for the differences, how the differences affect pools in the reaches, and what might happen to LWD in these reaches over time.

The two Caspar Creek experimental watersheds supported approximately 100-year-old second-growth redwood *(Sequioa sempervirens)* forest in 1968, when road building began for the first Caspar creek experiment. From 1971 to 1973, approximately 65 percent of the timber volume in the entire South Fork Watershed was removed in a series of selection cuts, with logs tractor-yarded to stream-adjacent roads. Twenty years later, 50 percent of the North Fork was harvested in a series of small clearcuts. Logs were cable yarded from ridgetop roads, and 100' selectively logged buffers were left along both sides of the mainstem.

LWD was inventoried in an 1800 m reach in the North Fork mainstem in 1986, 1994, and 1996, and in an equivalent reach in the South Fork in 1994 and 1996 (Keppeler 1996, O'Connor and Ziemer 1989, Surfleet 1996). In 1998, all recent LWD pieces >0.2 m diameter and 2 m long and all old LWD pieces >0.5 m^3 were tagged and measured in the two reaches. Those logs were resurveyed in 1999, and all pieces larger than the minimum new piece size were tagged at that time. Both reaches were remapped and remeasured in 2002 and 2004.

Since 1998, the volume of LWD in the North Fork study reach has remained more than twice that in the South Fork reach. We identified three potential causes for this difference. First, much of the existing wood in the South Fork channel was removed during the 1970s logging, and that LWD may not yet have been replenished. Second, there was significant blowdown along the North Fork in buffer strips left during the 1990s logging, and much of that wood entered the channel. Inputs into the South Fork channel during the same period were much lower. Third, since the 1970s logging, stands adjacent to the South Fork channel have not been capable of producing as much LWD as those along the North Fork. In 2004, trees within 100' of the South Fork channel were smaller and shorter than North Fork trees, and a higher proportion of the trees were species that are relatively resistant to blowdown

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(redwood) or fairly short-lived in the channel (alder).

We compared LWD volumes in the 800 m downstream subreach of each study reach to pool volumes in a 500 m section of that subreach (Lisle and Hilton 1999). Total pool volumes in the two reaches are similar, but pool LWD relationships differ. Most of the pool volume in the North Fork reach is in pools associated with second-growth LWD, and that proportion, as well as the total volume, increased from 1994 to 1996 in response to increased LWD from buffer strip blowdown *(fig. 1)*. In the South Fork, almost half of the pool volume is associated with residual old-growth pieces, and about 10 percent is in non-wood pools. Changes in second-growth associated pool volume appear to be related to changes in total LWD.

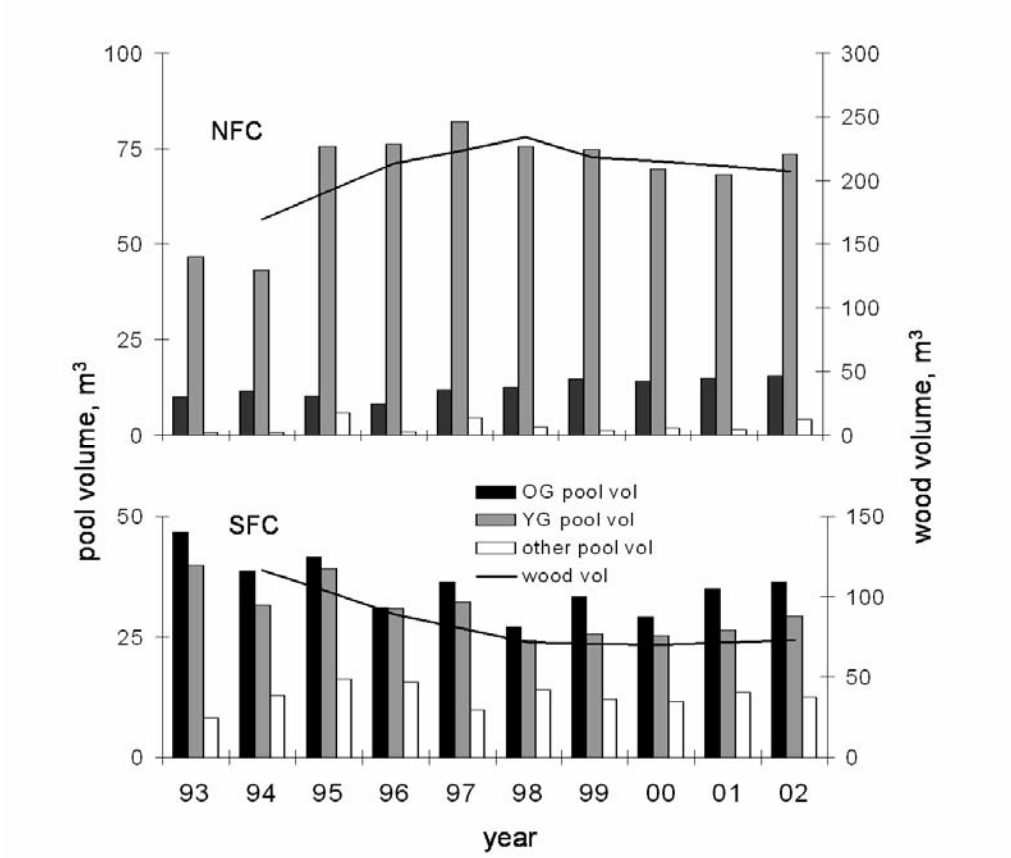

Figure 1—LWD Volume in the downstream 800 m of each study reach compared to pool volume in the downstream 500 m by type of pool each year, 1993 to 2002.

In the South Fork, 30 percent of all pieces and 16 percent of the volume was gone, moved, or broken from 1998 to 2004, although the total volume changed by less than five percent. In the North Fork, 24 percent of the pieces and 17 percent of the volume had changed, while the total volume increased, due primarily to input from snags. Monitoring continues at both tributaries. Data will be used to create a yearly wood budget for the channels, and will be used in combination with stand growth and wood input models to project the future of LWD in these reaches.

References

Keppeler, E. 1996. Caspar Creek Large Organic Debris revisited. Unpublished report supplied by author.

Lisle, Thomas E., Hilton, Sue 1999. **Fine bed material in pools of natural gravel bed channels**. Water Resources Research 35(4): 1291-1304.

O'Connor M.D., Ziemer, R.R. 1989 **Coarse woody debris in a second-growth Sequoia Sempervirens forest stream**. In: Proceedings of the California riparian systems conference 1988 September 22-24; Davis, CA. General Technical Report PSW-GTR-110; Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 165-171.

Surfleet, C.G., Ziemer, R.R. 1996. **Effects of forest harvesting on large organic debris in coastal streams**. In: Proceedings of the conference on coast redwood ecology and management, 1996 June 18-20; Arcata CA. Arcata, CA: Humboldt State University; 134-136.

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Adapting Silvicultural Practices to Respond to Changing Societal Demands for Forest Resource Management[1]

Stephen R. Horner[2]

Today's California forest managers are being asked to feed society's increasing appetite for forest products while providing exceptional protection for all non-commodity forest resources. Truly sustainable forestry—which requires balancing environmental protection, socio-economic factors and financial considerations of the landowner—must include progressive silvicultural options that improve forest growth and make for efficient timber harvest.

The results from a growth and yield study of a 20-year old pure redwood plantation on a highly productive site in the Redwood Region that has experienced 50+ percent increases in stand growth as a result of intensive management are used as a basis for predicting commodity production within a watershed using a high-yield/habitat protection matrix approach. The results suggest that both high growth rates of stands of commercial forest tree species and protection of terrestrial and aquatic plant and animal species can be achieved, but economic viability of the firm practicing sustainable forestry—and hence the economic success of a harvest-dependent community—is highly dependent upon operational flexibility. Given that commodity yield and habitat and species protection can be achieved, careful harvest unit planning is recommended but must be supported by operations windows that maximize harvest during dry seasons and reconfigured buffer zone boundaries that balance resource protection and efficient harvest operation.

[1] This poster was presented at the Redwood Science Symposium: What does the future hold? March 15-17, 2004, Rohnert Park, California.

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Riparian Vegetation Recovery Following Road Decommissioning[1]

Emily King[2]

A Humboldt State University Graduate Thesis is in progress in Redwood National and State Parks to study the regrowth of riparian vegetation following road decommissioning. In the last 25 years, the decommissioning of roads in the park has been quite intensive, both in number and complexity. Large areas are disturbed as the landscape is recontoured. Large woody debris is used to stabilize slopes, but little is done to restore vegetation after the decommissioning is complete. The methods of decommissioning roads have been changed over the years resulting in different vegetational stages and speeds of recovery. Long term effects of the disturbance are not well understood and little vegetation monitoring has been done in the decommissioned reaches.

This study will look at perennial stream crossings on decommissioned roads from different years to determine the riparian vegetation regeneration. It will also look at paired sites on the same stream reaches that were decommissioned using different methods to see if there is a difference in the composition of vegetation. Controls for each site will be located in adjacent, undisturbed areas. One goal of this study is to determine which methods of road decommissioning result in riparian vegetation regrowth that is most like the control areas.

[1] This poster was presented at the Redwood Science Symposium: What does the future hold? March 15-17, 2004, Rohnert Park, California.

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Are Suspended Sediment Yields a Function of Land Use in the Elk River Watershed, Humboldt County?[1]

Peter Manka and C. Hobart Perry[2]

The majority of watersheds in the redwood region on the North Coast of California are listed by the USEPA as impaired by excessive sediment. High volumes of sediment interfere with the migration and spawning of threatened and endangered salmonids. Excessive sediment in streams may also contaminate drinking water supplies, cause channel aggradation, or change flood frequency and extent. Turbidity threshold sampling is estimating the annual suspended sediment yields of three tributaries of the Elk River in Humboldt County, northern California. These streams have similar drainage areas (one to two square miles), similar geologies, and significant differences in land management. Little South Fork Elk River drains the largely undisturbed, old-growth forest of the Headwaters Forest Reserve. Most of the Corrigan Creek watershed is a mid-successional forest approximately 60 years in age. The South Branch of the North Fork of Elk River underwent extensive even-aged management approximately 13 years ago. We are exploring the differences in total suspended sediment yields and periodicity of suspended sediment movement. These differences provide insight into "background" levels of suspended sediment and the impacts of land management on suspended sediment production. The data may also provide information on the mechanisms and rates of recovery from sediment impairment.

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Effect of 70 Years of Recreational Car Camping on Vigor of Old-Growth Coast Redwood and Douglas-Fir[1]

Steven R. Martin,[2] John D. Stuart,[3] Portia Halbert,[4] and Mark A. Rizzardi[5]

Introduction

Recreationists have been car camping at Blooms Creek campground in Big Basin Redwoods state park annually for 70 years. Park managers are interested in better understanding the effects that such long-term recreational use may have on the health and vigor of the forest overstory.

The Problem

Trampling and vehicle use are major causes of impacts to soils in wildland recreation areas, including soil compaction, increased soil density, reduced macroporosity and aeration, changes in soil structure and stability, reduced litter and humus layers, reduced infiltration rates, increased runoff and erosion, changes in soil temperature regimes, a reduction in soil microorganisms, and changes in soil chemistry and available nutrients; these impacts are usually assumed to adversely affect plant vigor.

Concern over the effects of long-term recreational trampling on the vigor of mature redwoods has existed since the early days of the redwood state parks, but the few investigations into those perceived impacts have been inconclusive. This investigation seeks to measure more directly and quantitatively the vigor of mature redwoods and Douglas-fir in a campground that has withstood more than 70 years of recreational trampling.

Methods

The study was conducted in Big Basin Redwoods State Park. Study sites were located in the Blooms Creek campground and along the relatively untrammeled Opal Creek. The Blooms Creek campground was opened in the 1930s and consists of 48

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drive-in campsites and four walk-in sites. The Opal Creek site has a narrow, lightly used trail running through it with no evidence of off-trail use, and served as the control site.

Study sites were located in alluvial redwood forests with redwood and Douglas-fir as the dominant or co-dominant species. In each of the two study sites, we sampled all of the redwood and Douglas-fir trees that were emergent or dominant crown class. This resulted in sample sizes of 35 redwood and 22 Douglas-fir trees sampled in the campground, and 19 redwood and 12 Douglas-fir trees in the control site.

For each sampled tree we measured height and crown length, circumference of the tree, sapwood thickness and bark thickness. We used these measurements to calculate live crown percent, diameter, radius inside the bark, total basal area at breast height, heartwood basal area, and sapwood basal area. We then calculated crown length to sapwood basal area (CL/SBA) as an index measure of crown density, our chosen indicator of tree vigor.

Results

A Mann-Whitney test for equality of medians was performed to compare redwoods in the campground and control sites, and also to compare Douglas-firs in both sites. For redwoods, there was no significant difference (at $\alpha = .05$) in height, diameter, crown length, live crown percent, sapwood basal area, or the CL/SBA index measure of crown density between the campground and control study sites. For Douglas-fir, the only significant differences between the campground and control sites were for length of live crown and live crown percent, with Douglas-firs in the control site possessing a longer live crown and a larger live crown percent; there was no significant difference for crown density.

To further test for a campground effect controlling for tree height and diameter, separate linear regression models were constructed for each tree species. There was no statistically significant campground effect for the redwoods ($P = 0.79$) and Douglas-firs ($P = 0.94$) after controlling for tree height and diameter.

(Model: $\log(CSI) = \beta 0 + \beta 1 \log(Diameter) + \beta 2 \log(Height) + \beta 3$ Campground)

Conclusions

Despite intuitive concerns expressed by academics and resource managers alike regarding the detrimental effects of recreational trampling on the health and vigor of mature trees in recreational areas, our study of coast redwoods and Douglas-firs in a California state park recreational campground used annually for more than 70 years found no significant difference in crown sparseness between overstory redwoods and Douglas-firs in the campground with those in an untrampled control plot.

Canopy Closure and Soil Moisture in a Second-Growth Redwood Forest[1]

Justin Mercer and William Bigg[2]

This study examined the effects of second-growth redwood canopy on growing-season soil moisture conditions for redwood seedlings. Two sites were utilized to measure soil moisture content over the duration of the growing-season at varying levels of canopy closure. The first, a transect, beginning in a clear-cut and extending into an uncut second-growth redwood stand, was used to compare soil moisture depletion across the forest edge. The second employed a meadow to generate the same comparisons in a forest gap. Canopy measurements were derived from hemispherical photographs; with soil moisture data collected from the upper 20 cm of the topsoil and measured as gravimetric water.

The results of the study indicate a strong correlation between the extent of measured canopy and soil moisture conditions. Increasing exposure to sunlight correlated to lower levels of soil moisture throughout the growing season, significant differences in the rate of depletion, reduced minimum water balances, and shorter potential growing seasons.

Differences in soil moisture conditions were subtle amongst plots in the gap and the uncut forest, with more extreme differences evident for the clear-cut plots. Conditions in the clear-cut differed significantly from every other plot, including the gap center, with soil moisture depletion rates allowing a considerably shorter potential growing season.

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Riparian Zone Management and Analysis of Flood Hazard in Urban and Rural Areas[1]

Matthew D. O'Connor[2]

Riparian vegetation and woody debris in stream channels has long been recognized by engineers and landowners to contribute to flood hazard. Excessive vegetation and debris may cause local flooding, bank erosion, and channel avulsion. These disturbance processes are part of the natural pattern of disturbance that creates diversity in aquatic and riparian habitat. In urbanized and rural residential areas, however, these disturbance processes are a threat to property.

Historically, both private and public flood control efforts included removal of vegetation and woody debris from channels. State and Federal environmental regulations now limit degradation of aquatic habitat incidental to flood control efforts. Many streams in the region have thickly vegetated riparian zones where riparian vegetation is encroaching upon the channel. Debris jams also form where woody material is present. Flow resistance in these areas is high, increasing flood hazards.

An analysis of flood hydraulics and flow resistance in one northern California stream demonstrates the potential effect of riparian vegetation and woody debris on flood hazards. This case study demonstrates a method of analysis of flood hazard, paying special attention to quantification of the flow resistance associated with vegetation.

Field surveys of live stems and woody debris in the Elk River were used to determine the flow resistance of woody material in a low gradient coastal alluvial river channel. This stream is prone to flooding and has relatively dense stands of alder along the banks. Mean channel slope is about 0.001, mean bankfull width is about 50 ft (15 m), and mean bankfull depth is 11 ft (3.4 m). The channel is sand bedded, with some fine gravel, and has some deep pools associated with LWD.

The approach developed by Shields and Gippel (1995) was used as the basis for developing quantitative estimates of flow resistance. Two types of data were collected. Over a distance of about 2000 ft (580 m) partitioned into two reaches, detailed measurements of all stems (live or dead) in the bankfull channel >0.1 ft (3 cm) diameter were measured to determine the area of each LWD piece or live stem perpendicular to flow. These data allow a direct computation of flow resistance. Over a distance of 18,000 ft (about five km), the diameters of live and dead woody stems were measured along the channel centerline. This more extensive, less detailed survey was intended to estimate reach-scale variation of flow resistance of woody material and to provide perspective on spatial variation of channel conveyance and flood hazards as a function of the abundance of woody material in the channel. In

[1] This poster was presented at the Redwood Science Symposium: What does the future hold? March 15-17, 2004, Rohnert Park, California.

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both cases, the character of woody material was also observed. This included whether the material was live or dead, and standing or downed.

Flow resistance (Manning's n) of woody material in two reaches measured in detail was 0.034 for the reach with relatively few pieces of woody material crossing the channel and 0.046 in the reach with more obstructions in the channel. Center line surveys over a larger area suggest that woody material roughness values found in the reaches are likely much higher than those measured in the two detailed study reaches.

Estimated flow resistance of woody material in the Elk River study reach varied from about n = 0.03 to about 0.07. These n values are relatively high, and would represent the total flow resistance in many gravel bed streams in the region. Flow measurements and gaging records in Reach 6 suggest flow resistance at bankfull flow to be in the range n = 0.08 – 0.14. Resistance from woody material appears to represent about roughly 30 to 50 percent of the estimated total.

In a field study similar to that of Shields and Gippel (1995), Manga and Kirchener (2000) found that woody debris at their site provided about 50 percent of total flow resistance despite the fact that wood covered only about two percent of the channel surface area. Additional sources of flow resistance in the Elk River study reach would include the stream bed and banks, and bends in the river. At Shields and Gippel's study site on the Obion River in Tennessee, measured flow resistance attributed to the stream bed was about n = 0.042. The Obion River has very similar geometry and sediment size distributions to the study reach on the Elk River. Using the Obion River bed resistance of about n = 0.04 to represent bed resistance in the Elk River study reach would suggest n values in the range of about 0.07 to 0.11. Obion River reaches were straight. Some reaches on the Elk River are straight, but several reaches contain sharp bends that would likely add substantially to total flow resistance.

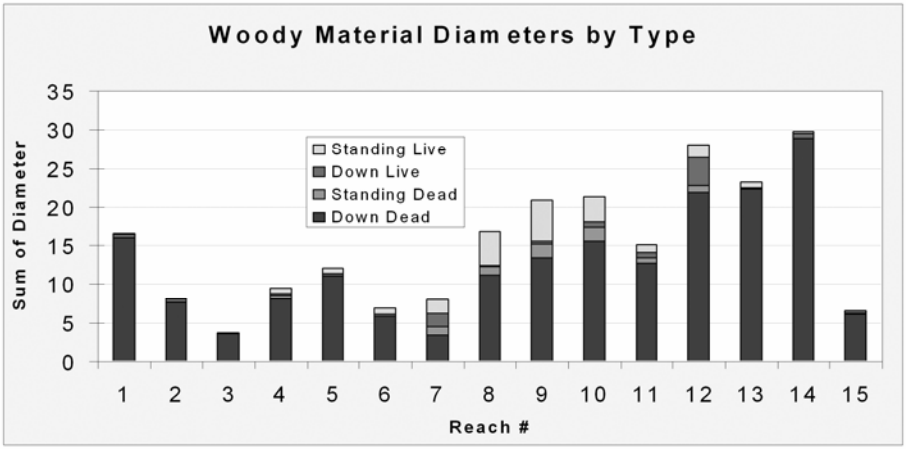

Figure 1—The character of woody stems expressed as the sum of stem diameters in units of feet is shown for consecutive 1,000 ft reaches in Elk River, Humboldt County, California. Down dead woody debris is the dominant type, however, live woody stems are significant in many reaches, particularly 7 through 10. Live stems are primarily found in dense stands of willow and alder on the channel banks.

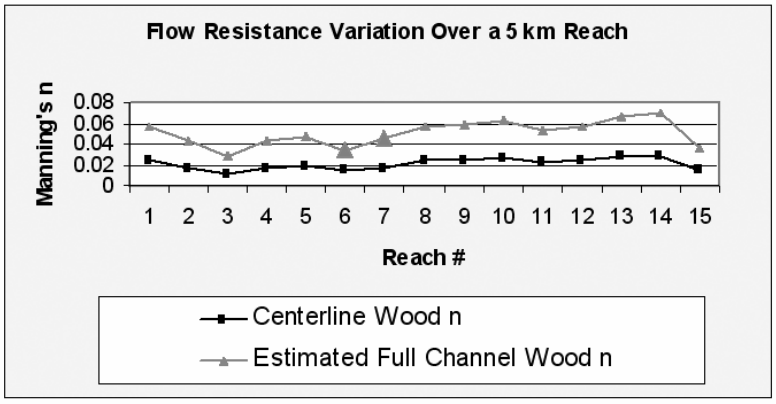

Figure 2—Estimated flow resistance expressed as Manning's n (a roughness coefficient commonly used in hydraulic calculations) is shown for consecutive 1,000 ft reaches in Elk River, Humboldt County, California. Two estimates are provided. The lower line in the graph is derived from field data for woody stems measured throughout the reach along the channel centerline only; it represents a minimum estimate of resistance due to woody stems. The second estimate (the upper line in the graph) is an extrapolation derived from the relationship between observations along the channel center line and full-channel observations in reaches 6 and 7; this estimate better represents the likely magnitude of flow resistance associated with woody debris throughout the study reach.

References

Manga, M.; Kirchener, J.W. 2000. **Stress partitioning in streams by large woody debris.** Water Resources Research. 36(8): 2373-2379.

Shields, F.D.; Gippel, C.J. 1995. **Prediction of effects of woody debris removal on flow resistance.** Journal of Hydraulic Engineering 121(4): 341-372.

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A Tree-Marking Procedure for Variable-Density Thinning—Applications to Old-Forest Redwood Restoration[1]

Kevin L. O'Hara[2] and Christa M. Dagley[2]

Key words: restoration, Sequoia sempervirens*, silviculture, stand density, stocking control, variable-density thinning*

Variable-density thinning is an operation intended to enhance short- and long-term stand structural diversity. By thinning to variable densities within a single stand, the resultant structure includes areas at wide spacings, unthinned areas, and areas with intermediate spacings. For some management objectives—such as for promoting wildlife habitat or old forest characteristics—this stand heterogeneity is desirable. Consistent implementation of variable-density thinning operations is difficult because variability is difficult to quantify in an operational setting: tree markers or thinners will have to monitor their activities so their marking or thinning is repeatable and consistent over time and space. To assist with variable-density thinning treatments, we developed a procedure for marking young stands (<20 years). This procedure assumes a target density is known: in this case the target is 50 trees/ac (124 trees/ha) plus an assumed mortality rate of 50 percent (resultant target density = 75 trees/ac (185 trees/ha)). Markers work in cells equal to 1/N acre where N = target density. A random number from zero to three is chosen that provides the number of residual trees for that cell. The resultant density should approach 75 trees/ac. This procedure was tested for variable-density thinning treatments in Del Norte County with target densities of 75 and 150 trees/ac (185 to 371 trees/ha).

Post-thinning results generally indicated the procedure resulted in densities close to targets *(table 1)*. The "high density" treatment at Cougar Ridge was low but this was largely due to the low numbers of trees in the blocks randomly selected for this treatment. Otherwise the procedure appears to be useful for achieving targets with variable-density thinning. However, the method is operationally difficult to implement because of the need to recognize cell sizes that vary with target density and generate a random number in the field. For research purposes, this method appears to be a promising method of achieving target densities and obtaining a variable-density structure. These treatments and the controls will be monitored to describe their future development.

[1] This poster was presented at the Redwood Science Symposium: What does the future hold? March 15-17, 2004, Rohnert Park, California.

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Table 1—*Post-thinning densities from variable-density thinning at Mill Creek in Del Norte County. TPA = trees per acre.*

Treatment site	Treatment	Target TPA	Actual TPA
Childs Hill	Control	N/A	657
	High density	150	166
	Low density	75	78
Cougar Ridge	Control	N/A	682
	High density	150	113
	Low density	75	67
Moratorium	Control	N/A	1357
	High density	150	140
	Low density	75	84

The California Geological Survey and the Review of Timber Harvest Plans in Redwood Forests[1]

Mark G. Smelser[2]

The California Geological Survey (CGS) has been assessing geologic issues associated with timber harvesting in the north coast redwood region since the implementation of the Z'Berg-Nejedly Forest Practice Act in 1975, and is currently a representative of the Interdisciplinary Review Team as defined in the Forest Practice Rules. CGS' Forest and Watershed Geology (FWG) Program provides technical information and advice about landslides, erosion, sedimentation, and other geologic hazards to the California Department of Forestry and Fire Protection (CDF), other state agencies, industries, and the public where proposed activities may affect public safety, soil productivity, water quality, and fish habitat. Within the FWG program, licensed engineering geologists provide independent technical review of proposed Timber Harvest Plans (THPs), Non-Industrial Timberland Management Plans (NTMPs), and other regional-scale land management projects submitted to CDF under the Forest Practice Rules. The geologic evaluation of a THP by CGS follows a systematic approach conducted in accordance with standards of professional practice and scientific accountability. The evaluation includes a desk review of the submitted THP or NTMP, review of pertinent geologic maps and reports, review of historic aerial photographs, participation in the pre-harvest field inspection as staff are available, and if geologic concerns are noted a written report is prepared that often includes specific recommendations for the plan submitter to address.

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A Context for Cumulative Watershed Effects in Redwood Forests[1]

Thomas E. Spittler[2]

Coastal northern California redwood forests are controlled by the complex interaction of geology, hydrology/climatology, and biology, each of which is in constant flux. Earthquakes, uplift and subsidence, sea level change, storms, droughts, floods, fires, and the growth, death, and evolution of species affect the region. Simple deterministic models cannot integrate these dynamic watershed components.

Comparing what is present today with conceptual "natural" conditions is speculation that cannot be supported. Vegetation management by Native California societies for the past 3,000 to 10,000 years produced a lower average biomass, more open forests and greater streamflow than exists where fires are suppressed. Plant and animal communities evolved under this managed fire regime. Because of the dynamic complexity of redwood forest watersheds and the lack of documentation on Native Californian management, models may not be capable of identifying desired conditions at a site-specific level.

Science has the tools to detect changes and rates of changes in the individual components that define a watershed. Integrating observations on changes to see if and how fast areas are trending toward the complex diversity of conditions anticipated to result from modeling may be one approach to understanding cumulative watershed effects in redwood forest watersheds.

[1] This poster was presented at the Redwood Science Symposium: What does the future hold? March 15-17, 2004, Rohnert Park, California.

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Adaptive Management Monitoring of Spotted Owls[1]

Mike Stephens,[2] Larry Irwin,[3] Dennis Rock,[3] and Suzanne Rock[4]

Extensive public and private forests occur in early to mid-successional stages from northern California through Washington. Many landowners and agencies are expected to manipulate many such forests over the next few decades to reduce fuel loads or increase growth via intermediate silvicultural treatments such as thinning or partial harvesting. We initiated an extensive, cooperative project to monitor responses of both the northern and California subspecies of spotted owls to applications of such less intensive forestry practices. Owls are fitted with 7 to 8 g back-pack radio transmitters and signals are recorded using handheld, directional Yagi antennae and portable receivers. The study employs a repeated, or multiple study-area approach, for which data will be combined via meta-analyses. The project combines both repeated observational experiments and manipulative experiments. The primary objectives allow comparisons among owl foraging use of forest stands with and without previous silvicultural treatments, and before-versus-after silvicultural treatments. Products involve resource selection function models, which can be used as decision-support tools for predicting owl responses to various silvicultural treatments in managed forests.

[1] This poster was presented at the Redwood Science Symposium: What does the future hold? March 15-17, 2004, Rohnert Park, California.

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The Effects of Harvest History on the Lichens and Bryophytes of the Arcata Community and Jacoby Creek Forests[1]

Sunny Bennett[2]

Historical and modern logging, including single tree selection (removal of 20 to 50 percent of individual stems within a unit) and patch cuts (removal of all stems in a unit, clearcut), have resulted in a mosaic of different aged stands within the Arcata Community and Jacoby Creek Forests. Continuous monitoring plots have been established as part of an ecologically sensitive, long-term management plan. I conducted surveys to identify the lichens and bryophytes present in the plots and to determine any effects of harvest history on species richness and abundance.

One hundred and fifty species were identified, including two rare lichens and one rare moss. Average abundance for most species was low (<1 percent cover) due to low frequency of occurrence. When grouped by harvest history, single tree selection plots had the highest mean number of species, and patch cut plots had the lowest mean number of species. Historically logged plots had the highest number of unique species (36), while single tree selection and patch cut plots had equal number of unique species (7).

Single tree selection is probably a better method of timber harvest than patch cutting to promote species diversity in the Arcata Community and Jacoby Creek Forests.

[1] This poster was presented at the Redwood Science Symposium: What does the future hold? March 15-17, 2004, Rohnert Park, California.

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A Tale of 10 Snags[1]

David L. Suddjian[2] and Thomas Sutfin[3]

During a 1995 50-acre timber harvest conducted on the Soquel Demonstration State Forest (SDSF) in Santa Cruz County, snags were created from ten large standing Douglas-fir trees to provide increased nest, roost and foraging sites for birds. The trees were 34 to 50 inches in diameter at breast height. A bird study was conducted prior to the 1995 timber harvest to asses its effects on breeding bird populations, with subsequent bird surveys conducted in 1996, 1998, and 2001.

By 2001, all ten snags showed evidence of use by cavity-nesting birds, including Pygmy Nuthatch, Pileated Woodpecker (a newcomer to the Soquel Creek watershed), Western Screech-Owl, Northern Pygmy-Owl and Northern Saw-whet Owl. Bird population changes also were noted. For example, by 2001, Acorn Woodpeckers, absent on the 1995 pre-harvest surveys, occurred at 67 percent of the survey stations; Hairy Woodpeckers occurred at 40 percent more survey stations; and Northern Flickers went from nearly absent in 1995 to being present at 50 percent of the stations. Although the creation of the snags alone probably did not change the bird population in the SDSF, the abundance of cavities, active nests, and foraging evidence in the snags by 2001, suggests the snag management program played a big role.

[1] This poster was presented at the Redwood Science Symposium: What does the future hold? March 15-17, 2004, Rohnert Park, California.

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Effects of Forest Management in the Caspar Creek Experimental Watersheds[1]

Jack Lewis,[2] Elizabeth Keppeler,[2] and Tom Lisle[2]

Caspar Creek Experimental Watersheds were established in 1962 as a cooperative effort between the California Department of Forestry and Fire Protection and the USDA Forest Service Pacific Southwest Research Station to research the effects of forest management on streamflow, sedimentation, and erosion in the rainfall-dominated, forested watersheds of north coastal California. The project has evolved from a simple paired watershed study into one of the most comprehensive and detailed investigations of its kind. In 1962, weirs were installed for measuring streamflow and sediment loads on the North and South Forks. From 1971 to 1973, 50 percent of the timber volume in the South Fork was selectively cut and tractor yarded, and the untreated North Fork was retained as a control. In 1986, thirteen new gaging stations were installed in the North Fork Basin and three unlogged tributaries served as controls when 48 percent of the North Fork basin was clearcut and cable yarded between 1989 and 1991. Ten new gaging sites in the South Fork will be used to assess impacts of selection harvest and road rehabilitation on tractor-logged terrain. The scope of research in the watershed has expanded beyond hydrological studies to include geomorphological, ecological, silvicultural, and biological investigations.

[1] This poster was presented at the Redwood Science Symposium: What does the future hold? March 15-17, 2004, Rohnert Park, California.

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Evaluation of Low-Altitude Vertical Aerial Videography as a Method for Identifying and Estimating Abundance of Residual Trees[1]

Linda M. Miller,[2] Scott D. Osborn,[2] and David J. Lancaster[2]

Low-altitude color aerial video was acquired within the northern section of the Redwood Region in Humboldt and Del Norte Counties, northwestern California. Four interpreters viewed a sample of video and identified residual trees within one-third hectare circular plots. Each sample plot was ground-truthed and residuals were identified and mapped.

Error matrices presented indicated that identification of residuals was not highly accurate for individual trees, nor consistent among interpreters. However, for three of four interpreters, linear regressions of number of interpreter-identified residuals per plot versus number of field-identified residuals per plot had significant slopes ($p < 0.005$). Coefficients of determination were 0.23, 0.22, and 0.41 for the three interpreters. Interpreters were not very successful at identifying old-growth legacy trees in video, and clonal rings of redwood trees were often mistaken for residuals in video due to large crown diameter.

It was concluded that low-altitude color aerial videography may not be accurate enough for identification of individual residuals, but could be used effectively to estimate abundance of residuals in an area of interest, for example, a watershed. Double-sampling and training of interpreters based on lessons learned in this study could improve prediction intervals of future studies. Identification of legacy trees in aerial video needs further investigation.

[1] This poster was presented at the Redwood Science Symposium: What does the future hold? March 15-17, 2004, Rohnert Park, California.

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Pathogenicity and Distribution of Native and Nonnative *Phytophthora* Species on *Sequoia sempervirens*[1]

Camille E. Jensen[2] and David M. Rizzo[2]

The pathogen *Phytophthora ramorum* is known for causing widespread mortality on coast live oak *(Quercus agrifolia)* and tanoak *(Lithocarpus densiflorus*) in California's coastal forests. However, it is not clear how this exotic pathogen will affect coastal redwoods *(Sequoia sempervirens)*. Additionally, two possibly native species of *Phytophthora* (*P. nemorosa* and *P. pseudosyringae*) may play a role in these redwoods systems. We are examining the potential pathogenicity and distribution of these three species on redwoods. In 2003, 54 plots were established throughout the geographic range of redwoods. Symptomatic tissue of redwood and bay laurel *(Umbellularia californica)* trees in the plots were sampled and tested for Phytophthora species using cultural and molecular techniques. Preliminary results show understory foliage of redwoods to be common substrate for *P. ramorum* in forests with high inoculum levels based on sampling from bay laurel leaves, but no associated redwood mortality has been observed. Both *P. ramorum* and *P. nemorosa* have been isolated from symptomatic tissue of coast redwoods, but have not been cultured from bark. *P. pseudosyringae* has not been isolated from coast redwoods. Future research is focused on 1) disease progression of each of the *Phytophthora* species on redwood, and 2) the interaction of these pathogens on redwood.

[1] This poster was presented at the Redwood Science Symposium: What does the future hold? March 15-17, 2004, Rohnert Park, California.

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Silvicultural Treatments to Control Stump Sprout Density in Coast Redwoods[1]

Christopher R. Keyes[2] and Peter J. Matzka[2]

Unmanaged stump sprouts of redwood *(Sequoia sempervirens)* concentrate stems in a small area, contributing to an aggregated spatial distribution of trees that potentially diminishes stand productivity and wood qualities, contributes to tree instability, mandates stand thinning at an early age, and indirectly contributes to the occurrence of cambium feeding damage caused by black bears. Past studies in redwood and other species have shown that sprouts are directly influenced by stump size, age, and height, and that sprout density and vigor can be affected by partial sprout removal, thermal wounding, shading, exposure to hormones, and bark removal. This study has been established for the purpose of identifying practical and efficient techniques for the operational control of immediate post-harvest stump sprouting capacity (basal bud management) and early sprout density management. Differences in the sprouting response of redwood stumps to treatments designed to debilitate the capacity of stumps to produce sprouts—including varying stump heights, mechanical stump scarification, bud incineration, and mechanical sprout removal—are being quantified. Equipment tested for feasibility in this study includes a portable high-temperature torch for bud and sprout incineration, motorized cutting tools for sprout removal, and the innovative use of chainsaws in the modification of stump morphology.

[1] This poster was presented at the Redwood Science Symposium: What does the future hold? March 15-17, 2004, Rohnert Park, California.

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Habitat Restoration, Landowner Outreach, and Enhancement of Russian River Coho Populations in Northern California[1]

Paul Olin,[2] David Lewis, Janet Moore, Sarah Nossaman, Bob Coey, Brett Wilson, and Derek Acomb

The Russian River and tributaries in Northern California historically provided habitat for sustainable populations of anadromous fish including coho, chinook and steelhead trout. Activities in the watershed, including gravel mining, construction of dams, agricultural expansion and urban development have degraded habitat such that all these fish populations are in decline, and they are listed as threatened or endangered under federal and state law.

To reverse these declining population trends, a ten-year effort by the California Department of Fish and Game has assessed over 800 miles of stream habitat throughout the watershed and identified priority restoration needs. Since 1997, University of California Sea Grant and Cooperative Extension outreach programs have created a knowledgeable cadre of riparian landowners committed to habitat protection and restoration to promote recovery of salmon. These programs have been responsible for completion of habitat assessments and more than 55 priority restoration projects throughout the watershed. A recently initiated wild captive broodstock program is an integral component of these efforts, and offspring from these fish will be used to re-establish coho in streams providing good habitat. A comprehensive release and monitoring program is being developed to allow for evaluation of this restoration and enhancement program.

[1] This paper was presented at the Redwood Science Symposium: What does the future hold? March 15-17, 2004, Rohnert Park, California.

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Conservation Value Assessment of the California North Coastal Basin by Using Special Elements and Focal Species[1]

Doug Smith,[2] Curtice Jacoby,[2] Chris Trudel,[2] Robert Brothers[2]

A conservation model was developed which identifies conservation priorities for the California North Coastal Basin. This process is a conservation value assessment based on conservation biology principles using a computer based GIS to analyze and map applicable information. It is based on assessing special elements, modeling focal species habitat, representing all ecotypes, and creating a community network. Special areas containing significant ecological elements, suitable habitat for focal species, and secure habitat for large carnivore and ungulates are identified. These areas are combined to create a landscape design that identifies conservation priorities. Core conservation areas and stepping stones imbedded in landscape linkages connecting and buffering them are identified. Actions to protect these areas will be taken through collaborative projects with key conservation organizations consisting of promoting best management practices, restoration, conservation easements, and fee title purchase. LEGACY—The Landscape Connection is a 501(c)(3) non-profit organization dedicated to the maintenance and restoration of the ecological integrity of northwest California, using GIS as our primary tool. Although we work with many advocacy groups, we do not engage in advocacy ourselves.

[1] This poster was presented at the Redwood Science Symposium: What does the future hold? March 15-17, 2004, Rohnert Park, California.

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