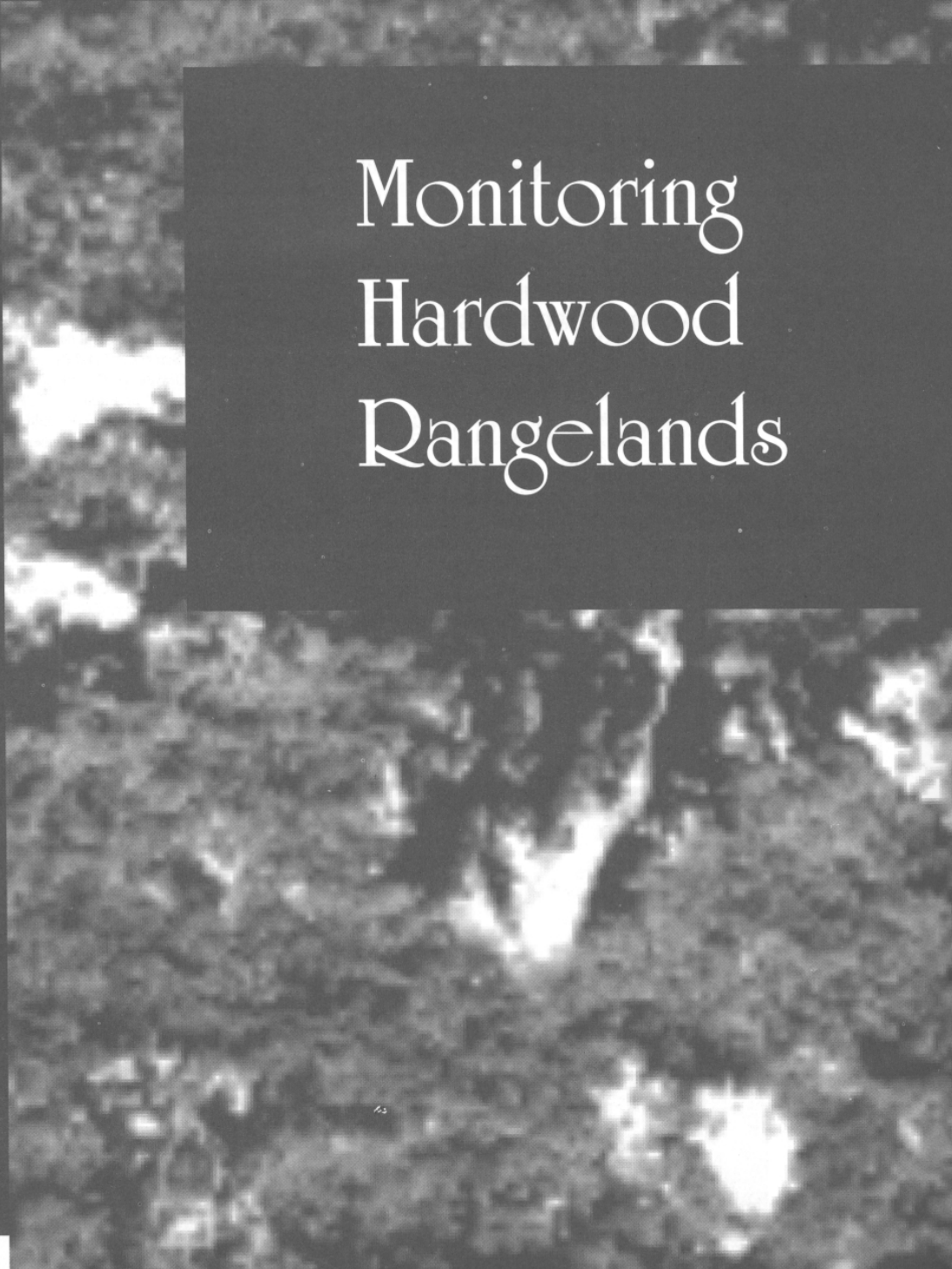
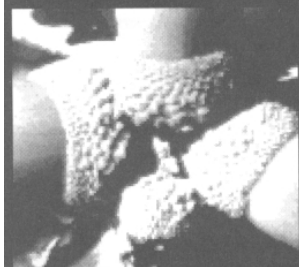




Monitoring Hardwood Rangelands



Monitoring California Hardwood Rangeland Resources: An Adaptive Approach¹

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Abstract: This paper describes monitoring hardwood rangelands in California within the context of an adaptive or anticipatory approach. A heuristic process of policy evolution under conditions of complexity and uncertainty is presented. Long-term, short-term and program effectiveness monitoring for hardwood rangelands are discussed relative to the process described. The objectives of monitoring include establishing baseline information about the extent, status and condition of hardwood rangelands throughout the state. Baseline information serves as a starting point for detecting change, evaluating the forces driving these changes, evaluating risk and identifying areas where policy actions are needed. Baseline and trend information also serve to invalidate analysis and modeling that has occurred, and improve our understanding of the ecological and social systems involved. Implications for monitoring under conditions of uncertainty and complexity, including what to monitor, how and when, are discussed.

Current policy issues, including those related to oak woodlands and hardwood rangelands, are marked by a high degree of complexity and uncertainty. Uncertainty surrounds our understanding of current and future ecological processes, behavior and response, as well as current and future societal preferences (Holling 1978). Events and responses are often unexpected. Reaction to such unexpected events is often hindered by reliance on information which is not likely to adequately address current issues. Furthermore, the public and private institutions charged with providing information or articulating policy and management response are often incapable of operating within such a complex and uncertain environment by their very design. (Bartlett and Baber 1987; Scott 1987). This paper examines an adaptive or anticipatory approach required by such a policy environment, that explicitly recognizes the uncertainty of information, accepts the need to modify policies based on new information, and includes a component specifically designed for filling important informational gaps.

ADAPTIVE ANALYSIS AND MANAGEMENT

Many of the concepts underlying the adaptive approach to assessment, policy analysis and management are presented in Holling (1978). The premise of the adaptive or anticipatory approach is that the issue of uncertainty pervades the major resource and environmental problems of today; and that resilience based on the variability of the natural and management parts of the system should be the overall criterion of policy design.

Monitoring and the Adaptive Approach

A fundamental, integral part of adaptive assessment and policy analysis is a monitoring and feedback mechanism that allows institutional learning to occur and provide the basis for changes in policy and management. Because of the complex systems involved, the choice of what variables to monitor is extremely important. Structural features, such as distribution, age and linkages are more important than individual variables (Rolling, 1978). Where and when to monitor is important as well, since events in one area can emerge as impacts in another, perhaps distant area, at some unknown later date. Incorrect choices in these areas can result in concluding that no change has occurred when, in fact, it has.

Benefits should be attached to increasing information on unknown or partially known social, economic and environmental effects. One response to high levels of uncertainty and complexity is to attempt to "know everything" before proceeding. By valuing information, the development of it can be focused on those areas that provide the greatest return in terms of increasing our understanding of the issues in a way that facilitates positive policy actions.

While some experimentation and development of new information should be gathered through an integrated research plan, the actual management or policy actions themselves should also be designed to develop new information. Such an approach adds resiliency by diversifying the sources, types and timing of new information. It also provides a necessary "reality check" with those actually involved in management or policy actions, and actively involves them in the adaptive and anticipatory aspects of policy.

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Policy Evolution

A heuristic description of how resource policy might evolve in a complex and uncertain environment is useful for highlighting key areas where information and monitoring come to bear. For simplicity's sake, the process can be broken down into a number of steps.

1. A concern about some environmental attribute or process is raised, often based on a mix of empirical evidence and intuitive reasoning. Neither may be very precise, but are compelling enough to evoke some response.

2. Historical and existing current information is reviewed in light of the concern, with the goal of refuting or substantiating the concern. More likely than not, however, the best available information does not fully answer the questions that have been raised.

3. Models are developed in an effort to decrease some of the uncertainty about the future natural conditions and processes. These range from simple qualitative discussions to more detailed quantitative or mathematical models.

4. Model results will suggest a number of policy alternatives, which are discussed and debated, some of which may be adopted. A comprehensive policy would include aspects of project management and mitigation, research and monitoring, and periodic review.

5. Periodic review of management and policy is made in light of research and monitoring results. Modifications are made, if warranted by the new information. Modifications are also made in light of new environmental or social questions that arise.

This simple description of policy evolution shows that existing information, monitoring and the new information resulting from monitoring all play key roles in adaptive management and assessment, but at different points in the process.

TRENDS AND PROJECTIONS IN HARDWOOD RANGELAND POLICY

The sustainability of California's hardwood rangeland resources is a major concern of the State Board of Forestry. Board policy clearly states that regeneration of the diversity of hardwood species should be assured, soil and water quality protected, and wildlife habitat diversity maintained on hardwood lands. Further, land conversion should be directed away from environmentally sensitive areas, avoiding damage to the viability of wildlife populations and negative effects on resource management (Board of Forestry, 1986). Historical trends and projections of the resources provide a starting point for policy actions, including management and monitoring.

Historical Trends in Oak Woodlands and Hardwood Rangelands

Bolsinger (1988) estimated that hardwood types on woodland decreased by 1,185,000 acres from 1945 to 1985. The estimate, while not precise, does provide an order of magnitude of the change in oak woodlands over the 40 year period. The rate of loss averaged close to 30,000 acres per year. The cause of conversion was not constant, however, over this time period. From 1945 to 1973 the major cause of conversion was rangeland clearing. Most of this clearing was done in the mid-to southern Sierra foothills, the central coast counties and Tehama County. Over a period from 1966-72 to 1981-84 the primary cause was residential-commercial development, followed by road and freeway construction. The rate of conversion increased, as well. Significantly, the study estimated that 279,000 acres of woodlands are in areas being developed for residential and other uses.

An analysis by FRRAP (California Department of Forestry and Fire Protection, 1988) focused on conversion of forest and rangeland cover types to agricultural and urban uses. The analysis found that approximately 27,000 acres of hardwood woodland and 590,000 acres of hardwood woodland-grass were converted to agricultural or urban uses from 1950 to 1980. Most of the conversion occurred in the Sacramento, Central Coast and Central Sierra regions. The analysis looked only at conversion to non-forest and non-rangeland cover types, and did not include, for example, the conversion of oak woodland types to grassland for grazing.

In spite of the differences, the two estimates do provide bounds on the order of magnitude of historical trends in the oak woodlands and hardwood rangelands. While the range of between 600,000 and 1.2 million acres may seem too broad to some, it does indicate that the change has not been trivial. This broad range cannot, by itself, answer the question of whether too much conversion has taken place, but it does serve to contain the initial discussion.

These analyses illustrate two important points that must be considered. First, environmental assessment depends on data that were developed at different times, for different purposes, under different conditions for long term assessment. The luxury of a consistent set of data points that were developed over a forty or fifty year span with the explicit purpose of comparison is rarely the case. In fact, such a set of data should not be expected, given the complexity and changing nature of environmental issues, and the time spans involved.

Second, the dynamics surrounding the particular phenomenon of interest can and do change. In the particular case of oak woodlands, the primary cause of conversion shifted from rangeland clearing to residential-commercial development. The rate of conversion also changed. Developments in process identified by Bolsinger (1988) might indicate that the rate of conversion due to construction is increasing as well.

These insights imply that the design of any data gathering or long term monitoring program must balance the need to be consistent over time to allow for comparison, but must also be flexible enough to accommodate changing circumstances and

dynamics. It is very difficult to know beforehand what the changes will be. Experience indicates that change, however, will occur.

Projections of Hardwood Rangelands

Assessing future trends and the likelihood of changes is fundamental to adaptive management and policy analysis. Whether accomplished by sophisticated computer models, extrapolation of current trends, or obtained through expert opinion, such forecasts or simulations provide a focal point for current policy and management actions, as well as for monitoring efforts.

The future extent and condition of the hardwood rangelands were simulated as part of the CALPLAN model (Davis and others 1987; Marose and others 1988). The model represents an effort to incorporate the best available data sources related to trends in hardwood rangelands, including current distribution, current and future harvest practices and cutting rates, regeneration rates and successional patterns. Current, and especially future harvest practices and conversion rates are based on projections of population and market conditions that are expected to affect hardwood rangeland use.

Results of the baseline scenario for California included acreage of hardwood rangelands by county and seral stage for future decades to the year 2010. Results indicate that about 300,000 acres of the initial 7.5 million acres will be converted to other uses or other vegetation types. Virtually all of the loss is found in young seral stages (0 - 6 inch dbh).

The Central Coast Region is projected to lose about 4 percent, and the Sacramento Region 8 percent. All other regions are projected to lose about 2 percent. These projections are consistent with the historical trends mentioned earlier. The causes of change are also consistent. For example, early seral stages are reduced in areas such as Tehama County due to clearing and burning to increase forage availability for grazing. The driving force behind change in the Central Coast Region is conversion to urban and agricultural uses.

The results provide a pointer to focus short and long term management and monitoring efforts. They indicate the geographic locations where significant changes in hardwood condition and distribution are expected, and the probable causes of such change. The results are also useful for estimating impacts on different wildlife species.

Given this starting point, immediate management and policy actions can be targeted for implementation. A monitoring program can be developed to provide information about the effectiveness of the Board's policy. Monitoring can also provide the information necessary to invalidate the assumptions about both ecological and social responses embedded in the forecasting models.

MONITORING

California's program to protect hardwood rangeland resources includes three types of monitoring: long-term, short-term and program effectiveness (California Department of Forestry and Fire Protection, 1989). Each of these activities focuses on different aspects of environmental and social processes and responses. For each, monitoring involves change detection, understanding the reasons for that change, and an assessment of the risks and benefits change has for the sustainability of the resource.

Long-Term Monitoring

The primary objective of long-term monitoring is to establish baseline information about the extent, status and condition of hardwood rangelands throughout the state. Baseline information serves as a starting point for detecting change, evaluating the forces driving these changes, and identifying areas where policy actions are needed. While the products of the long-term monitoring program are information, the uses are directed towards the continual evaluation and adaptation of hardwood policy.

Long-term monitoring addresses the following questions: Is the condition and extent of hardwood rangelands changing? If so, where is it changing? Is it changing according to our expectations? If not, how is it differing from our expectations, and why?

Long-term monitoring is primarily accomplished through periodic mapping of vegetation cover types. This effort is the responsibility of the Forest and Rangeland Resources Assessment Program. The initial mapping effort was based on 1981 aerial photographs and includes only stands 40 acres or larger in extent. Six cover types (blue oak, blue oak-foothill pine, coast live oak, valley oak, interior live-canyon live oak and montane) and four canopy cover classes (< 10 percent, 10-33 percent, 34-75 percent and > 75 percent) are recognized. This classification scheme is similar to that established within the Wildlife Habitat Relationship database (Mayer and Laudenslayer, 1988), and permits inferences on habitat suitability from the mapped vegetation information.

In order to detect changes in the hardwood resource base, a second project to remap hardwood cover types has recently been initiated. The purposes of this project are to both verify, where possible, the original mapping effort and detect differences due to actual change, not simply those due to differences in classification, scale and boundaries. Changes in technology and need have led to changes in approach. The re-mapping will be done with satellite data, and will use a classification scheme more closely in line with the WHR system. These changes have been made while acknowledging the need for consistency and repeatability over time and scale in order to make meaningful comparisons. All attempts will be made to maintain that consistency,

while still allowing for the incorporation of changes in methods and understanding of the underlying biological system.

Mapping of cover types focuses on the response of the system to the various forces that would lead to conversion. By itself, a periodic, large scale mapping project is only a backward-looking monitoring system. An appropriate adaptive and anticipatory monitoring scheme must also look at the "demand side" of the equation, to track the progress and change in the forces affecting change.

Large scale population growth and resultant conversion to urban and agricultural uses is expected in the Coastal counties and Central Sierra. Population trends and projections are thus a necessary part of the long term monitoring efforts as well.

Large scale conversion to grassland or grazing types due to the application of management practices resulting in changes in seral stage or conversion is expected in the northern areas of hardwood rangeland, such as Tehama County. Whether or not such practices will be applied as projected in the CALPLAN model will depend on a number of factors, including the direction of world commodity markets and the resiliency of the biological system. Applied research projects are underway in a number of these areas. The results of these projects will be useful for invalidating the model projections.

Short-Term Monitoring

Another component of hardwood policy is short term monitoring, under the responsibility of the Forest Improvement Program of the Department of Forestry and Fire Protection. This component is primarily a means of targeting areas for intervention efforts such as the education program of the Integrated Hardwood Range Management Program. While long-term monitoring strives for consistency and repeatability, short-term monitoring is oriented towards field level decisions with less than perfect information. In spite of this, short-term monitoring also provides valuable new information for overall policy development. This information is gathered through a variety of means, including activity reports, networks and overflights of particular areas.

For example, harvesting hardwoods for fuelwood has been raised as an issue affecting the extent and condition of hardwood resources. While it does not appear to be one of the long term driving forces leading to large scale changes, it can have localized, extreme impacts. Research has shown that this activity is difficult to track directly, happens very quickly and can be severe. It is also related to energy costs and the general state of the economy.

The latest trauma in the Persian Gulf has sent oil prices skyrocketing. This would serve to focus short-term monitoring on those areas that have a history or proclivity to harvest fuelwood. The mechanisms of short-term monitoring are particularly suited to pick up sudden changes. Nor is it necessary that the monitoring be completely systematic, consistent or quantitative.

This information will also prove useful in invalidating the assumptions of models used in assessment and planning. If an increase in fuelwood harvesting were not to occur, then the

underlying assumptions about the causes of fuelwood cutting would be partially invalidated. On the other hand, some confidence in the models would result from an observed increase in harvesting. Either of these results would have implications for the current hardwood policy.

Program Effectiveness

The third monitoring activity focuses on the effectiveness of the research and education program, under the responsibility of University of California Cooperative Extension. The program attempts to increase understanding and awareness of hardwood resource issues through research and extension. Monitoring the program's effectiveness provides important feedback for more fully understanding and invalidating the assumed responses of both the natural and social systems that have been used to date.

The program may be effective in that information is created and adequately extended to landowners, for example, yet have no impact on changes in hardwood condition and distribution. This would indicate a lack of understanding of how landowners use better information in their decisions.

Focusing Monitoring Efforts: Risk Assessment

Identifying "important" or "critical" areas—places that deserve highest priority for protection or monitoring—can help effectively use monitoring resources, as well as form the foundation of risk assessment. Risk assessment will form the basis for the next round of models, programmatic responses and monitoring.

Current and expected knowledge of the intrinsic ecological factors and responses to events can serve to develop areas of high risk. Such areas serve to increase focus of short-term monitoring and intervention, if needed, and modification of long-term monitoring with regard to what variables are measured. Historical trends and model simulations, mentioned earlier, give some indication about where losses in hardwood extent are expected, and why FRRAP is currently involved in a study to develop the parameters against which relative risk can be evaluated. The ecological factors include the extent, condition and distribution of hardwoods; water quality and soil risks; and wildlife habitat diversity. The social and economic factors, or activities, include probability of conversion to other uses; range management activities, including grazing and clearing; and commercial harvesting.

Research results play a tremendous role in developing both the methodologies and empirical evidence for risk assessment. The ecological factors just mentioned are general, to say the least. But, for example, as understanding of regeneration and recruitment questions improves, estimates of relative risk of losses in extent and distribution, or declining condition, can be improved. As these improvements are made, changes in management and monitoring activities are likely to be needed as well.

CONCLUSIONS

The current policy environment requires that an adaptive approach to resource management and assessment be taken. A key feature of the adaptive approach is to anticipate change, and to actively incorporate learning and responding to change as part of the entire policy design. Monitoring in order to learn, through new information, plays a critical role in the adaptive approach. Monitoring must occur at many different levels, using a variety of tools and information sources. In the case of monitoring trends in California hardwood rangeland resources, it includes long-term, short-term and program effectiveness activities.

The choice of variables—what, where and when—is a major consideration in an anticipatory monitoring program. Experience with hardwood rangelands indicates that some of the important variables, such as extent and condition, are best suited to a long-term, systematic approach. These structural variables also serve as first level approximations for variables that may be important, like regeneration success, but our understanding of which is still evolving. Structural variables, such as population growth and economic activity, must also be tracked in order to understand the social systems involved.

Other variables, such as fuelwood harvesting, are better monitored over the short-term, under less rigorous design conditions. The short-term and program effectiveness monitoring activities also strive to gather new information apart from a structured research plan. Their results can have significant impact on model invalidation and subsequent policy actions. In fact, one of the primary uses of all monitoring information is to test and try to invalidate our assumptions. Feedback from the programmatic level provides a "reality check" based on the growing experience of the people involved in management actions.

Both the ecological and social systems involve guarantee that circumstances and knowledge will change. Consequently, it is reasonable to expect that the monitoring programs themselves will change. The basic design may change due to new technology or, more importantly, the advent of different questions. The

variables chosen to measure are also likely to change, as our understanding of the underlying ecological and social processes improves.

Maintaining the connections between the different levels of monitoring, and insuring that feedback with the policy goals, design and implementation strategy occur, are the major challenges in using the adaptive approach.

REFERENCES

- Bartlett, Robert V.; Baber, Walter F. 1987. Matrix organization theory and environmental impact analysis: a fertile union? *Natural Resources Journal* 27(3): 606-615.
- Board of Forestry. 1986. Policy Options for California's Hardwoods. 25 p.
- Bolsinger, Charles L. 1988. The hardwoods of California's timberlands, woodlands and savanna. *Resour. Bull. PNW-148*. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 148 p.
- California Department of Forestry and Fire Protection. 1988. California's forest and rangelands: growing conflict over changing uses. Sacramento, CA. Forest and Rangeland Resources Assessment Program; 348 p.
- California Department of Forestry and Fire Protection. 1989. Integrated hardwood range management program: accomplishments and new directions. Report to the California State Board of Forestry by the Forest and Rangeland Resources Assessment Program; 55 p.
- Davis, Larry S.; Marose, R., and DeLain, Lynn. 1987. CALPLAN: a model to simulate outputs from California forest and rangelands under alternative futures. In: *The 1985 symposium on systems analysis in forest resources*; 1985 December 9-11; Athens, GA. Georgia Center for Continuing Education, University of Georgia; 29-42.
- Marose, Robin; Tuazon, Raul; Davis, Larry S. 1988. Implementing an ownership-behavior simulation of private sector timber supplies. In: Kent, Brian M.; Davis, Larry S., Technical Coordinators. *Proceedings, 1988 symposium on systems analysis in forest resources*; 1988 March 29-April 1; Pacific Grove, CA. Gen. Tech. Rep. RM-161. Fort Collins, CO: Rocky Mountain Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 114-123.
- Mayer, Ken; Laudenslayer, William F, eds. 1988. A guide to wildlife habitats of California. California Department of Forestry and Fire Protection: 166 p.
- Holling, C.S. ed. 1978. Adaptive environmental assessment and management. New York: John Wiley and Sons; 377 p.
- Scott, Richard W. 1987. Organizations: rational, natural and open systems. Second edition. New Jersey: Prentice-Hall, Inc.; 377 p.