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Ecosystems under Four Different Public Institutions: A Comparative Analysis

ABSTRACT

Two-thirds of the Sierra Nevada lies within the jurisdiction of public land-based resource management institutions. Public land-based institutions operate within a context of increasingly complex political and social environments and of ecological independence between reserves and adjacent non-reserve resource systems. The core analysis is based on an institutional comparison of four adjacent yet different public institutions managing forests in the southern and central Sierra Nevada. Sequoia National Forest, Mountain Home Demonstration Forest, Sequoia and Kings Canyon National Parks, and the Tule River Indian Reservation all manage areas with similar ecological characteristics.

The present landscape pattern associated with each institution and the probable direction of these landscape patterns can be best accounted for by the interaction between internal organizational characteristics and institutional mandates, rather than by bio-physical endowments or scientific principles of land, timber, forest, or ecosystem management. The key organizational factors which emerge from this case study are the degree of institutional centralization, criteria used for budget allocations, means for ensuring public accountability, and lastly, degree of local-level planning and management flexibility. Maintaining ecosystem integrity based on the "island-in-time" self-contained reserve model is inadequate to ensure resource preservation or conservation because significant impacts on areas within a reserve arise from outside of it and management regimes within a reserve affect those aspects of the ecosystem that lie outside of it. The three factors found to positively affect institutional performance are tight feedback loops between responsible research and resource management, high levels of institutional legitimacy and public trust, and active inter-organizational coordination.

INTRODUCTION

The current condition of the Sierra Nevada ecosystem is a product of the historical interaction between spatially variant ecological processes and social and institutional dynamics. Approximately one third of the Sierra Nevada is privately owned. The remaining two thirds of the Sierra Nevada lies within the jurisdiction of public land-based resource management institutions which include federal, state and county agencies and Native American authorities. These public institutions differ in terms of their purposes, mandates, organizational characteristics, histories, and planning procedures. In addition to these land-based public institutions, a marble cake of federal, state and county authority extends across and through the whole Sierra Nevada, in some cases providing the basis for cooperative exchange, and in other cases for conflict. Within this marble cake context of overlapping authority, public resource management institutions have managed the resources within their jurisdictions in different ways to produce unique combinations of public and private, and commodity and non-commodity benefits.

The ecological and institutional characteristics of the southern Sierra Nevada provide an opportunity to examine how and why public institutions differentially shape the landscapes they manage. Within close proximity to each other are four different land-based public institutions which manage areas with similar ecological characteristics. The institutions are a national forest (Sequoia National Forest), a state forest (Mountain Home Demonstration Forest), a national park (Sequoia and Kings Canyon National Parks), and a Native Ameri-

Sierra Nevada Ecosystem Project: Final report to Congress, vol. II, Assessments and scientific basis for management options. Davis: University of California, Centers for Water and Wildland Resources, 1996.

can Indian reservation (Tule River Indian Reservation). The national forest and national park cover western sierra ecosystems ranging from lower elevation oak and grass woodlands up through the mixed conifer and true fir belts to areas above timberline. The Native American reservation extends from oak and grass woodlands up through the mixed conifer and true fir belt and the state forest falls totally within the mixed conifer belt. Giant sequoia (Sequoiadendron giganteum) groves are located within the boundaries of all four of these institutions (see figures 51.1 and 51.2). Table 51.1 summarizes the elevation range, area and vegetation types of the four institutions.

Although the four institutions examined in this study manage some comparable ecosystems, the unique characteristics of each institution in combination with their different mandates, have produced different patterns on the landscape, different mixes of benefit flows, and different conflicts. The first two sections of this report address the question of how the different purposes, mandates, organizational characteristics, histories and operating rules of each institution account for the observable patterns on the landscape and the particular mix of benefits that each institution provides. We briefly examine each institution in terms of its original purpose, current operating mandate, and its key organizational characteristics. We then trace the linkages between these factors and institutional outcomes in terms of landscape patterns, benefit flows and the degree and nature of conflicts it is engaged in. We show that in some cases institutions with similar legislative mandates can produce different landscape patterns and conversely that institutions with different mandates can sometimes produce similar landscape patterns.

These four institutions were originally endowed with similar biological and physical resources. Each has experienced the changing social values concerning forests and other natural resources. Our premise is that the present landscape pattern associated with each institution and the probable direction of these landscape patterns, can be best accounted for by the interaction between internal organizational characteristics and institutional mandates, rather than by biophysical endowments or scientific principles of land, timber, forest or ecosystem management. The key organizational factors which emerge from this case study are the degree of institutional centralization, the criteria used for budget allocations, the means for ensuring public accountability, and lastly, the degree of planning and management flexibility.

The perception that current social pressures for timber, grazing, water diversions, recreation opportunities and development on the Sierra Nevada ecosystem threaten the integrity of ecosystem structure and function was a key driving force behind the creation of the Sierra Nevada Ecosystem Project. Therefore, it is prescient to also analyze some of the elements which comprise effective resource management strategies and policies under conditions of social conflict over the "proper" goals of public institutions charged with managing forest ecosystems. Accordingly, the last section of this report examines factors which contribute to the ability of public land management institutions to respond to increasingly sophisticated, differentiated and numerous public(s) while simultaneously maintaining their legitimacy within society and the integrity of the ecosystems within their jurisdiction. Indications that the context of resource management on public lands has become more uncertain and complex include increasing legislative oversight, the extent of public controversy concerning federal public lands management especially regarding the ecological and social consequences of past and present timber harvesting, grazing practices and fire suppression activities and policies, current efforts to use "adaptive management" principles in resource management policy and planning, shifts away from the preservation of objects to the management of ecosystems within the National Park Service and from single resource to "multiple use" to ecosystem management within the National Forest Service. Perhaps most significant is the recognition that resource management and stewardship efforts based on the "island-in-time" self contained reserve model are decreasingly effective strategies for resource preservation or conservation because significant influences on areas within a reserve arise from outside of it and management regimes within a reserve impact those aspects of the ecosystem which lie outside of it. Examples of the permeability of reserve boundaries, which we call porosity in this report, include air pollution, fire, and in some cases sedimentation and changes in hydrologic regimes resulting from upstream management activities.

To mitigate against the bias that ensues when only one case

TABLE 51.1

Elevation, area, and vegetation types of the four institutions.

Characteristic	Sequoia National Forest	Sequoia–Kings Canyon National Park	Mountain Home State Demonstration Forest	Tule River Indian Reservation
Lowest elev. (ft)	928	1,443	4,903	918
Highest elev. (ft)	12,218	14,494	7,583	7,334
Total acres	1,118,241	863,372	5,048	53,907
Hardwoods and shrubs	28.6%	9.2%	1.3%	69.4%
Mixed conifer	68.8%	52.1%	98.7%	30.6%
Bare rock	2.6%	38.7%	0%	0%

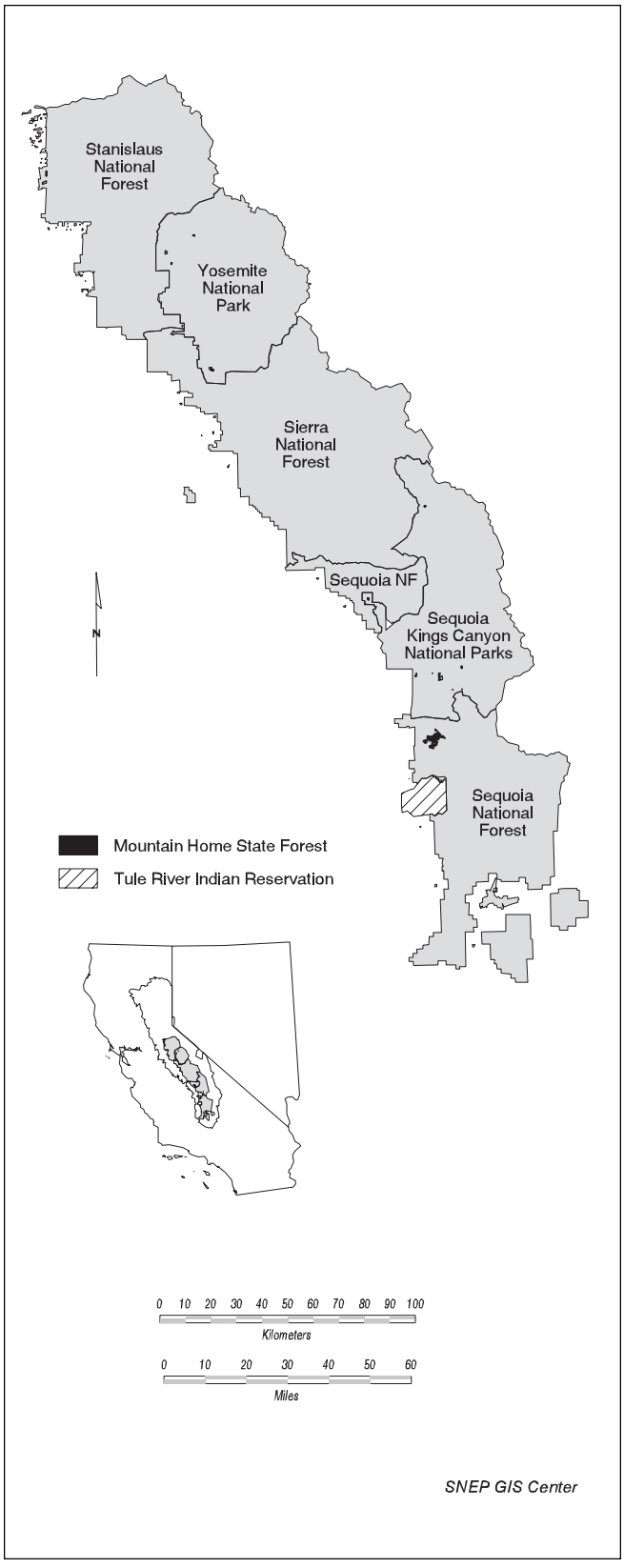


FIGURE 51.1

Land-based public institutions in the southern Sierra Nevada.

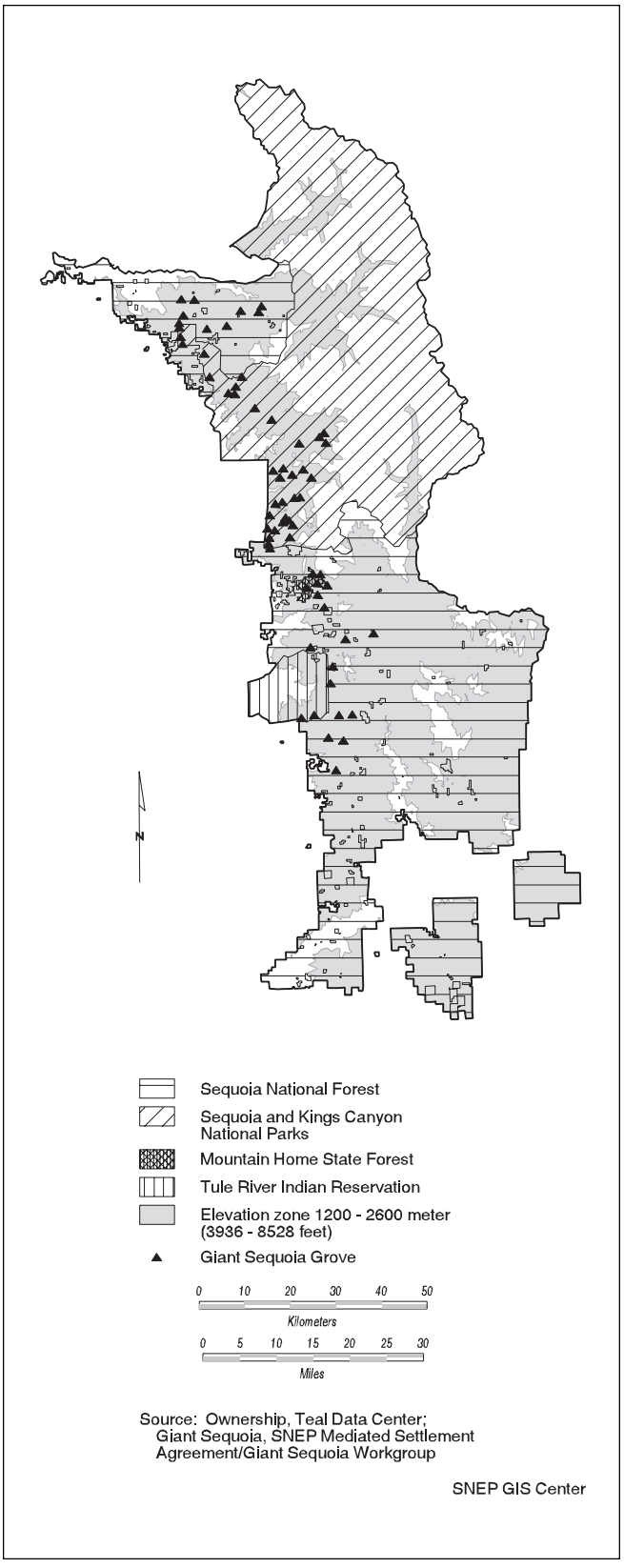


FIGURE 51.2

Detailed ownership and ecological map of the four public institutions.

is used to represent a whole set, the last section of the report includes analyses of the Stanislaus National Forest and Yosemite National Park. Based on this expanded comparative analysis, three factors emerge which positively affect institutional performance under the increasingly porous and complex conditions faced by all public forest owners in the Southern Sierra Nevada. While all the institutions face significant challenges there is greater optimism where tight feedback loops between research and resource management exist, institutional legitimacy and public trust are maintained and strengthened, and inter-organizational coordination occurs. The organizational requisites for achieving these three objectives are also analyzed in this section of the report.

THE FOUR STUDY INSTITUTIONS: PURPOSE, STRUCTURE, OUTCOMES

This section demonstrates the ways in which agency jurisdiction affects the Sierra Nevada ecosystem by comparing the effects of different jurisdictions on similar ecosystems. In this section we review the origins and mandates, institutional characteristics, and benefits of resource management for each of the four study institutions. To the extent that historical interactions between ecosystem dynamics and public land-based institutions account for the present condition of the Sierra Nevada ecosystem, the section provides one lens for understanding and accounting for those conditions. Implicitly, this assessment of what has happened and why, within each of the four jurisdictions also provides basis for determining the probable outcomes of different policies that may seek to influence ecosystem condition through public land-based institutions.

Mountain Home Demonstration Forest

Acquisition and Multiple Use Mandate

In 1946 the state of California purchased the 4,807 acre Mountain Home Tract from the Michigan Trust Company and established as a demonstration forest within the California Department of Forestry (CDF). The local Fresno-Visalia "Native Sons and Daughters of the Golden West," alarmed at the rapid rate of giant sequoia harvesting, were instrumental in lobbying the California Legislature to purchase the tract. The demonstration forest is adjacent to private parcels on the west and to public lands on the east. It also surrounds, and provides much of the recreational opportunities to the users of, Balch County Park. The authorizing legislation of the purchase (section 4426, chapter 1496 of the Statutes of the State of California) clarifies the purpose of the forest, "The Mountain Home Tract Forest in Tulare County shall be developed and maintained, pursuant to this chapter as a multiple use forest, primarily for public hunting, fishing and recreation." The multiple use policy for the forest is clarified in the following quotation from an information pamphlet published by the demonstration forest, "Recreational use is made dominant, with other uses—water conservation, timber production, forage and mining—secondary, and the general governing policy is to be established by the California State Board of Forestry."

Organizational Characteristics: Decentralized Local Autonomy

The Mountain Home Demonstration Forest has several unique characteristics which differentiate it from the other organizations in this case study and which help to account for what it does, why, and with what effects. Its relatively small size forces intensive rather than extensive resource management. Consequently multiple uses consistent with its legislative mandate must be satisfied from the same, rather than adjoining or non-contiguous, areas. The organization of the management of the forest is unusual for its high levels of staff continuity: Dave Dulitz, the present Forest Manager, has been Forest Manager since 1979, and he has been on the forest staff since 1974. The average tenure of the previous four forest managers was approximately eight years. The staff also possess localized site-specific knowledge which, in combination with decentralized decision making arrangements, enables them to experiment with, monitor and evaluate different forest management techniques and to engage with non-CDF researchers to conduct research within the forest. Lastly, the ratio of staff to land area is relatively high—there have been two full time positions, Forest Manager and Assistant Forest Manager, to manage the 5,000 acre forest and recently a third full time position was created.

The active research agenda at Mountain Home State Forest, consistent with the purpose of a demonstration forest, is facilitated by its decentralized organization. The forest staff are able to submit requests for research to the California Department of Forestry, or sometimes to contract directly with university researchers for specific research projects which can be funded from the California Forest Improvement Program. Examples of research programs include wildlife and fisheries studies conducted in collaboration with the California Department of Fish and Game and University of California researchers, fire history studies conducted by researchers from the University of Arizona, and fire and forest (particularly giant sequoia) management research conducted by faculty from the University of California and the California Polytechnic University. Several on-going research projects, i.e. wildlife and fire history, are also conducted in coordination with other adjacent land-based public agencies such as the Sequoia National Forest and Sequoia and Kings Canyon National Parks. Mountain Home Demonstration Forest also provides most of the seed stock for California Department of Forestry nurseries. Last year 150 sacks of giant sequoia cones were collected for this purpose. Individual trees resistant to blister

rust have been identified and their cones are collected in order to propagate blister rust resistant seedlings.

Landscape Patterns and Benefit Flows: Balanced Multiple Use

The Mountain Home Demonstration Forest is an intensively managed, multiple use demonstration forest. Grazing permits are not issued because of incompatibility with recreation and to allow historically overgrazed areas to regenerate. Timber harvesting is tempered by the proximity and density of recreation use within the forest. Harvests are planned to minimize visual impacts by using only single tree and small group selection harvests. Clear cutting is not practiced for aesthetic reasons, and harvest entry intervals have been increased from 15-20 to 30 years to minimize entry-related forest damage and the associated negative visual impacts. The forest has been under a sustained yield management plan consistent with its multiple use mandate that was implied in the 1946 authorizing legislation. The volume of timber on the forest has increased from 92,454 mbf at the time of its purchase to 105,458 mbf in 1990. During this period (1946-1993) 96,028 mbf of timber was harvested (Mountain Home Demonstration Forest information pamphlet). The forest is managed as two overlapping forests. The sequoia groves and the camping facilities constitute a preserve/recreational forest while the non-sequoia forest is managed as an uneven-aged production forest. Unlike the national forests where these two uses are practiced on widely separated areas, at the Mountain Home Demonstration Forest adjacent areas of production forest and preserve/recreational forest create a mosaic of different management regimes within a concentrated area. Recreation uses not consistent with this mosaic pattern of land management, e.g. wilderness backpacking, are not feasible at Mountain Home Demonstration Forest. However, the demonstration forest borders on, and provides direct access to, the Golden Trout Wilderness of the Sequoia National Forest.

Annual recreational use has increased from 3,000 visitors in 1963 to close to 40,000 in recent years. Managing day and overnight visitors occupies an increasing proportion of the staff's time and energy and has lead to the creation of a third full time position primarily to carry out recreation related and interpretive work. Partly due to the increasing recreational use of the forest, and because it is a demonstration forest, the forest managers have developed several on-site interpretative programs and disseminate information through the CDF series, "California Forest Notes". Their public education and outreach efforts include the financing and construction of an interpretative center in Balch County Park which is surrounded by Mountain Home Demonstration Forest, the closure of a campground located on a Native American archeological site and its conversion into a self-guided archeological trail, and a public education campaign about the effects of white pine blister rust and pine bark beetle damage and the importance of salvage logging of diseased trees. A combination of tempered harvesting practices, outreach and education efforts, and the short two week public comment period required under the Timber Harvest Plan (THP) planning process limited public controversy and conflict over Mountain Home Demonstration Forest harvesting operations. The primary source of conflict relates not to controversy over forest management but to unruly visitors, especially during the major holiday weekends.

The original purpose for which the Mountain Home Demonstration Forest was purchased, i.e. to preserve old growth giant sequoia groves, combined with its mandated emphasis on recreation and the subsequent evolution of maximum sustained yield production forestry in non-sequoia areas, has produced a mosaic of differently managed and used patches within a relatively constrained geographical area. The forest is extensively roaded and is intensively used as a production and recreation forest. Consequently there are no large intact landscape units. Riparian areas and meadows are in better condition than they would be otherwise due to the ban on stock grazing. The decentralized organization of the forest administration has provided the local decision making autonomy necessary for establishing and maintaining feedback loops between resource science and resource management. For example, in response to research findings which suggested that larger openings were required for successful sequoia regeneration, selective harvesting methods were shifted from single tree to small group selections which created open patches from .5 to 1 acre large. Although the forest administration staff do not have the capacity to conduct research themselves, they successfully compensate for this by contracting with other agencies and universities which do have research capacity.

Sequoia National Forest

Reservation for Multiple Use

The 1.1 million acres which comprise the Sequoia National Forest (SNF) were originally reserved from the public domain as part of the 4 million acre Sierra Forest Reserve in 1893. Local lobbying efforts, spearheaded by George Stewart, editor of the Visalia Delta, and other Tulare County residents were instrumental in influencing President's Harrison's decision to reserve the southern portion of the Sierra Nevada range. While local support was also an important factor in the California State legislature's decision to authorize the purchase of the Mountain Home Demonstration Forest, in this case local concerns focused primarily on threats to the San Joaquin Valley's water supply posed by uncontrolled upstream mining, grazing, fire and lumbering, as well as concerns, shared perhaps by fewer individuals, about the negative impacts of these activities on the natural beauty of the area and especially the large giant sequoia trees (Dilsaver and Tweed, 1990). In 1908 the Sequoia National Forest was created from that portion of the Sierra National Forest south of the watershed of the Middle fork of the Kings River which by this time had been transferred along with the other forest reserves from the Division

of Forestry of the Department of Interior to the newly formed U.S. Forest Service headed by Gifford Pinchot within the Department of Agriculture. The original purpose of the national forest reserves are described in the 1897 Organic Act which established the purposes for which forest reserves could be withdrawn from the public domain, and provided the primary statutory authority for the administration of the forest reserves by what was to become the U.S. Forest Service. The Organic Act states that the purposes of national forests are to "preserve and protect the forest within the reservation" in order to secure "favorable conditions of water flow" and "to furnish a continuous supply of timber". The 1960 Multiple Use Sustained Yield Act expanded the purposes for which the National Forests were to be managed to include outdoor recreation, range, wildlife and fish, in addition to those purposes set forth in the 1897 legislation (Dana and Fairfax, 1980).

Organizational Characteristics: Centralized Hierarchy

In his organizational (and now historical) study of the Forest Service, Kaufman analyzes how the Forest Service is able to ensure that widely dispersed field officers operating under a wide variety of social and ecological conditions will do what is asked of them in a manner which achieves the centrally determined goals of the organization. Kaufman (1981) argues that the Forest Service counteracts the centrifugal tendencies towards fragmentation through hierarchical organization and specialization, the development of centrally controlled "preformed decisions" and concomitant means to detect deviation, and the "homogenization" of staff through in-service training and indoctrination and through frequent personnel transfers.

The Multiple Use Sustained Yield Act of 1960 and new planning procedures mandated in the National Environmental Policy Act of 1969 (NEPA), the Forest and Rangeland Renewable Resources Planning Act of 1974 (RPA) and the National Forest Management Act of 1976 (NFMA) have broadened the mission of the Forest Service and transformed the means for accomplishing that mission since Kaufman's study was completed. However, considerable debate exists as to the extent to which the Forest Service has institutionalized its diversified mission. For example Twight and Lyden (1989) show that the attitudes, preferences and values of 394 district rangers are similar to those of the Forest Service's "resource user constituency" and differ strongly from the service's "environmentalist constituency". They attribute this to the Forest Services "institutionalized socialization process, the most important features of which have apparently changed little since Kaufman's 1960 analysis" (Briggs 1982, cited in Twight and Lyden). Culhane (1981), on the other hand, rejects the claim of isomorphism between forest ranger's attitudes and those of their industry clients. Instead he posits a model of interest group politics and multiple clientelism to explain public lands politics and policies. Consistent with Culhane, Tipple and Wellman (1991) argue that the Forest Service has transformed from an agency which emphasizes efficiency and economy to one which now also embraces "responsiveness and representativeness."

While the degree of change within the Forest Service is debatable and probably varies from region to region, significant structural continuities have persisted which are relevant for this study's focus on the Sequoia National Forest. First, the Sequoia National Forest is still part of a hierarchical organization which follows centrally mandated and externally legislated standardized planning procedures. Second, its staff are relatively frequently transferred (although less often than previously), relative to the other three institutions in this study. Third, at the forest level, administrators and staff have minimal control over funding for research and the generation of research questions. Lastly, the majority of funding for forest management activities, excluding fire protection funds, is tied to commodity production targets.

Examples of the effects of centralization on decision making autonomy on the Sequoia National Forest can be taken from three arenas: planning, fire management, and research. Resource planning on the forest must comply with the NEPA, RPA and NFMA federal planning requirements, the 1988 Land Management Plan for Sequoia National Forest as modified by the locally negotiated Mediated Settlement Agreement, and the 1993 interim guidelines for the California Spotted Owl. The combined prescriptive effects of these multiple layers of internally mandated and externally legislated planning procedures leave little opportunity for local level planning innovation. They also decrease incentives for intensive monitoring and evaluation of the impacts of resource management plans other than to ensure that legal stipulations are fulfilled because the flexibility does not exist to incorporate the new information monitoring and evaluation generates into subsequent management plans. Finally, the plethora of requirements each of these documents contains, combined with the uncertainty of possible future changes in planning requirements and procedures, and the possibility of successful legal challenges, generates considerable uncertainty about what resource management activities will be possible in the future. This uncertainty mitigates against effective long range planning and fosters a more ad hoc approach which approximates what Lindblom (1959) termed "muddling through."

The Sequoia National Forest is also constrained in its ability to use fire as a management tool. Internal fire policies severely limit the opportunity to use a prescribed natural fire program that would allow some lightning fires to burn. Funding for the planning and implementation of prescribed burns is tied to funds allocated for timber management and harvesting (Aaron Gelobter, Deputy Fire Management Officer pers. comm.). Most of the funds for prescribed burns and fire suppression not related to timber management are available only in high risk contexts, i.e. situations where either structures or urban interface areas are threatened. Although mechanisms exist to enable fire managers to plan and conduct prescribed burns to promote non-commodity ecosystem values, they are generally not well funded. The commodity ori-

entation of fire programs and funding priorities constrains the ability of the managers of the forest to effectively use fire as a resource management tool within an "adaptive management" framework.

In addition to constraints on local level planning autonomy and ability to use fire to achieve non-commodity purposes, there is little research capacity at the national forest level. An exception to this are "administrative studies" which focus on applied management issues and are carried out by forest service staff. In an attempt to insulate research from "administrative evangelism" the 1915 internal restructuring of the Forest Service established a separate and parallel research branch comprised of experiment stations accountable directly to the Chief Forester rather than to the Regional Forester (Schiff 1962). Schiff shows that despite the organizational separation of science and administration, research establishing the important role of fire in enabling longleaf pine (Pinus palustris) regeneration in the southern United States was deliberately suppressed throughout the first half of this century because it ran counter to the anti-fire sentiment prevailing within the administrative branch of the Forest Service. Although concentrating the agency's research capacities in a separate research branch did not insulate scientific inquiry from administrative concerns, it did separate resource management from resource science. Without effective use of the institutionalized channels of communication and feedback between managers at the forest level and scientists at the experimental stations, it was inevitable that questions of concern to managers of forests relatively distant from experiment stations, such as the Sequoia National Forest, would remain unanswered. For example, pending research questions include the effects of forest management activities on sensitive furbearers such as the red fox and pine marten, the effects of different kinds of fire and other management regimes on giant sequoia regeneration and tree failure rates, the effects of grazing on range and riparian ecosystems, and the hydrological and aquatic resource effects of alternative management practices.

Landscape Patterns and Benefit Flows: Multiple Use and Sustain(able) Yields?

Up until the 1950s, the primary uses of the Sequoia National Forest had been low levels of hydroelectric development and mining, some logging on the western slopes of the forest, and recreational use particularly in the Mineral King and Kern Plateau areas. During this time primary resource management activities consisted of fire suppression and livestock control. Beginning in the 1950s the Forest Service began an extensive timber harvesting program which focused on achieving maximum sustained yield timber production in some areas, and in other areas such as the Kern Plateau, sought to integrate timber production with other multiple use land management objectives. Previously unroaded areas were roaded and where roads already existed, particularly on the west side, they were widened and rebuilt to satisfy both intensified timber harvesting and recreational use pressures. During this period timber was harvested using salvage and selective cutting methods. During the 1970s the Forest Service, aware of the ecological importance of giant sequoia groves, "pursued an aggressive grove acquisition and protection program" which excluded groves from timber management goals, and involved creating four grove classes and prescribing acceptable management activities per class (Doug Leisz, pers. comm.).

By the late 1970s some stands had become understocked. In response to these forest conditions, to pressure from private timber interests to increase harvest levels and to "the allowable cut effect" which linked allowable cut levels to future anticipated growth rates, management of the forest shifted to extensive clearcutting and a shortened cutting cycle (from 150 to 70 years). The shift to clearcutting and short rotations maximized the present net value of commodity outputs, provided opportunities to quickly restock harvested areas with desirable species and hence maximize long term timber yields, and was an effective response to the non-declining even flow constraint which required sustained timber harvest levels. This accelerated short rotation timber harvesting program continued through the mid-1980s. Although the logic of the shift to short rotation clearcutting was silviculturally sound, inadequate investment in post-harvest site preparation and reforestation as well as harsh sites created other problems. By the mid-1980s public concern about clearcutting and other environmental consequences of the timber harvesting program, and the threat that harvesting in and adjacent to giant sequoia groves posed to that species, lead to 22 administrative review appeals challenging the 1988 Forest Land Management Plan and the supporting Environmental Impact Statement. The Forest Service's attempts to respond to the appeals lead to a series of mediated negotiations which produced the Mediated Settlement Agreement. The MSA is the product of a political process of negotiation, not the result of consensus based decisions grounded in resource science. It addresses management, and the monitoring and evaluation of the effects of management, of the full range of ecological processes concerning both the sequoia and non-sequoia forests, meadows, and riparian areas within Sequoia National Forest.

Grazing is regulated by annual permits for specific allotments and has continued since the forest was reserved from the public domain. Because of the steep slopes in the southern portion of the range, some riparian areas are steep, rocky and inaccessible to livestock. However high elevation meadows and lower elevation riparian zones and the blue oak savannah are areas of current concern in terms of range and riparian condition, aquatic habitat, and blue oak regeneration. The Forest Service is now under pressure to revise its grazing policies due to concern about possible range deterioration, the adequacy of existing range condition monitoring efforts, and the timing of grazing permits. Current policy al-

lows livestock grazing on the forest in the spring when soil moisture levels make the range particularly vulnerable to erosion, rather than later in the year when the range ecosystem is more resilient to grazing effects. An interagency study team recently evaluated the Sequoia National Forest's range condition and management program. The team's report suggested changes in grazing policy such as improved monitoring and evaluation of the range condition, and delaying the grazing season by several weeks to lessen the negative effects of grazing.

Sequoia National Forest receives more visitors than the more famous but less developed Sequoia-Kings Canyon National Park (figure 51.3). The majority of users come from the Central Valley and the Los Angeles area, a smaller percentage come from the San Francisco Bay area and other countries. The permanent communities and resorts surrounding Lake Isabella are technically within the National Forest. Differences in how these establishments are treated may account for the large variations in visitor days in the 1970s. In order to accommodate the growing recreation activity within the forest, campground management and other recreational activities are contracted to private firms through special use permits. In recent years the number of law enforcement officers on the staff has increased from 2-3 to 10-12 to respond to the law and order problems associated with increased visitor use. As at the Mountain Home Demonstration Forest, altercations between visitors, and visitors who do not observe Forest Service rules are the most common forms of conflict resulting from increased recreational use of the forest.

In summary, the management of Sequoia National Forest has been characterized by intensive and extensive timber harvesting and associated road construction, continued grazing, and high levels of recreational use. These uses reflect the multiple use mandate of the Forest Service embodied in the 1960 Multiple Use Sustained Yield Act. However the landscape effects of the Forest Service's mandate have also been shaped by the centralized organization of the service, the budget priority given to commodity resource production activities, the lack of adequate reinvestment in reforestation and other non-commodity resource values and the lack of effective integration of research with resource management. Together these factors have mitigated against innovation in forest management and grazing policy, have restricted the use of fire as a means to restore pre-fire suppression policy ecosystem structure and function, and have made it exceedingly difficult to sustain a feedback loop based on intensive monitoring and evaluation between resource science and resource management. In 1983 these factors led to logging operations in and around giant sequoia groves on the basis of slender evidence that logging in groves would promote giant sequoia regeneration. The controversy that resulted when the logging was "discovered" by the public was a key factor in precipitating the Mediated Settlement Agreement in 1990.

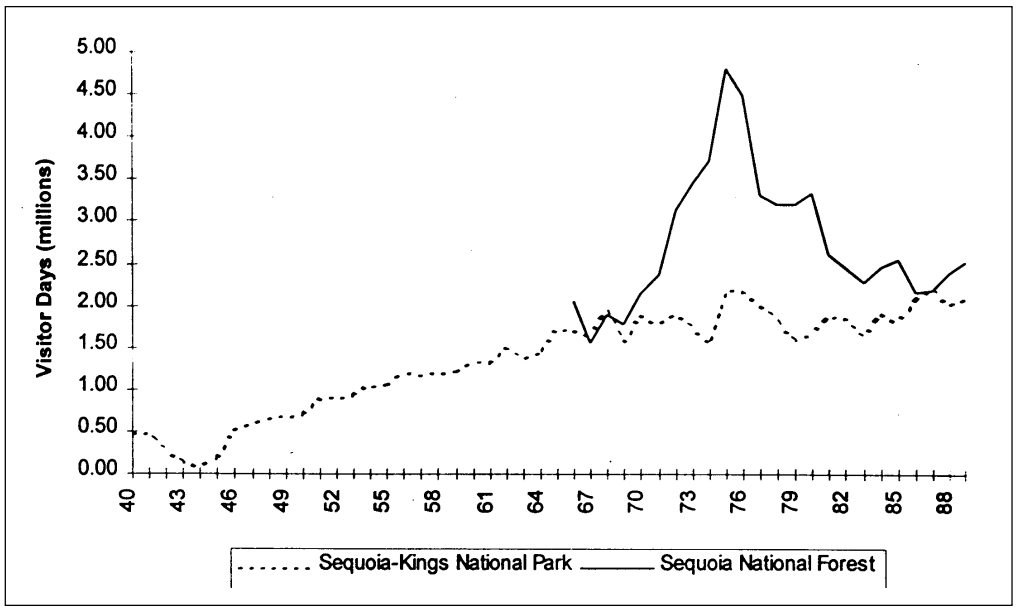
Sequoia and Kings Canyon National Parks

Reservation, Expansion and Preservationist Mandate

Sequoia and Kings Canyon National Parks comprise approximately 864,000 acres of land primarily in the upper watersheds of the Kaweah, Kern, and middle and south forks of the Kings Rivers. This area was acquired in stages, beginning in September 1890 with the withdrawal of two townships and four sections from the public domain to establish the beginning of the Sequoia National Park, and culminating in the creation of Kings Canyon National Park and its transfer from the Sequoia National Forest to the National Park Service in 1940. The Mineral King area was officially included in the park in 1978 (Dilsaver and Tweed, 1990).

FIGURE 51.3

Sequoia and Kings Canyon National Park and Sequoia National Forest visitor trends.



The legislative history of the park's early expansion exemplifies the interrelationship between reserved and non-reserved areas. Less than one week after the initial legislation was passed which established Sequoia National Park (H.R. 11570), a second bill (H.R. 12187) was passed without debate by the House and the Senate and was signed by President Harrison. This bill called for a large federal reservation of public lands surrounding the existing state reservations of Yosemite Valley and the Mariposa Grove of giant sequoias, the addition of five townships to the initial one township comprising Sequoia National Park, and the permanent reservation of the Grant Grove. The bill is interesting because its origin illustrates that preservationist goals and corporate interests are sometimes complementary. H.R. 12187 apparently was quietly substituted for another bill (HR 8350) which called for a much smaller reservation around Yosemite Valley and no extension of Sequoia National Park. Runte (1990) argues that in order to gain congressional support for a larger reservation than called for in H.R. 8350, John Muir and his preservationist friend, editor Robert Johnson, sought and received the support of Southern Pacific Railroad executives for a larger reservation. Soon afterwards H.R. 12187 was introduced. It authorized a reservation five times larger than the alternative bill called for. Inspired by Daniel K. Zumwalt who was a land agent for Southern Pacific Railroad, the bill passed the House and Senate "virtually without debate" September 29 and 30, and on October 1, 1890, President Harrison signed it into law (Runte 1990).

Dilsaver and Tweed suggest that the Southern Pacific Railroad stood to gain from a large federal reservation in three ways. It would benefit from the increased passenger travel and the associated tourist enterprises which the national parks were expected to attract. The railroad's substantial agricultural land holdings in the San Joaquin Valley would have an assured water supply. And the reservation would increase the value of sequoia groves on private timberlands to the north and south of the park which the railroad was involved in, and would eliminate the Kaweah Colony of loggers operating within the reserve who may have otherwise have competed with the railroad for a share of the timber market (Dilsaver and Tweed, 1990). Runte draws an analogy between the support Southern Pacific gave for the reservation of Yosemite National Park and the active promotion of Yellowstone National Park by the Northern Pacific Railroad. He also demonstrates that this was not the only time preservationist and capitalist interests coincided. In 1905 and again in 1906 Muir appealed directly to railroad magnate Edward H. Harriman, whose empire included not only Southern Pacific but also the Union Pacific and Illinois Central Railroads, to solicit his support for the retrocession of Yosemite from the custodial authority of California to the federal government. The railroad's interest in the transfer was based on anticipated increased tourism and passenger rail travel following federally funded improvements in visitor facilities. John Muir and the Sierra Club had been long standing critics of the Yosemite Commission's management of the park. They felt federal control would be more efficient and effective at removing hunters, herders and other trespassers and at providing facilities for increasing visitor use. Runte attributes the speedy passage of California's transfer bill and of its acceptance by the U.S. House and Senate to Harriman's lobbying efforts. This case represents one early example of the interdependence between preservationist interests and economic interests. Because the areas inside and outside of the newly reserved areas are part of a larger, shared system of ecological and economic relations, management policies taken within reserves influence the management decisions (and consequently the landscape patterns) on private and public lands outside the reserve.

The initial land reservation which created Sequoia National Park differed from the reservation of the Sierra Forest Reserve in 1893 in one significant way—the legislation establishing Sequoia National Park called for the protection of the natural features within its boundaries while the presidential proclamation establishing the Sierra Forest Reserve only required that land sales within the reserve be stopped. Consequently, military protection was provided to protect the park from illegal activities such as grazing, logging and trapping, while in the Sierra Forest Reserve mining, grazing and logging were allowed to continue (Dilsaver and Tweed, 1990). The difference between prohibiting and allowing extractive uses in these two reserves presaged the rancorous debates between preservationists and conservationists whose differences were crystallized in the legislative mandates of the National Park Service and U.S. Forest Service.

The protectionist land management philosophy within national parks was codified in the 1916 legislation establishing the National Park Service. The Park Service's organic act states that the purpose of the Park Service is, "to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations" (Dana and Fairfax, 1980). The tension between the potentially contradictory goals of preserving "natural and historical objects" and "providing for the enjoyment of same," especially within the current context of shifts in park management philosophy from preserving objects to managing ecosystems, presents a considerable challenge to the management of Sequoia and Kings Canyon National Parks (SEKI).

Organizational Characteristics: Moderately Centralized Flexibility

The organization of the management of SEKI represents a mid-range alternative to the examples of decentralized and centralized organizations which the Mountain Home Demonstration Forest and the Sequoia National Forest represent. One important consequence of SEKI's mid-range position is the potential this provides for scientific research and for integrating research with resource management. Until re-

cently, this capacity was institutionalized within the Division of Natural Science which was created in the wake of the influential 1963 Leopold Report. By 1971, the Division of Natural Science was comprised of a chief scientist, a research botanist, several wildlife rangers and other permanent and temporary research positions (Dilsaver and Tweed, 1990). Prior to the creation of this division, scientific research within SEKI waxed and waned with fiscal conditions, the support of park superintendents, and the interests of individual researchers. The decade and a half preceding the Second World War was a period of active research primarily focused on giant sequoia reproduction and vegetation and wildlife management. Examples of this early research included Emilio Meinecke's 1926 study of human impacts on giant sequoia, George Wright's system-wide study (1929-31) of wildlife policy which led to the creation of a wildlife division, and Lowell Sumner's research at SEKI, begun in 1935, which lead to the eventual development of wildlife, vegetation and backcountry management programs (Dilsaver and Tweed, 1990). This research was actively supported by the then Park Superintendent Colonel White who was one of the earliest administrators to advocate prioritizing "atmosphere preservation", e.g. ecosystem level values, over enhancement of visitor experience. The park's research program (and that of the whole park service) withered during the war and throughout the 1950s, until at the behest of preservationist groups, several studies were commissioned which reviewed the status of ecosystem management within national parks. The most influential of these was the Leopold Report which "provided a framework for the organized expansion of science as a management tool" and was instrumental in shifting the goals of park management from the "protection of objects ... to an aggressive attempt to reestablish ecosystems" (Dilsaver and Tweed, 1990). At SEKI the Leopold Report gave renewed impetus and support to the park's various wildlife management programs and to prescribed burning as a management tool. This included research on prescribed burning as a management tool for giant sequoia and other conifer species by R. J. Hartesveldt, H.T. Harvey, H.S. Shellhammer, R.E. Stecker, B.M. Kilgore, and H.H. Biswell.

SEKI's location in the mid-range of the centralized-decentralized spectrum is a necessary but not always sufficient condition for it to use the knowledge gained through research, monitoring and evaluation to improve the scientific basis and reduce the unanticipated consequences of subsequent resource management plans. SEKI has the decision making autonomy, planning authority and staff resources necessary to use the information research and experience generate to modify, amend, and tailor their resource management plans. However, financial constraints and political and constituency pressures sometimes challenge the ability of park resource managers to implement the management plans developed in consultation with park resource scientists. For example, due in part to funding constraints and conflicting attitudes towards fire within the public and other resource management agencies, only about 10% of areas which should be burned "to protect park resources" are prescribed burned each year (Jeff Manly and William Tweed, pers. comm.). Similarly, under conditions of fiscal retrenchment, competition for funding often emerges between resource managers who feel that an adequate knowledge base already exists to implement more resource management programs, and research scientists who often feel that further research is necessary and should be funded in tandem with resource management programs. The creation of the National Biological Service (NBS) and subsequent transfer of all the research scientists from SEKI to the NBS is the most recent threat to SEKI's research capability. It appears therefore, that effectively integrating science with resource management requires not only local level autonomy and capacity to generate research questions and conduct research, but also institutionalized mechanisms which ensure that the knowledge gained through research will be incorporated into subsequent management plans.

In addition to coupling science with resource management, SEKI must also maintain and cultivate the support of its public constituencies, even as it implements resource management programs, for example controlled burning in giant sequoia groves, which run counter to prevailing and historical norms and attitudes about what should and should not be allowed in forests and what forests should look like. However, the park's relatively narrow preservation mandate restricts the number of special interest groups it must be responsive to, especially in comparison to the Sequoia National Forest whose multiple use mandate ensures that there will be multiple and conflicting special interest groups.

Unlike the Sequoia National Forest which, prior to the 1970s legislation requiring public involvement in resource planning, did not depend on public support in order to fulfill and justify its mission, the early superintendents of SEKI depended on "visitor days" to legitimize the park's purpose and budget and to help justify its expansion. The low number of visitors to Sequoia National Park during the first thirty years of its existence lead to concerns among park administrators that without adequate public support it, and the National Park Service, might not survive. In order to generate more public support for the park, radio and magazine publicity was encouraged and Park Superintendent White initiated the campfire programs and guided nature walks for park visitors which have become the hallmark of the National Park Service's onsite interpretive program (Dilsaver and Tweed, 1990). Consequently, SEKI has not had the organizational autonomy to proceed along a course of action against which substantial public opposition existed. As a result the organization has always funded extensive outreach and extension efforts designed to create a supportive public constituency, and more recently, to generate public support for controversial management programs such as increased prescribed burning in sequoia groves and elsewhere within the parks. When a resource management plan generates controversy, as prescribed burning did following the Yellowstone fire, and when a pre-

scribed burn within the park scorched several large giant sequoia trees, the park management generally responds, in this case by curtailing the burning program, until public support can be regained or perhaps more realistically, the opposition simply wanes.

Landscape Patterns: From Protectionism to Ecosystem Management

Consistent with its legislative mandates, and in contrast to the multiple use mandates of Mountain Home Demonstration Forest and Sequoia National Forest, SEKI has followed a preservationist strategy of land management in combination with efforts to initially encourage visitors and then, when their increasing numbers threatened the natural features the park was mandated to protect, to control and restrict their activities. Some early park management programs would be considered inappropriate within the current interpretation of the park's legislative mandate. These included allocating grazing permits for 2,675 cattle within the park from 1918-1931, a predator control policy which depended on steel traps and poison, indiscriminate killing of problem black bears (15 between 1922 and 1931), and the construction of bleachers to enable tourists to view black bears pawing through the garbage dump (Dilsaver and Tweed, 1990). Fortunately, these programs were relatively short lived, had relatively low level landscape impacts, and provided the impetus for developing management programs based on principles of ecosystem management.

The factors most significant in producing SEKI's current ecological landscape are the historical institutionalization of total fire suppression, the park's preservation mandate which prohibits predominantly commercial uses of the park's natural resources, the historically high visitor use rates and concentration of visitors in some areas, especially Giant Forest, and the commitment among park administrators to block proposed highways into the park's backcountry and across the Sierra crest to Owens Valley (Dilsaver and Tweed, 1990). The absence of commercial timber harvesting (significant numbers of trees have been removed to reduce hazards), mining and grazing, combined with a commitment to minimize road construction, has preserved the integrity of larger landscape blocks than has occurred on the other landscapes in this study managed for multiple use. However, the long standing policy of total fire suppression has interrupted ecological processes, transformed forest structure, and halted the regeneration of some conifer species, notably giant sequoia. Therefore, while landscape blocks may have been preserved relatively intact, ecosystem structure and function has been less successfully maintained. In addition to this, but on a smaller landscape scale, areas of high visitor use such as campgrounds, Giant Forest, and other areas where concessionaires facilities are concentrated, have been disturbed to the extent that the very objects of preservation, e.g. the giant sequoias, have become threatened. Current research agendas and resource management programs address restoration of ecosystem structure and function and explore ways to reduce the negative ecological impacts of visitor congestion. For example, the prescribed burn program in Mineral King with funding secured for five years, represents the most ambitious attempt so far to reduce fuel buildup and restore forest structure to pre-fire suppression conditions across a relatively large landscape block. Similarly, public hearings regarding current SEKI proposals to shift concessions out of the Giant Forest area may actually achieve that end. That park superintendents since the 1940s have unsuccessfully attempted to either reduce the number of accommodations at Giant Forest or to relocate the facilities elsewhere speaks to the extent to which SEKI's management decisions have been tempered, and at times driven, by the organizational necessity of maintaining public support for its activities. This is perhaps analogous to the manner in which timber harvesting on the Mountain Home State Forest has been tempered by the exigency of promoting and managing for recreation.

Tule River Indian Reservation

Establishment—Sovereignty as Mandate

The 55,356 acre Tule River Indian Reservation located in southern Tulare County was established in 1873. More than nine Californian tribes speaking different languages were relocated here from an area extending from the Kings River south to the desert beyond and to the southeast of the Tehachapi range. Consequently only a few of the culturally significant areas for the tribes are located within the reservation. Most areas of cultural significance are scattered across a much broader region encompassing their former seasonal migration areas. The reservation contains a full west side Sierra transect including grassland, blue oak woodland and chaparral below 4,000 feet, black oak and ponderosa pine between 4,000 and 5,000 feet, mixed conifer forest extending to 7,000, and true fir above 7,000 feet (Rueger, 1992). Giant sequoia groves are located within the mixed conifer belt and extend into neighboring Sequoia National Forest.

Current Organization: High Public Accountability

The nine elected members of the Tribal Council set the objectives and policy which govern resource management on the reservation (Rueger, 1992). In addition to the elected council, the traditional elders council also provides considerable leadership. The USDI Bureau of Indian Affairs (BIA) has formal authority on the reservation but currently does not play an active role in management. In the 1950s and 1960s the BIA-sponsored timber harvest plans achieved high levels of production and supported a sawmill on the reservation. Currently, resource management programs are implemented by the Tribe's Natural Resource Department with assistance provided by their consulting forester Brian Rueger from Integrated Forest Management. The reservation's vegetation types have been mapped using aerial photographs obtained from the consulting firm Hammond Jenson and Wallen. This pro-

vided the basis for an initial resource inventory, and for the establishment and subsequent monitoring of growth plots in both the mixed conifer and oak woodland belts.

Landscape Patterns—Culturally Attuned Multiple Use

The resource management philosophy of the reservation closely approximates Mountain Home Demonstration Forest's multiple use mandate with the exception that the public(s) is/are on-site," i.e. they live on the reservation as opposed to the demonstration forest whose public owners are the citizens of California. As on the Demonstration Forest, timber sales have historically been a primary source of locally generated revenue for the reservation. Since the reservation assumed direct control of its natural resources from the Bureau of Indian Affairs, the reservation's timber management program has sought to balance the economic values of timber with recreational and aesthetic values and the socio-cultural benefits the forests provide the reservation's inhabitants. From a technical point of view, the forest is harvested at less than its sustained yield potential. Although giant sequoia trees are not harvested, whitewood species distributed throughout giant sequoia areas are intensively managed. Timber harvest levels and employment generation are sometimes reduced if planned timber harvests or other resource extraction activities would damage tribally defined ecological, cultural resources or other non-commodity resources. Unlike the nearby federal or state properties, the social review process does not involve complex reporting and legal analysis. Given the extreme attention paid to sequoia groves on adjacent federal and state ownerships, it is surprising how little attention giant sequoia groves on the reservation receive. Dead and down giant sequoias are harvested for forest products and the groves are used primarily for recreation and other cultural values. However, other flora such as red willow and riparian vegetation have greater cultural significance to many tribal members.

In addition to timber harvesting, grazing and firewood cutting are important consumptive uses of the reservation's resource base. Firewood cutting is important both for local use and off-reservation sale. Firewood cutters (only tribal members can cut firewood) are supposed to pay $5 per cord and harvest only in specified locations. However rules restricting cutting areas are difficult to enforce and there is evidence of over-harvesting of oaks similar to what can be seen on some private ranches throughout the southern Sierra Nevada. The resource management staff apparently feel that the social conflict that strict enforcement would generate does not warrant the slight improvement in resource management enforcement would provide. Grazing on the reservation follows 1983 guidelines established to promote long term range productivity and reduce some of the localized overgrazing problems. Stocking levels have decreased as some tribal members no longer graze stock and others have not increased their herd sizes. The oak woodland and grass lands appears to have more dry residual matter than adjacent ranches which suggests that overgrazing is less serious than on many other lands in the region. The physical impacts of relatively loose policies towards both firewood harvesting and grazing are visible to both the resource management staff and interested tribal members. At the present time, the low-cost monitoring strategy appears sufficient. Stronger responses could be developed and implemented if needed but the staff clearly weighs this against the potential conflict among tribal members.

The Tule River Indian Reservation's approach to resource management, as shaped by the Tribal Council, exemplifies the key tenets of a multiple use management philosophy which balances commodity and non-commodity resource values. After historically fluctuating timber harvest levels, harvests are now planned to be compatible with non-commodity uses of the forest. In a manner analogous to the Mountain Home State Forest, timber harvest receipts subsidize other resource management activities and still produce a large financial surplus. Unlike the other public institutions, most of the beneficiaries live on the parcel. Daily contact between stakeholders holding a range of goals and the resource managers who report to the Tribal Council provides numerous avenues for these parties to discuss resource management without the formal reporting procedures used in most state and federal systems. While this can be considered a constraint for professional resource managers, it reduces the political uncertainty which arises for national forest and national park managers whose stakeholders are often situated outside the local area.

PAIRED INSTITUTIONAL COMPARISONS

The Many Meanings of Multiple Use

Merely knowing the legislative mandate of an institution is inadequate basis for anticipating what it will actually do and with what impacts. The case study descriptions suggest that an institution's internal organization, the criteria used for budget allocations, the relationship between research science and resource management, and relationships with the public(s) who have stake in it strongly influence the way an institution interprets and implements its mandate and with what ecological effects. Table 51.2 compares the purpose, organizational characteristics, levels of conflict and forest structure of the four study institutions. The structural diversity of the mixed conifer forests in the national forest, national park and state forest is described using the 'later seral and old growth' (LSOG) ranking system developed by Franklin and Fites-Kaufmann (1996) for the Sierra Nevada Ecosystem Project. The rankings are based on large landscape level units consisting of thousands of acres. Rankings of 1 and 2 represent young and relatively simple forests, a ranking of 3 represents mature forests with some late seral attributes, and forests

TABLE 51.2

The four study institutions by organizational characteristics and forest structure.

Institution	Mt. Home State Demonstration Forest	Sequoia National Forest	Sequoia and Kings Canyon National Parks	Tule River Indian Reservation
Purpose/mandate	Multiple use	Multiple use	Preservation	Sovereignty
Organization	Decentralized	Centralized hierarchy	Moderately centralized	Decentralized
Planning autonomy	High	Low	Medium	High
Budget allocation criteria	Floating	Linked to commodity output	Linked to visitor use	Floating
On-site research	High	Low	High	Low
Means for maintaining accountability	Formal	Formal	Formal	Informal
Conflict level	Low	Medium/high	Low	Low
Later seral and old growth (LSOG) ranking, by area				
1&2 (low)	1.2 thousand acres (24% of mixed conifer forest area)	488.7 (66%)	8.0 (9%)	Not surveyed (NS)
3 (med)	2.9 (57%)	185.2 (25%)	74.9 (38%)	NS
4&5 (high)	1.0 (19%)	75.7 (10%)	105.4 (54%)	NS

with rankings of 4 or 5 have considerable structural complexity with many large diameter trees, snags, and down logs. Figure 51.4 graphically represents the percentage distribution of the structural diversity categories for the conifer forests in the mixed conifer forest belt (1200-2600 meters). Bare rock and other areas unsuitable for forest growth in the mixed conifer belt were excluded from the analysis (see table 51.3 for these areas). The figure shows that the most structurally complex mixed conifer forests are in Sequoia and Kings Canyon National Parks, the least structurally complex forests are in Sequoia National Forest, and the forests in the Mountain Home Demonstration Forest are of intermediate structural complexity.

Two paired examples from table 51.2 illustrate how organizational characteristics influence the ways institutions interpret their mandates, and the consequent social and ecological outcomes: the Sequoia National Forest and the Mountain Home Demonstration Forest, and Mountain Home Demonstration Forest and the Tule River Indian Reservation. On paper, the mandates of the Sequoia National Forest and the Mountain Home Demonstration Forest both emphasize "multiple use", but they give different weights to the importance of those multiple uses. The original mandate of the Forest Service which focused solely on timber supply and water flow, was subsequently modified to include recreation and other multiple uses. The mandate for the demonstration forest emphasized recreation over other forest uses such as "water conservation, timber production, forage and mining". Based only on knowledge of their respective mandates, we would expect the Sequoia National Forest to resemble a multiple use forest and Mountain Home Demonstration Forest to be primarily oriented towards preserving giant sequoia and

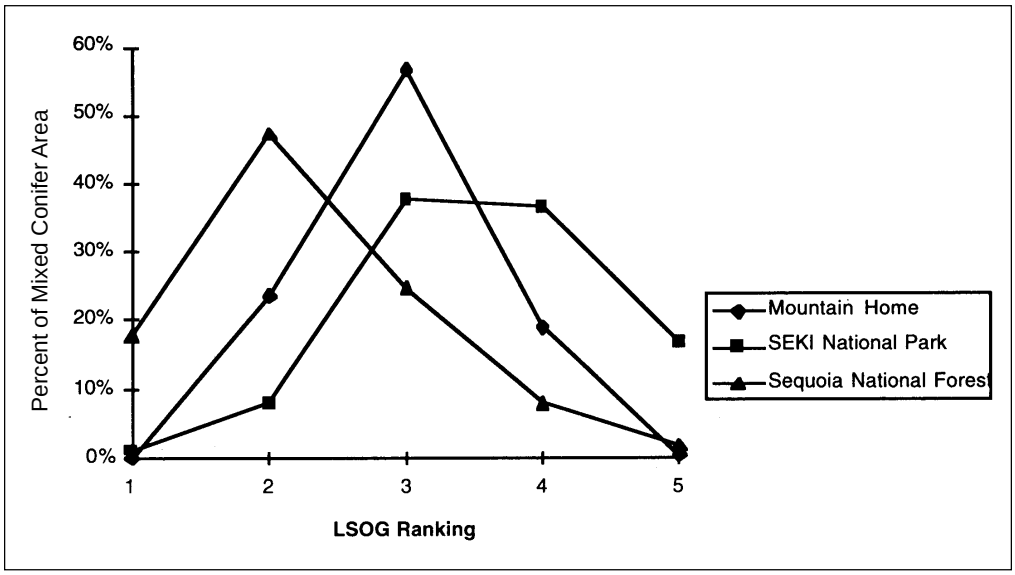


FIGURE 51.4

Structural diversity of mixed conifer forests in different ownerships.

TABLE 51.3

Late seral/old growth structural diversity rankings of the surveyed institutions.

Characteristic	Sequoia National Forest	Sequoia–Kings Canyon National Park	Mountain Home State Demonstration Forest	Tule River Indian Reservation
Mixed conifer region acres 1,200–2,600 m (4,000–8,500 ft)	905,654	248,767	5,048	Not surveyed (NS)
Acres with forest cover in mixed conifer region	749,715	198,312	4,990	NS
Low structural diversity LSOG 1&2	66%	9%	24%	NS
Medium structural diversity LSOG 3	25%	38%	57%	NS
High structural diversity LSOG 4&5	10%	54%	19%	NS

providing recreational opportunities. Contrary to this, we have shown not only that both forests are managed as multiple use forests, but also that the ways in which conflicting resource use patterns are reconciled, the integrity of the feedback loop between research and resource management, and the degree of controversy over resource management activities significantly differs between them. We suggest that these differences can be accounted for by examining the differences in relative degree of centralization, constituency relations and the structure of funding between the national forest and the demonstration forest.

The Mountain Home Demonstration Forest emphasizes timber production to a greater extent than their mandate would lead one to expect to cross-subsidize the administration and management of the rest of the forest. However, due to its decentralized organization and local planning autonomy, Mountain Home forest managers can practice intensive forest management in small patches of mixed conifer forest while simultaneously enhancing recreational opportunities and preserving giant sequoia groves in adjacent areas. Freedom from the need to maximize commodity output targets enables the forest managers to temper timber harvesting to reduce potential conflicts with recreation use by using single tree or small group selection harvest methods and by decreasing the entry frequency by 50 percent. These same organizational and funding characteristics enable forest managers to experiment with, and monitor and evaluate, alternative timber management and fire regimes.

The Sequoia National Forest, on the other hand, also manages for multiple use but through quite different organizational, planning and funding structures. The centralized organization of the forest administration, the tendency for funding to be linked with commodity outputs, and the lack of local level research capacity, restrict the ability of the forest managers to develop innovative timber management plans. This resulted in accelerated timber harvest rates in the 1970s and early 1980s whose ecological effects eventually lead to the multiple appeals of the forest's Land Management Plan and the negotiated Mediated Settlement Agreement. We argue that more flexible funding arrangements which do not tend to prioritize commodity over non-commodity resource management, a more complete feedback loop between research and resource management, and a more vigorous set of outreach and interpretive programs, could have enabled managers to produce less controversial resource management plans. This paired example shows how and why the meaning of "multiple use" can vary according to organizational and social context.

The Mountain Home Demonstration Forest and the Tule River Indian Reservation illustrate an example in which the high public accountability of the latter and the mandate of the former produced roughly comparable landscape outcomes. Both these institutions follow intensive resource management programs which nevertheless are able to balance commodity and non-commodity resource values in ways which satisfy the diverse needs of the public(s) they are accountable to. The Tule River Indian Reservation is not mandated to follow any specific resource management approach. Its present culturally attuned multiple use management regime developed because of the high levels of accountability reinforced through a number of political and cultural channels. The Mountain Home Demonstration Forest also provides a mix of commodity and non-commodity resources, but not because of formal public accountability procedures. Unlike the more complex public input procedures used on both the National Park and the National Forest, the procedures for the two smaller parcels meet the legal minimum but have a strong record of being responsive to local concerns. Public input is more informal and less structured for the two smaller parcels than for the large federal forest and park.

These two sets of examples illustrate how social context, accountability, organization, funding and planning flexibility interact to influence how an institution interprets and implements its mandate. They suggest that policies which seek to influence what institutions do by modifying the legal framework alone, will probably produce as many unexpected as expected outcomes. However, they also suggest that there is a wide variety of possible sources of leverage through which

policy can influence institutions, and that an effective policy will probably combine several.

Funding Effects on Accountability

Regardless of other factors, the criteria used to determine budget allocations always exert considerable influence on the course an organization steers. The funding for Sequoia and Kings Canyon National Parks and for Sequoia National Forest has been historically tied to visitor days and commodity targets, respectively. The national parks' dependence on visitor days renders constituency support essential for the organization's survival. The relatively high scientific research budget at the national parks was based in part on competitive bidding for funding outside of the normal Park Service appropriations. Sequoia National Forest's dependence on meeting internally defined target output levels retains decision making and planning control within the organization and makes it difficult to justify expending the resources required for maintaining external constituency support. The decision to pursue an externally mediated settlement in the late 1980s and the lingering difficulty of getting significant support from the signatories illustrate some of the long term problems which emerge when constituency support is not maintained.

The structure of funding for these two organizations has also helped to generate the central tensions that each faces. Within Sequoia and Kings Canyon National Parks this tension stems from the contradiction between the historical emphasis on preservation and current shifts towards active resource management which must not threaten the primarily non-local constituency support which the national parks depend on. Within the Sequoia National Forest, a central tension exists between meeting internally (internal to the National Forest Service but often determined above the national forest level in the regional or national offices) defined commodity targets and simultaneously satisfying increasing and often conflicting constituency demands for the protection and provision of non-commodity resource values.

EFFECTIVE MANAGEMENT RESPONSES IN COMPLEX ENVIRONMENTS

This section addresses elements of an effective strategy for managing public lands within a context of increasingly complex political and social environments and of growing ecological interdependence between reserves and adjacent resource use systems. Under these conditions we suggest that three elements necessary for effective resource management are applied research programs, the maintenance of public trust and institutional legitimacy, and inter-agency coordination. To reduce the potential biases which stem from studying only a single national park or forest, in this section we expand the comparative analysis to include Yosemite National Park and the Stanislaus National Forest.

From "Islands in Time" to Porous Reserves and Complex Environments

Protection of natural resources, whether defined as preservation or conservation, has historically involved establishing boundaries around that which is to be protected and then developing the political capacity to secure the boundaries from external threats and the administrative capacity to control what occurs within the boundaries. The Sierra and Stanislaus National Forests and Sequoia and Kings Canyon and Yosemite National Parks were reserved from the public domain in order to protect the otherwise threatened natural resources which fell within their boundaries. While the initial motivations for reserving these lands were similar, e.g. to protect them from degradation by private interests, soon after their reservation they were imbued with different management philosophies and purposes, administrative structures, and political constituencies. Although purchased, instead of reserved from the public domain, Mountain Home Demonstration Forest was similarly established with strong local support to protect the large giant sequoias it contained from harvesting. Finally, the Tule River Indian Reservation established the boundaries of sovereignty of people who once claimed a much larger territory. Here again, it could be argued, one of the initial purposes of the reservation was to protect those inside it from an environment so hostile that there was little or no chance of surviving in it.

While the "island in time" approach to resource protection may have succeeded in the past, it is now ineffective. Mounting external pressures on reserve boundaries make them appear increasingly porous, and the increasing differentiation of the social and political environments of reserves heightens the tensions between alternative and sometimes mutually exclusive management objectives. The porosity of reserve boundaries refers to situations where influences which impact areas within an agency's jurisdiction arise from outside it. Examples include the effects of air pollution on southern Sierra conifers, wildfires which move without regard to jurisdiction, water claims from outside the reserve which affect the supply of water within the reserve, and habitat degradation and/or reduction on adjacent lands on which migratory wildlife are seasonally dependent. The threats these external pressures and influences pose are not insignificant. For example in 1980, in response to two private studies of the threats adjacent land use posed for public lands management (NPCA 1979) the National Park Service released a report on threats to the national parks which showed that more than fifty percent of the threats originated from sources or activities external to the park, and that air quality was endangered in more than forty-five per-cent of the parks.

In addition to increasingly porous boundaries, the social

and political environment of public lands management has grown more complex and uncertain. Long term planning on national forests is hindered by the uncertainty created by restrictive court injunctures and temporary guidelines which determine what management activities are allowed where. In many instances court orders and temporary guidelines such as for the California Spotted Owl and the Mediated Settlement Agreement on the Sequoia National Forest are manifestations of the difficulty of managing public lands for constituencies with conflicting values and attitudes about the prioritization and acceptability of different resource uses. In addition to being asked to satisfy increasing claims from diverse public(s) for different resource amenities, the agencies responsible for managing public lands are also asked to adopt "adaptive management" and "ecosystem management" approaches, which if they are to be effective, require a level of integration between resource science and resource management which has historically been difficult to sustain.

Research Capacity and Integration with Resource Management

Although little disagreement exists regarding the importance of research, there is considerable debate about the most effective way to organize research and to integrate it with resource management. Variables across which the organization of research can vary are: the degree to which it is centralized or decentralized; the extent to which research budgets constitute a separate line item or are subsumed within other budget categories; the degree to which research scientists are accountable to administrators or to other scientists; the degree of complementarity between research agendas and outcomes and the information needs of resource managers; the extent to which research agendas dovetail with a macro-level coordinated strategy or are tailored to meet site-specific objectives; and the extent to which research capacity is concentrated within an organization or is accessed from other institutions through contracts and coordinated agreements.

The formal organization of research within the National Park Service and National Forest Service exemplify alternative combinations of the above variables and therefore, opportunity to identify the strengths and weaknesses of different research organization structures. Additionally, differences in research activity and degree of linkage with resource management exist between units even when they share the same formal structure. For example substantial differences exist between Sequoia and Stanislaus National Forests in terms of research activity and its links with management. This section of the report comparatively analyzes the organization of research on these two national forests and then between them and Yosemite and Sequoia Kings Canyon National Parks.

Although both the Sequoia and Stanislaus National Forests share the same centralized model of research common throughout the Forest Service, there are unexpected differences in the level of research on the two forests. On the Stanislaus National Forest there is one experimental forest, the Stanislaus-Tuolumne Experimental Forest, as well as several Research Natural Areas (RNA's). Both the experimental forest and the RNA's have been set aside as research sites by and for Pacific Southwest (PSW) Research Station scientists who are involved in a wide variety of ongoing research projects. Examples of research on the forest include silvicultural experiments in the experimental forest, aspen and black oak research and other research projects in various of the RNA's, research on herbicide use and effects, and the interagency Mokelumne River Watershed Project (Henly, 1993). Following the Stanislaus Complex Fire in 1987 which burned approximately 145,500 acres, PSW scientists established a paired watershed study to measure the erosion and sedimentation associated with two different salvage logging methods. In addition to research carried out by scientists from off-site PSW research stations, administrative studies which approximate research but are often explicitly related to management goals, are conducted by on-site personnel. Recent examples of this type of research include studies of forest health by entomologists and pathologists on the forest staff, as well as studies of the advanced cut-to-length logging technology and the complementary relationship between it and prescribed burning for fuels reduction under conditions of high fuel loading. The Stanislaus National Forest also has the only funded prescribed natural fire management and research program in California.

The relatively high level of research activity on the Stanislaus National Forest contrasts sharply with that of the Sequoia, at least in recent years as described earlier in this report. Several factors account for this difference. Among them include the closer proximity of the Stanislaus to PSW research stations in Albany and Redding, possible ecological differences between the two forests which make the Stanislaus more attractive given the research agendas of PSW scientists, differences in receptivity to "outside" (PSW) researchers among the personnel on the two forests, and, on the Sequoia National Forest, a possible dearth of the initiative and enthusiasm required to carry out in-house administrative studies given the public controversies and confrontations the forest has been embroiled in since the late 1980s.

However, even on the Stanislaus National Forest the highly centralized research structure has generated shortcomings and criticism. Two recurring criticisms concern the research agenda setting process which forest managers feel they have little or no ability to significantly influence and contribute to, and the project based funding of many management programs whose target driven structure often leaves inadequate funds for on-site research and monitoring. Past and present forest managers stated that the research agendas of PSW scientists often do not address forest-level management concerns and information needs, and that the management implications of research are not explicitly stated in a manner which promotes communication between researchers and managers. Managers contrasted this with research and administrative studies

conducted by forest entomologists and pathologists on the forest staff which are aimed at answering management related research questions. Because of the lack of perceived benefits from research conducted on the forest, some forest managers felt that the reductions in the area which could be managed for multiple use because of land allocations for research natural areas and experimental forests were not warranted.

Research within the National Park Service is organized very differently from the U.S. Forest Service. Important differences include the lack of a separate research branch within the Park Service, research budget allocations which are not clearly separated from resource management activities, and the assignment of research scientists to individual parks where they report either to the park superintendent or to the regional chief scientist. Interviews with research scientists and resource managers at Sequoia and Kings Canyon and Yosemite National Parks indicate that, at least in these two parks, this decentralized model of agency research has generated research with explicit and clearly communicated management objectives. The organizational proximity of researchers and managers facilitates communication and coordination between them and enables park scientists to address research questions of applied significance to managers. While this model makes it possible to integrate research and resource management and thereby avoid the problems associated with the Forest Service's centralized research organization, it also has its own particular shortcomings. These are detailed in the many reviews of the Park Service's research program beginning with the report of Leopold and colleagues (1963) and ending most recently with a report by the National Research Council (1992). Some of the most common criticisms these reports contain are the lack of an integrated and coordinated research agenda at the national and sometimes even regional level which can result in fragmentation and duplication of research effort, the low budget priority of research and competition with resource management activities for funding, the sacrifice of long-term research goals in the face of administrative pressures to provide guidance for shorter term resource management decisions, and a tendency for research scientists to leave the Park Service because of these and related constraints. To redress these problems these reports often suggest a centralized model of research organization within an independent research branch which would resemble the organization of research within the U.S. Forest Service. Yet it is unclear how these recommendations, if implemented, would avoid the weaknesses documented within the Forest Service research model.

The comparison of the advantages and disadvantages of the centralized Forest Service research program and the decentralized Park Service program suggests that only a hybrid research organization will be able to provide the local autonomy required for effective feedback between research and resource management while simultaneously providing the organizational resources and insulation from short term administrative imperatives necessary for the sustained ecological research which is needed to define and achieve conditions of ecosystem health. While an independent research branch is probably a necessary element of this hybrid approach, effective integration of research with resource management will only occur when research is organized at the local level either through "in-house" administrative studies, or through cooperative studies involving university researchers or scientists in other state and federal natural resource agencies. The extensive program of contracted research of this type described earlier in this report for the Mountain Home Demonstration Forest exemplifies an effective use of this strategy in a situation where there is little or no "in-house" research capacity within the forest management staff. Another example of how research can be integrated with resource management is the envisioned organization of future research within Yosemite National Park. In the proposed plan inventorying, monitoring and evaluation functions would be accomplished with park personnel and all other research needs would be met by contracting with scientists from other agencies such as the National Biological Survey as well as universities. Although administrative studies and cooperative studies with outside researchers are possible on national forests, they appear to be effectively utilized only by National Forest staff with a "can do" reputation. Only by changing the structure of funding, the incentives for investing time and energy in these types of research activities and providing the requisite local level staff autonomy will administrative and cooperative studies be conducted by other than "can do" forests.

Constituency Support: Its Importance, Maintenance and Restoration

The ability of public land-based resource management agencies to maintain their institutional legitimacy and the trust of the public(s) is especially important, and difficult to achieve, as their social and political environments become increasing complex and the tensions inherent in satisfying diverse and sometimes conflicting values grow stronger. The conflicts and administrative appeals associated with the Sequoia National Forest's land management plan which eventually lead to the negotiated Mediated Settlement Agreement (MSA) suggest that the procedures necessary for satisfying the legal provisions for public involvement in resource management planning mandated by the National Environmental Policy Act (NEPA), the Resources Planning Act (RPA), and the National Forest Management Act (NFMA) are not sufficient to ensure minimal public support for agency resource management plans. This section of the report identifies some of the components of agency-constituency relations which help to maintain institutional legitimacy and public trust in the agency. We do this by analyzing the factors which account for the variation over time in relations with the public on the Stanislaus National Forest and by briefly comparing this with Yosemite National Park.

Relations between the Stanislaus National Forest and the public(s) it serves and the degree of engagement of forest personnel with local communities, have waxed and waned over time. While it is difficult to fully explain these fluctuations, they are related to factors such as the degree of decision making autonomy at the ranger district and forest level, the extent of conflict the forest is embroiled in and the response of forest service personnel to conflict, e.g. whether they withdraw into a defensive position or not, and the extent to which leadership is willing and able to take the initiative with regards to outreach and provides support and incentives for staff to do the same. Interviews with retired Forest Service personnel from the Stanislaus National Forest revealed the extensive, proactive outreach efforts which existed on the forest during the 1970s and early 1980s. For example, at the district level forest service personnel would organize field trips one or more times a year to which local community members, county supervisors, personnel from other state and federal resource agencies including the local representative of the Regional Water Quality Control Board, and representatives of non-government organizations were invited. The purpose of the field trips was generally to observe and discuss a planned, in-process, or completed resource management plan such as a timber harvest, reforestation effort, watershed rehabilitation project, prescribed burn, or fuel break near an urban-wildland interface. These "show-me" trips were not simply geared for generating public support for pre-determined courses of action, but were an effort to solicit informed public input which was used to modify plans and projects where possible to better satisfy constituency needs and objectives. Modifications to resource management plans which at least partially resulted from the public input solicited during these fieldtrips included reductions in the size of clearcut blocks, not harvesting trees along travel corridors for aesthetic reasons, spatial harvest patterns which least hindered the movements of wildlife, and attempts through fencing and the control of stock numbers to reduce damage to sensitive areas from stock grazing.

At the forest level outreach and extension activities included maintaining regular contact with the staff and elected members of the state and federal legislatures, elected county officials, and local newspaper editors, and inviting local journalists to attend annual planning meetings. As one forest service retiree described, "It (was) a matter of getting out on your own and running the people down." One important component of this proactive outreach effort was the willingness to publicly admit errors, to explain how and why they were made, and to redress them and minimize the likelihood of a recurrence. This was crucial in maintaining the public's trust, the agency's legitimacy and local political support. Two factors which enabled these relatively high levels of outreach and extension were leadership support at the forest and region levels for staff to spend time in outreach and at least minimal levels of decision making autonomy at the district and forest levels within the Forest Service. Together these factors provided adequate incentives and rewards for Forest Service personnel to invest time and resources for maintaining public trust and institutional legitimacy.

During the latter half of the 1980s and the early 1990s, and for a variety of reasons including the perceived reduction of leadership support for outreach, declining decision making autonomy at the district and forest levels, and increasing conflicts over timber harvests and related resource management issues, the level of public trust in and the legitimacy of the Stanislaus National Forest waned. It appears that the informal modes of public participation described above were gradually supplanted by the formalized involvement methods mandated in the Resources Planning Act, and that possibly in a defensive move, the previously robust informal relationships with community and political leaders were no longer as actively cultivated. Concomitant with this process was a decline in the perceived willingness of the forest service personnel to admit mistakes and acknowledge when errors were made. Not surprisingly, this has generated friction and resentment in some local circles, one manifestation of which was a recent home-rule initiative that, although voted down, had adequate support to be placed on the county election ballot.

More recently, the Stanislaus National Forest's innovative and aggressive prescribed burn program, and the program's integration with other forest management activities, may be triggering a resurgence of the type of outreach which existed previously. Last June and during the recent 5,000 acre prescribed burn, fieldtrips were organized to which non-Forest Service researchers, environmental group and forest industry representatives, and congressional staff members were invited. While this and similar outreach efforts may help improve public awareness, public trust will probably not be regained without some devolution of planning authority to the district and forest level which allows substantive public involvement, and without an "error embracing" attitude and the concomitant organizational openness this attitude requires. Public confidence and trust, once lost, is hard to restore. However, and perhaps paradoxically, as the social and political environment within which the Forest Service operates becomes more complex and contentious, the importance of maintaining institutional legitimacy becomes increasingly important.

The National Park Service has, for the most part, not suffered the same loss of legitimacy and trust which some argue the Forest Service has. This is at least partly due to its narrower legislative mandate and because its activities have not aroused the same degree of public controversy and subsequent scrutiny that the Forest Service's have. One park administrator at Yosemite National Park said that the "white hat" image of the Park Service has sometimes enabled park managers to "skate on thin ice" regarding the scientific basis of their resource management programs and the extent to which NEPA and other planning laws are followed "in letter rather than in spirit." The difficulty of managing the tension

inherent in the Park Service's mission between providing for visitor enjoyment and managing natural resources for future generations has in some cases generated ecological harm and/or conflicts with the public. Despite the relatively narrow mandate of the Park Service, the more complex social and political environment within which it operates presents challenges that did not exist even a decade previously. For example, in Yosemite National Park these challenges include poaching within park boundaries, increased gang activity in the park as well as drug-related crimes, and conflicts between public attitudes that national parks exist primarily for personal recreation and enjoyment and park research and resource management programs which seek to restore ecosystem processes and values. In an attempt to address these challenges in a proactive rather than reactive fashion, park administrators are planning an unusual off-site outreach program which will involve sending rangers to elementary schools in Fresno, Modesto, Merced and other local school districts to teach students basic ecosystem principles and concepts and to discuss the nature and purpose of national parks.

Investing resources in maintaining constituency relations and institutional legitimacy becomes increasingly important as the environments of resource management institutions grow more complex and contestatory. Under these conditions a public agency will likely be able to retain its institutional legitimacy and the trust of the public(s) for whom it manages the resources within its jurisdiction by following a proactive strategy of public outreach, on- and off-site interpretative programs, and extension work which involves all of the various and concerned interest groups. Accomplishing this probably requires minimal degrees of local level organizational autonomy, widening the envelope of acceptable planning outcomes in the interests of fostering substantive public involvement, providing leadership support and organizational incentives for personnel to invest time and energy in outreach efforts, and a non-defensive attitude which allows errors to be acknowledged and transformed into learning opportunities.

Inter-Agency Coordination

Coordination between public resource management institutions is increasingly important as reserve boundaries become more porous and social and political environments more complex. Examples of formal coordination among the agencies in this study include cooperative fire suppression agreements between California Department of Forestry and the U.S. Forest Service, the coordination of research activities on fire history studies and wildlife research between university researchers, Sequoia Kings Canyon National Parks, Mountain Home Demonstration Forest and Sequoia National Forest, and efforts to mesh wilderness use policies between U.S. Forest Service and the Park Service. One of the more long-lived examples of inter-agency coordination is the Sierra wilderness group. The wilderness group was begun in the mid-1970s to coordinate research, resource use and condition monitoring and fire management within the wilderness areas distributed across different land-based public institutions. More recently the group has sought to establish uniform wilderness and backcountry regulations throughout all wilderness areas in the central and southern Sierra regardless of agency jurisdiction. Other examples of coordination include an inter-agency manager's group, wildlife and fisheries research and management group, a GIS group and annual meetings of the region's forest supervisors and park superintendents. Cost-share programs, using funds from tax receipts or provided by interested non-government organizations, also provide opportunities for mutually beneficial inter-agency resource management programs. For example, through cooperative agreements California Department of Fish and Game revenues from hunting licenses and other taxes fund wildlife habitat improvement programs on national forest lands such as meadow restoration and controlled burning.

One of the more recent examples of inter-agency coordination in the southern Sierra Nevada is the Giant Sequoia Ecology Cooperative which was formed soon after the 1992 symposium on Giant Sequoias held in Visalia, California. It emerged as an inter-agency response to public controversy about management and regeneration of large giant sequoias, and common agency recognition of the sparse scientific basis for giant sequoia management. The Giant Sequoia cooperative will facilitate the coordination and sharing of giant sequoia related research amongst the member institutions. Ideally the cooperative will combine the comparative strengths of each member institution in a manner which strengthens the linkage between resource scientists and resource managers, and improves the public accountability of the participating agencies vis a vis sequoia management. More informal forms of coordination include reciprocal road easements between the Tule River Indian Reservation and Sequoia National Forest, and between Sequoia National Forest and Mountain Home Demonstration Forest.

Coordination between agencies also sometimes includes county government and other local community organizations. Mariposa County has four or five memorandums of understanding (MOU) with Yosemite National Park addressing a wide range of activities from building permits to search and rescue coordination. One of the MOU's regarding transportation involves four other adjacent counties and the California Department of Transportation. MOU's can function to help maintain channels of communication between public agencies and local communities and government. They are one vehicle through which tensions and conflicts of interest between public agencies and local communities can be reduced and/or resolved. In this respect they perform a similar political function as do the forms of outreach and extension discussed above.

Inter-agency coordination emerges under conditions of porosity and complexity when the benefits outweigh the costs

of coordination.(Romm and Baker, 1990). It capitalizes on the comparative advantages of different resource management agencies, for example coordination between Sequoia Kings Canyon National Parks and Sequoia National Forest, or Mountain Home Demonstration Forest and university researchers, compensates for the lack of on-site research capacity on the national and demonstration forests. Inter-agency coordination also provides local level arenas for resolving potential conflicts among agencies and between them and local communities and government, it enables more efficient utilization of scarce resources through coordinated project planning, and it helps bring policy and managerial coherence to ecosystems riven by jurisdictional boundaries.

CONCLUSION

Integrating resource science with resource management, maintaining constituency support and public accountability, and coordinating the activities of multiple state, federal, and county organizations and various non-government interests and organizations, are increasingly important as the political environment within which resource agencies work becomes more complex and contestatory. The research basis of resource management decisions can be presented and defended in public forums. This is crucial in order to maintain an institution's credibility and legitimacy. Although good science will not produce a consensus when differing values are at stake, it will provide the basis for establishing viable alternative policy options.

The Sierra Nevada ecosystem is likely to become more porous and complex in the future. In some cases the most serious threats to ecosystem health originate from outside agency jurisdictions. The organizational autonomy necessary in order to respond effectively to these and other threats to ecosystem health will only be granted by the public to those government agencies with legitimacy and accountability. Under these conditions, static legislated or rigid centrally planned policies are unlikely to produce lasting ecosystem protection. The range of organizational policy levers which can be used to affect the public land-based institutions in the Sierra Nevada include shifts in the funding and organization of research to create hybrid research organizations, relaxing the links between commodity outputs and budget levels, providing the local level flexibility, means and incentives necessary for maintaining institutional accountability and legitimacy, and facilitating formal and informal modes of interagency coordination at all levels. Policies which operate in these non-legislative arenas are often process rather than target oriented: instead of legislating outcomes they attempt to create institutional mechanisms for resolving conflict which incorporate scientific research and maintain institutional accountability.

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