

The Integrated Hardwood Range Management Program: Education and Research as a Conservation Strategy¹

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***Abstract:** California's hardwood rangelands cover 10 million acres, providing wildlife habitat, esthetics, recreation, and watershed protection. About 85 percent of the area is privately owned, and private ranchers supply most of these open space values. The important public values from these privately-owned wildlands has created pressure for the state to regulate oak harvest and conversion. However, current policy calls for a program of intensive educational outreach. This program, started in 1986, is known as the Integrated Hardwood Range Management Program (IHRMP), and is a partnership between the University of California, California Department of Forestry and Fire Protection, and California Department of Fish and Game. The effectiveness of research and education as a tool for conservation of important environmental resources is discussed on the basis of the 9-year history of the IHRMP.*

Background

California's oak-covered rangelands, also known as oak woodlands or hardwood rangelands, occupy almost 10 million acres (Bolsinger 1988, Pacific Meridian Resources 1994). They provide habitat for 313 wildlife species, making them the most biologically diverse broad habitat type in California (Standiford and Tinnin 1996). Oak woodland values also include esthetics, recreation, and watershed protection. These large expanses of wildlands are somewhat unique in the western United States, with more than 80 percent in private ownership (Greenwood and others 1993). Livestock production is the dominant land use, and private ranchers supply most of these open space values (Huntsinger and Fortmann 1990).

The California State Board of Forestry (BOF) is a regulatory and policy-making body responsible for the state's forests and rangelands. A variety of interest groups have expressed concerns about oak woodlands to the BOF since the early 1980's. In response to these concerns, the BOF commissioned an Ad Hoc Committee on Policies for Forest Practice Regulation in California Hardwood Forest Types to clarify hardwood stocking criteria in the Forest Practice Rules. The Committee report in 1982, though focused primarily on hardwoods on commercial forest land, also discussed the importance of hardwoods on "non-commercial" land.

Three incidents resulted in continued concerns about hardwood lands: (1) Monterey and Santa Clara counties petitioned the Board to classify oaks as commercial species regulated under the Forest Practice Act because of concerns over hardwood harvesting; (2) a Timber Harvesting Plan (THP) in the Northern Sierra requested removal of most black oaks in a critical migratory deer corridor; and (3) the increase in the number of new biomass power plants held the possibility of severe impacts to hardwoods on commercial and non-commercial lands. In 1983, the Hardwood Task Force (HTF) was commissioned by the BOF to study all aspects of the state's hardwood resources. The HTF identified 19 issues affecting hardwoods and concluded that basic information about hardwood species and educational outreach were lacking. HTF recommended delineating

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hardwood areas into either conifer lands or hardwood rangelands and concluded that hardwoods on all lands should be considered commercial species requiring regulation (Pillsbury 1983).

On the basis of the issues raised by the HTF, the California Department of Forestry and Fire Protection (CDF), California Department of Fish and Game (CDF&G), USDA Forest Service (USFS), and University of California (UC) prepared a joint report to the BOF (Mayer and others 1985), and Board Staff outlined possible policy directions (Board of Forestry Staff 1986). The Board asked UC, CDF and CDF&G to develop a program of research, education, and monitoring on hardwoods responsive to these policy issues, which became the Integrated Hardwood Range Management Program (IHRMP) on July 1, 1986.

As discussion of hardwood issues became clarified, the BOF adopted a Resolution on Hardwoods on February 3, 1987. This resolution concluded that although the BOF had the authority and obligation under the Forest Practice Act to protect the hardwood resource, it was premature to declare hardwoods commercial under the Forest Practice Act. It was felt that an intensive educational program, problem-focused research, and frequent monitoring of the resource would be the most effective way to work with landowners and local governments to resolve hardwood issues. The IHRMP was the mechanism expected to accomplish the goals of this non-regulatory program. This policy has continued up to the present. IHRMP, through presentations and annual reports, has kept the BOF informed about the effectiveness of educational programs in accomplishing voluntary compliance with resource protection standards, results of research studies, and trends in resource use.

Development of IHRMP

Several guiding principles were used during development of the IHRMP:

- Was the research base on ecological and managerial factors affecting hardwood rangelands sufficiently well-developed to begin the design of an educational program?
- Could materials be developed for use in an educational program?
- Could UC's educational network of county-based Cooperative Extension offices deliver an educational program on hardwood rangeland conservation?

A survey of the literature and of researchers at various academic and public resource management institutions revealed that there was a very large base of research-based knowledge that could form the foundation for an educational outreach effort (Muick and Bartolome 1985). More than 113 different research studies, conducted between 1953 and 1985, were identified in this general survey. Given this base of knowledge, a general book, directed to landowners and resource management professionals, that summarizes the best available research-based information on hardwood rangelands was developed. The "Preliminary Guidelines for Managing California's Hardwood Rangelands" formed the basis for initial educational outreach efforts (Passof and others 1985). Finally, most of the hardwood rangeland counties in the state had a farm advisor with a strong educational and applied research effort directed at livestock producers and rangeland owners. New educational efforts were being developed for the influx of ranchette owners moving into California's foothills. This network of county advisors had already formed a Hardwood Workgroup to begin to organize and coordinate educational outreach to hardwood rangeland owners.

Since the elements for a research and educational program were in place, plans for the Integrated Hardwood Range Management Program were developed to build on this base (Passof and Bartolome 1985). One component of this effort

called for increasing the staffing level of Cooperative Extension advisors and specialists working specifically on hardwood rangeland issues, to support delivery of local-based educational efforts through county extension offices. The second major component was to develop a competitive grants research program to address high-priority knowledge gaps on hardwood rangelands.

The IHRMP’s mission is stated as follows:

“To maintain, and where possible expand, the acreage of California’s hardwood range resource to provide wildlife habitat, recreational opportunities, wood and livestock products, high quality water supply, and aesthetic value.”

The initial goals and direction of the IHRMP were driven by statewide concerns about regeneration, wildlife habitat, and conversion pressure (IHRMP 1988). The initial focus of the educational and research effort was directed at a stand or single property level. As understanding of the ecological processes on these lands has increased, the IHRMP goals have broadened to include multi-ownership, landscape level considerations (IHRMP 1992). Although vast areas of hardwood rangelands still occur as interconnected large blocks, several impacts threaten to fragment these areas and reduce their ecological value. Historically, clearing for agricultural production and rangeland improvements resulted in the major source of loss (Bolsinger 1988). In recent years, however, the process of population migration from urban areas to rural foothill locations and conversion of hardwood rangelands to suburban and industrial development have been the predominant source of loss and fragmentation of hardwood rangelands (Bolsinger 1988). *Figure 1* traces this evolution of program goals in 1986 to the broader landscape-based considerations that are in operation today.

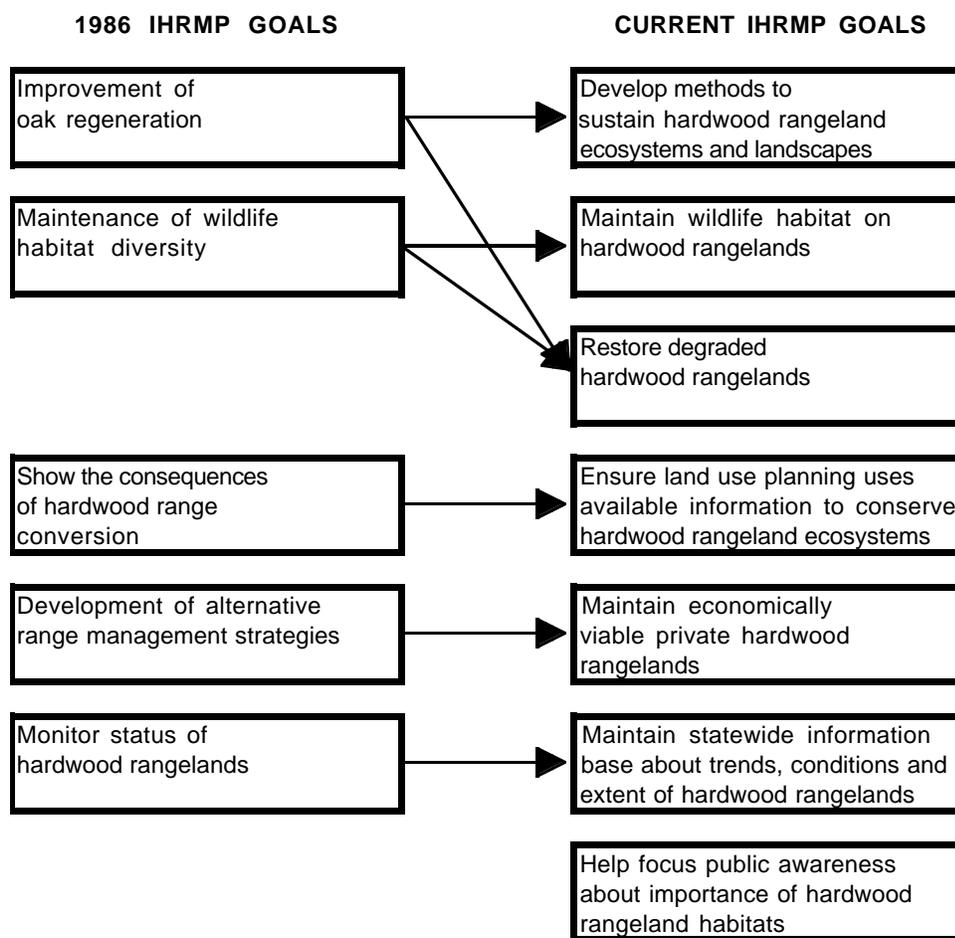


Figure 1—Evolution of IHRMP program goals.

The IHRMP has been administered as a collaborative effort between CDF, CDF&G, and UC. These organizations meet together at least quarterly for joint planning and priority setting. CDF has developed monitoring programs, UC has developed educational outreach programs, and CDF&G has had primary responsibility in assessing wildlife habitat values of the hardwood resource. UC and CDF jointly manage a competitive grants research program, ensuring that the highest priority problems are addressed, thereby eliminating duplication of effort. In recent years, the BOF has contracted with the California Oak Foundation (COF) to assist IHRMP efforts at urban public outreach and improve links with the development and planning communities. IHRMP effectiveness is monitored by contrasting current attitudes and management practices to baseline studies conducted early in the program. These surveys, combined with ecological monitoring, ensure program effectiveness and accountability.

Several criteria can be used to evaluate whether this coordinated educational and research approach to conservation of hardwood rangelands is successful. Each of these general criteria is considered in some detail in the sections below.

- Is new knowledge being developed?
- Are management practices that incorporate research-based knowledge being implemented by landowners and resource management professionals? Are management practices applied in such a way as to ensure sustainability of hardwood rangeland habitats?
- Are the trends of hardwood rangeland conversion being reversed? Are large-scale conversions due to range improvement, firewood harvest, and agricultural development reduced to a non-significant level? Does urban development maintain the ecological integrity of hardwood rangeland open space?
- Do conservation policies recognize the knowledge base on hardwood rangelands? Is the objective of these policies to sustain the ecological values of hardwood rangelands in an area?

Development of New Knowledge

Through UC and CDF funding, the IHRMP has funded 66 research studies over 10 years, which in turn has stimulated additional research on various aspects of hardwood rangelands. Specific areas investigated with IHRMP funding include: oak regeneration (20 projects); wildlife habitat (11 projects); soil, water, and land use issues (10 projects); hardwood rangeland management strategies (10 projects); and monitoring trends and status of hardwood rangelands (15 projects). This research has been conducted by investigators at various UC, California State University, and private university campuses, as well as at private research and consulting firms.

These research studies, resulting in more than 150 new scientific articles, contribute to the understanding of the extent of ecological and managerial processes on hardwood rangelands (IHRMP 1992). Research results have been disseminated in IHRMP-sponsored symposia and workshops and incorporated directly into educational documents and newsletters.

Research in oak regeneration has resulted in a better understanding of the ecological processes of natural regeneration (Gordon and others 1989; Swiecki and Bernhardt 1993). The high probability of achieving stump sprouting reduces the concern that a lack of sapling trees once suggested (McCreary and others 1991; Standiford and others 1996). Practical techniques for artificial regeneration have been developed, and oak seedlings are now widely available commercially (McCreary 1991). Genetic studies, underway to develop recommendations on

oak seed sources for restoration projects, have shown large within-population variability (Riggs 1990). A new study has been started to evaluate the effects of hardwood rangeland fragmentation on the genetic diversity of oak species.

Studies on hardwood rangeland ecology have resulted in development of an ecologically based classification system (Allen and others 1991). IHRMP research has shown that extensively managed blue oak stands in wide areas of California have been quite stable over 60 years in the absence of land use changes (Davis 1995; Holzman and Allen-Diaz 1991). Pollen analysis of cores taken on hardwood rangelands suggests that current oak density on hardwood rangelands may be higher than at any time over the past several thousand years, possibly because of fire exclusion (Byrne and Mensing 1991). The importance of oaks for nutrient cycling on rangelands has been demonstrated (Dahlgren and Singer 1994; Firestone 1995; Frost and Edinger 1991). It has also been shown in one regional study that removal of up to one-third of the oak canopy has little effect on water quality and yield (Epifanio and others 1991).

Research on sustainable management practices has shown that diversifying enterprises on hardwood rangelands reduces risk and the need for oak clearing to offset livestock market fluctuations (Standiford and Howitt 1993). Recreational hunting programs provide an oak conservation incentive, and can increase ranch net present value by 30 to 50 percent (Loomis and Fitzhugh 1989; Standiford and Howitt 1993). Seasonal grazing practices have been developed to reduce moisture competition to oak seedlings (Hall and others 1992). Relationships between forage growth and oak overstory have been described for various regional locations (Bartolome and McClaren 1992; Frost and McDougald 1989). Combined with earlier studies (Holland 1980; Kay 1987), this relationship has helped to clarify when oak canopy enhances or suppresses forage production, and has resulted in the development of regionally based oak retention standards (Standiford and Tinnin 1996).

Hardwood rangeland wildlife studies have shown the value of different habitats for a variety of wildlife species, and models of habitat value have been developed and refined (Block and others 1990; Wilson and others 1991). Riparian zones in hardwood rangelands have been shown to be a particularly rich source of biological diversity (Tietje and others 1991). The effects of urbanization and fragmentation on wildlife habitat have been documented (Scott 1995).

Incorporating Knowledge into Management Activities

An important aspect of the development of educational programs is to characterize the demographics of the various audiences that have an impact on hardwood rangelands (Day 1987; Huntsinger and Fortmann 1990; McClaran and Bartolome 1985; Pillsbury and Oxford 1987; Whittington and Tietje 1993; Wright and Preister 1986). *Table 1* shows the wide variety of educational programs developed for the diverse audiences affecting hardwood rangelands.

A number of different surveys were implemented to evaluate the effectiveness of these various educational programs. A survey comparing participants in the IHRMP educational program to the population at large showed that ranchers, resource managers, conservation groups, and consultants, though diverse, have a strong set of shared values (Stewart 1991). Natural beauty and maintenance of wildlife diversity were the two most important values of hardwood rangelands to all audiences surveyed. Cooperative Extension (CE) has had some contact regarding oak woodland issues with 49 percent of the ranchers in California, and 69 percent of the resource managers. Of those who attended various IHRMP educational workshops, 74 percent of the ranchers and 70 percent

of the resource managers have had some follow-up discussions with CE about oaks. Individuals who participated in IHRMP educational programs were more likely to carry out oak-enhancing management activities than non-participants.

Table 1—IHRMP educational methods addressed to various audiences

Educational methods	Audience addressed							
	Ranchers	Resource managers	Planners	Govt. officials	Devel- opers	Home- owners	Youth	Public
Workshops	X	X	X	X	X	X		
Field days	X	X				X		X
Symposia		X	X		X			
Organization in-service		X	X					
Consultation	X	X	X	X	X	X		
Associations/ groups	X	X	X	X	X	X	X	X
Volunteers						X	X	
Publications	X	X	X	X	X	X	X	X
Newsletters	X	X	X	X	X			
News releases	X					X		X
Direct mailing	X	X	X	X				
Audio-visual	X	X				X	X	X
Curriculum							X	

The attitudes and management practices of hardwood rangeland owners were evaluated in 1985, just prior to the intensive educational outreach of the IHRMP (Huntsinger and Fortmann 1990). This same survey was repeated in 1992 to discern trends that resulted from the expanded educational programs (Huntsinger 1992). This follow-up research showed that education must be an ongoing process because at least 18 percent of hardwood rangeland properties had been sold in the 7-year period. The survey grouped owners into three categories: small (fewer than 200 acres); medium (200-5,000 acres); and large (more than 5,000 acres). In the 7 years between surveys, the only major change in demographics was that, in the small ownership class, average income increased dramatically and average parcel size decreased by 50 percent. This reflects exurban migration patterns into hardwood rangelands. Livestock grazing was still the dominant hardwood rangeland use after 7 years, occurring on 67 percent of all acres. The percentage of owners of large parcels who rely on livestock grazing as their major source of income declined from 70 percent in 1985 to 50 percent in 1992. Following the 7-year period of intensive educational outreach, oaks were more valued for wildlife habitat, soil protection, enhancement of property values, and for browse and mast production. The number of owners of large parcels selling firewood decreased from 40 percent in 1985 to 23 percent in 1992. The number of landowners of large parcels who cut living trees for forage enhancement declined from 58 percent in 1985 to 38 percent in the 7-year period. During this same time, the number of owners who conducted wildlife habitat improvements increased from 56 percent of the owners of large parcels to 64 percent. The surveys showed that owners who value oaks for wildlife, erosion control, and beauty were more likely to undertake oak promoting activities (protect sprouts, maintain fixed oak canopy levels, thin softwoods to promote oak growth, plant oaks). Owners who received advice from CE or other public advisory services were more likely to carry out oak-promoting practices. Strong attitudes against regulation of hardwood rangelands continued in the majority of all ownership classes.

Trends in Hardwood Rangelands

CDF has assumed responsibility in the IHRMP for monitoring changes in the availability and condition of hardwood rangelands. This included an effort to detect long-term changes on hardwood rangelands based on periodic statewide mapping. A baseline map was developed from aerial photos taken in 1981 and distributed to all county planning departments in California (Greenwood and others 1993; Pillsbury and others 1991). These maps are also available in digital format from the Teale Data Center in Sacramento. A second mapping project was completed in 1994 based on Landsat imagery (Pacific Meridian Resources 1994). This project showed errors of omission in the original mapping effort based on aerial photography. Ground checks of both the aerial photographs and remote sensing of satellite imagery showed underestimates of stand level canopy cover.

The USDA Forest Service Pacific Northwest Research Station has responsibility for regular inventory and assessment of hardwood rangelands in California. The first-ever statewide inventory was conducted in 1985 (Bolsinger 1988). These areas were resurveyed by field crews in 1994, and final reports are due in 1996. This inventory effort will provide the first detailed assessment of changes in stand structure over a 10-year period, form the basis for long-term evaluations of hardwood rangeland stands, and guide future education, research and policy efforts.

There has been no historical assessment of the acreage and volume of firewood harvested on hardwood rangelands. Annual reports of oak firewood harvest are made to the State Board of Equalization Timber Tax Division as the basis for yield tax payments; however, these reports may severely underestimate the extent of harvest on hardwood rangelands. To address the impact of firewood harvest on hardwood rangelands, CDF personnel monitored firewood harvesting annually by air from 1988 through 1992. Surveyors estimated acreage, intensity, and location of harvest sites on most of California's hardwood rangeland acreage. Approximately 27,000 acres had some firewood harvest in this 4-year period, yielding approximately 314,000 cords of firewood (Standiford and others 1996). There was a general downward trend in both acreage and volume harvested, consistent with the trends detected in the sociological survey (Huntsinger 1992). The harvest survey indicated that 0.1 percent of the total hardwood rangeland acreage was harvested annually. Although this is insignificant on a statewide basis, the survey showed that canopy retention after harvest was less than the recommendations in IHRMP and CDF&G educational materials in 96 of 120 areas observed in this 4-year period (Giusti and Tinnin 1993; Passof and others 1985).

The aerial monitoring showed significant regional impacts from firewood harvesting in Shasta and Tehama counties. Although they have less than 10 percent of California's hardwood rangeland, 50 percent of the total cords were harvested in these two counties (Standiford and others 1996). Harvest in these counties exceeded tree growth by about 10 percent over this 4-year period. This indicates that these harvest levels were not sustainable, and volume and canopy cover would gradually decline should this trend continue. These trend data were utilized by local decision-makers to develop local hardwood rangeland policies (see next section). No other counties had this harvest intensity, leading to the conclusion that firewood harvest was significant only in the northern Sacramento Valley region.

The assessment of California's hardwood rangelands by the Pacific Northwest Research Station showed that conversion of hardwood rangelands to urban uses was the largest single source of loss over the past decade (Bolsinger 1988). Given this trend, several efforts are underway to assess the extent of urbanization and to monitor the effect of hardwood rangeland fragmentation.

The CDF Strategic Planning unit evaluated various residential build-out scenarios in the Central Sierra Nevada region and showed a high probability of large-scale habitat change with the current county general plan in several areas (Doak 1989). CDF also spearheaded a project, known as the Sustainable Landscapes Project, in the Central Coast and Northern Sacramento Valley. This project was designed to assess the current landscape patterns and land use of hardwood rangelands, evaluate what patterns of landscape were necessary to sustain hardwood rangeland values into the future, and show how various land use alternatives affect this goal of landscape sustainability (Greenwood 1995). Several CE regional offices of the IHRMP are in various stages of setting up local information centers to assist in monitoring hardwood rangeland habitat and land use change. This effort has been closely coordinated with various bioregional planning groups.

Local Policy Initiatives

In May 1993, the Board of Forestry held hearings on hardwoods to evaluate the effectiveness of research and education as an approach to hardwood rangeland conservation. These hearings showed that there was strong support for the continuation of research, outreach, and monitoring, and that the kinds of threats facing hardwood rangelands vary greatly throughout California. Firewood harvesting was recognized as a concern in the northern Sacramento Valley, conversion to subdivisions was important in the central Sierra Nevada and southern California, and conversion to intensive agriculture was an issue in the North Coast. These findings confirmed that statewide regulations would not be able to effectively address the wide diversity of conservation issues. The BOF decided to intensify its outreach to local governments and encourage their participation in local policy development with the assistance of the IHRMP. Following a period of outreach, the Board will evaluate progress by local governments in providing policies which protect hardwood rangelands and determine where statewide policies might be needed to address continuing problems.

The IHRMP, consistent with the BOF resolution, has worked closely with local governments to encourage the development of local policies to conserve hardwood rangelands. At this time, 37 counties have adopted, or are in the process of developing, local oak conservation strategies. The different approaches fall into three general categories: voluntary guidelines, general planning process, and local ordinances. Each of these is discussed below.

County Voluntary Guidelines

At the 1993 BOF Hardwood Hearings, political and agricultural leaders from Tehama County volunteered to initiate a broad-based effort to address concerns about extensive firewood harvest in their area. This resulted in the appointment of a county oak committee composed of various resource agencies, environmental groups, agricultural groups, and CE. They developed a set of voluntary guidelines for oak retention designed to maintain economic viability of grazing and ecological values. This set of guidelines was passed by the county Board of Supervisors and mailed to all landowners in the county (Gaertner 1995). The success of this pilot project encouraged several other counties to develop voluntary guidelines. There are currently 12 counties in various stages of developing voluntary guidelines. The leadership for drafting guidelines varied in different areas of the State. Some were facilitated by the local chapter of the California Cattleman's Association, the County Board of Supervisors, the County Planning Department, or the Resource Conservation District. Each effort addresses important local issues and includes education and monitoring. For

example, several of the voluntary guidelines in the northern Sacramento Valley addressed impacts from firewood harvest, whereas biomass harvest, fire protection, and soil erosion were important issues addressed in guidelines for the southern Sierra Nevada. Most of the guidelines also have general recommendations on urban development patterns.

General Planning Process

The county General Plan sets policies governing land use. The California Oak Foundation, working with the BOF, put together sample language on the importance of oak woodlands for the General Plan and mailed this to all county planning departments. Pilot educational activities have started in several Central Coast counties to utilize overlays of the CDF hardwood maps and parcel maps to implement landscape-based oak conservation strategies in the county planning process (Tietje and Berlund 1995). A Bay Area county compiled all existing oak policies for the county into a general booklet to be used for review of specific project plans which impact oak woodlands and to suggest mitigations. Another project between the county CE office and the planning department reports on the state of knowledge about riparian hardwoods in the county and develops project guidelines to implement the General Plan policy to protect and restore hardwood riparian habitats. In southern California, the IHRMP has worked closely with three county planning offices and Boards of Supervisors in the design of a corridor system to minimize the effects of habitat fragmentation. General regional and county-wide habitat conservation plans (HCP) have been coordinated with the goals of the IHRMP in southern California.

Ordinances

Some areas have used ordinances as a mechanism to protect oaks. Ordinances create a regulatory environment at the county or city level and usually involve a permitting process for the removal of any tree over a certain size class and mitigation standards where tree removal is allowed. Most tree ordinances have focused on the single tree rather than at a broad habitat scale. CDF has developed an educational book on ordinances which describes the importance of setting objectives for an area before writing an ordinance and monitoring whether the objectives have been accomplished (Bernhardt and Swiecki 1991). This book has been distributed to all counties in California. At this time, 11 counties have ordinances designed to protect oak trees.

Conclusion

Table 2 summarizes some of the important accomplishments of the IHRMP, current trends, and possible future considerations. Important information has been developed on the ecology and sustainable management of hardwood rangelands through activities of the IHRMP. Sociological and biological monitoring shows that diverse audiences have accepted and acted on information provided by IHRMP programs. A large number of counties have started the process of adopting local conservation strategies to conserve hardwood rangelands. It is quite clear that education and research have played a major role in conserving hardwood rangelands. Major accomplishments have been made in the more rural areas of California, where livestock and natural resource management are the predominant land use. Where individual landowners have the ability to implement management activities that affect large acreages, education and research have contributed to decisions that favor conservation of oaks.

However, the IHRMP activities have also shown that, for much of California, conversion of hardwood rangelands to urban or suburban land use is having the

Table 2—General overview of Integrated Hardwood Range Management Program accomplishments and future plans

Problem Area	Information Developed	Current Policy/Outreach	Trends	Future Considerations
Methods to sustain hardwood rangeland ecosystems and landscapes	<ul style="list-style-type: none"> • Ecology of natural regeneration • Ecological processes described • Oak genetic architecture 	<ul style="list-style-type: none"> • Cost-share programs • Local groups develop landscape goals • Education to landowner groups 	<ul style="list-style-type: none"> • Range watershed management plans • Stable stands over 60 years • Sapling recruitment gaps 	<ul style="list-style-type: none"> • Expand cost-share participation • Develop landscape goals • Coord. with fire planning
Maintenance of wildlife habitat on hardwood rangelands	<ul style="list-style-type: none"> • Models of wildlife habitat relationships • Popular publications developed • Values of habitat components 	<ul style="list-style-type: none"> • Oak retention guidelines • Develop local habitat goals • Wildlife habitat relationships (WHR) for general use 	<ul style="list-style-type: none"> • Habitat fragmentation, from development • More wildlife consideration by landowners • Higher hunting values • Cumulative effects of previous conversions 	<ul style="list-style-type: none"> • Evaluate retention guidelines • Develop landscape habitat goals • Refine WHR • Coordinated resource management process
Restore degraded hardwood rangelands	<ul style="list-style-type: none"> • Artificial oak regeneration techniques 	<ul style="list-style-type: none"> • Outreach to restoration and nursery community • Develop community planting events 	<ul style="list-style-type: none"> • 1 million seedlings yearly • Restoration professionals • Mitigation requires restoration 	<ul style="list-style-type: none"> • Develop tree spacing goals • Low cost regeneration techniques • Restoration of native grasses and brush
Ensure that land use planning uses available information to hardwood rangeland ecosystems	<ul style="list-style-type: none"> • Effects of conversion on wildlife habitat • Open space conservation tools • <i>Planners Guide</i> publication • <i>Quercus</i> newsletter 	<ul style="list-style-type: none"> • Input on local policies • Use taxation (Williamson Act, etc.) • Public acquisition funds • Tax incentives for conservation easements • Education for planners • Utilize General Plans for conservation goals 	<ul style="list-style-type: none"> • 11 county tree ordinances • Residential development major impact • High population growth on hardwood rangelands • Land trusts as receivers for open space 	<ul style="list-style-type: none"> • State-mandated tree ordinances • Oak conservation element in General Plan • Conversion permits • Coordinate Firesafe planning and oak conservation • Develop local oak land use goals
Maintain economically viable hardwood rangelands	<ul style="list-style-type: none"> • Sustainable management publications • Grazing strategies for oak regeneration • Relationship of oaks and forage production • Conservation incentives of diversified enterprises 	<ul style="list-style-type: none"> • Local workshops for landowners, managers • Ranching for Wildlife • Monitoring by resource professionals • Work with associations • New markets for environmental products 	<ul style="list-style-type: none"> • Decrease in large-scale firewood harvest • Localized impacts of firewood harvest • Decrease in landowner reliance on livestock as sole income source 	<ul style="list-style-type: none"> • Expand participation in cost-share programs • Declare hardwoods commercial under Forest Practice Act • Develop sustainable landscape goals • Coordinate with range water quality planning • Certify management practices
Maintain statewide information base on hardwood rangelands	<ul style="list-style-type: none"> • GIS developed • Aerial harvest monitoring • Effective monitoring methods developed • Satellite imagery and change detection 	<ul style="list-style-type: none"> • Hardwood maps available to counties • Coord. mapping with conservation groups • Coordination between state/local databases 	<ul style="list-style-type: none"> • Increasing local use of GIS technology • Remote sensing may simplify monitoring 	<ul style="list-style-type: none"> • Update geographic information system • Support regional landscape projects • Multi-agency monitoring effort • Continue aerial harvest observations • Notification of harvest

continued

Table 2, continued

Help focus public awareness about importance of hardwood rangelands	<ul style="list-style-type: none"> • Youth education curriculum on hardwood rangelands • Urban attitudes study 	<ul style="list-style-type: none"> • News releases • Work with schools, 4-H, youth groups • Radio public service announcements • Coordinate with Calif. Oak Foundation 	<ul style="list-style-type: none"> • Increasingly urban population • Environmental attitudes by urban populace • Poor understanding of private stewardship 	<ul style="list-style-type: none"> • Expand media advertisement • Ties between urban and rural • General tax to internalize public values
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largest impact on sustainability of resource values. The IHRMP has initiated education and research activities to address this concern. Growth in the application of geographic information system (GIS) technology and availability of oak resource data layers should help local planners and developers to assess impacts on oak woodland values. Educational materials developed for this issue have been widely accepted by professionals working in the land use arena. However, success will be demonstrated only by a significant effect on the rate or pattern of development. Conversion to residential and industrial uses is a land use decision that is determined through a political process involving action by elected officials with input from different constituencies. Political and economic forces vary greatly across California, and "success" in land use decision-making involves individuals agreeing on a political course of action. Conserving hardwood rangeland values in this kind of decision-making environment will present a new and important challenge for a research and education strategy. Program effectiveness must be evaluated very carefully over the next several years to determine whether education and research alone are sufficient to sustain the ecological values of hardwood rangelands.

References

- Allen, B.H.; Holzman, B.A.; Evett, R.R. 1991. **A classification system for California's hardwood rangelands**. *Hilgardia* 59(2): 1-45.
- Bartolome, J.W.; McClaren, M.P. 1992. **Composition and productivity of California oak savanna seasonally grazed by sheep**. *Journal of Range Management* 45: 103-107.
- Bernhardt, E.A.; Swiecki, T.J. 1991. **Guidelines for developing and evaluating tree ordinances**. Report to California Dept. of Forestry and Fire Protection Urban Forestry Program; 76 p.
- Block, W.M.; Morrison, M.L.; Verner, J. 1990. **Wildlife and oak woodland interdependence**. *Fremontia* 18: 72-76.
- Board of Forestry Staff. 1986. **Policy options for California's hardwoods**. Report to State Board of Forestry. Sacramento, CA.
- Bolsinger, Charles L. 1988. **The hardwoods of California's timberlands, woodlands, and savannas**. Resour. Bull. PNW-RB-148. Portland, OR: Pacific Northwest Research Station, Forest Service, U.S. Department of Agriculture; 148 p.
- Byrne, R.; Edlund, E.; Mensing, S. 1991. **Holocene changes in the distribution and abundance of oaks**. In: Standiford, Richard B., technical coordinator. Proceedings of the symposium on oak woodlands and hardwood rangeland management; October 31 - November 2, 1990; Davis, CA. Gen. Tech. Rep. PSW-126. Berkeley, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 182-188.
- Dahlgren, R.A.; Singer, M.J. 1994. **Nutrient cycling in managed and non-managed oak woodland ecosystems**. Land, Air and Water Res. Paper 100028. Davis, CA: Univ. of Calif.; 91 p.
- Davis, F.W. 1995. **Vegetation change in blue oak and blue oak/foothill pine woodland**. Report to California Department of Forestry and Fire Protection. Contract 8CA06673. Sacramento, CA: California Department of Forestry and Fire Protection; 34 p.
- Day, N. 1987. **Study of urban attitudes towards oak trees**. Report by Polaris to the California Dept. of Forestry and Fire Protection. Sacramento, CA: California Department of Forestry and Fire Protection.

- Doak, S.C. 1989. **Modeling patterns of land use and ownership.** Final report to California Department of Forestry and Fire Protection. Contract no. 8CA63967. Sacramento, CA: California Department of Forestry and Fire Protection.
- Epifanio, C.R.; Singer, M.J.; Huang, X. 1991. **Hydrologic impacts of oak harvesting and evaluation of the modified universal soil loss equation.** In: Standiford, Richard B., technical coordinator. Proceedings of the symposium on oak woodlands and hardwood rangeland management; October 31 - November 2, 1990; Davis, CA. Gen. Tech. Rep. PSW-126. Berkeley, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 221-224.
- Firestone, M.K. 1995. **Nutrient cycling in managed oak woodland-grass ecosystem.** Final report to the Integrated Hardwood Range Management Program. Berkeley, CA: University of California; 56 p.
- Frost, W.E.; Edinger; S.B. 1991. **Effects of tree canopies on soils characteristics of annual rangeland.** Journal of Range Management 44: 286-288.
- Frost, W.E.; McDougald; N.K. 1989. **Tree canopy effect on herbaceous production of annual rangeland during drought.** Journal of Range Management 42: 281-283.
- Gaertner, S. 1995. **Local action to conserve California's oak woodlands.** In: Newsletter of Integrated Hardwood Range Management Program. Quercus 3(1): 1-7.
- Giusti, G.A.; Tinnin P.J. 1993. **A planner's guide for oak woodlands.** Publication of the Integrated Hardwood Range Management Program, Univ. of Calif., Berkeley, 104 p.
- Gordon, D.R.; Welker, J.M.; Menke, J.W.; Rice, K.J. 1989. **Competition for soil water between annual plants and blue oak seedlings.** Oecologia 79(4): 533-541.
- Greenwood, B., ed. 1995. **The Central Coast sustainable landscapes project.** A report by the participants of the Central Coast sustainable landscapes project to the California Dept. of Forestry and Fire Protection. Sacramento, CA: California Department of Forestry and Fire Protection.
- Greenwood, G.B.; Marose, R.K.; Stenback, J.M. 1993. **Extent and ownership of California's hardwood rangelands.** Prepared for Strategic Planning Program, California Dept. of Forestry and Fire Protection. Unpublished report.
- Hall, L.M.; George, M.R.; McCreary, D.D.; Adams, T.E. 1992. **Effects of cattle grazing on blue oak seedling damage and survival.** Journal of Range Management 45(5): 503-506.
- Holland, V.L. 1980. **Effect of blue oak on rangeland forage production in central California.** In: Plumb, Timothy, technical coordinator. Proceedings of the symposium on the ecology, management and utilization of California oaks. Gen. Tech. Rep. PSW-44. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 314-318.
- Holzman, B.A.; Allen-Diaz, B.H. 1991. **Vegetation change in blue oak woodlands in California.** In: Standiford, Richard B., technical coordinator. Proceedings of the symposium on oak woodlands and hardwood rangeland management; October 31 - November 2, 1990; Davis, CA. Gen. Tech. Rep. PSW-126. Berkeley, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 189-193.
- Huntsinger, L. 1992. **Impacts of education: Preliminary results of a follow-up survey.** In: Integrated Hardwood Range Management Program Fifth Progress Report. Berkeley, CA: University of California, Berkeley; 19-27.
- Huntsinger, L.; Fortmann; L.P. 1990. **California's privately owned oak woodlands: owners, use, and management.** Journal of Range Management 42(3): 147-152.
- IHRMP. 1988. **Integrated hardwood range management program: First progress report.** Berkeley, CA. 25 p.
- IHRMP. 1992. **Integrated hardwood range management program: Fifth progress report.** Berkeley, CA. 47 p.
- Kay, B.L. 1987. **Long-term effects of blue oak removal on forage production, forage quality, soil and oak regeneration.** In: Plumb, Timothy R.; Pillsbury, Norman H., technical coordinators. Proceedings of the symposium on multiple-use management of California's hardwood resources. Gen. Tech. Rep. PSW-GTR-100. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 351-357.
- Loomis, J.B.; Fitzhugh, E.L. 1989. **Financial returns to California landowners for providing hunting access: analysis and determinants of returns and implications to wildlife management.** Trans. 54th North American Wildlife and Nat. Res. Conf. 54: 196-201.
- Mayer, K.E.; Passof, P.C.; Bolsinger, C.; Grenfell, W.W.; Slack, H. 1985. **Status of the hardwood resource of California: a report to the Board of Forestry.** Sacramento: California Dept. of Forestry and Fire Protection; 126 p.
- McClaran, M.P.; Bartolome, J.W. 1985. **The importance of oaks to ranchers in California foothill woodlands.** Rangelands 7: 158-161.
- McCreary, D.D. 1991. **Artificial regeneration of native oaks in California.** Conference Proceedings, 1991 Society of American Foresters Annual Meeting, August 4-7, San Francisco, CA. Bethesda, MD: Society of American Foresters.

- McCreary, D.D.; Tietje, W.D.; Schmidt, R.H.; Gross, R.; Willoughby, W.H.; Weitkamp, B.L.; Bell, F.L. 1991. **Stump sprouting of blue oaks**. In: Standiford, Richard B., technical coordinator. Proceedings of the symposium on oak woodlands and hardwood rangeland management; October 31 - November 2, 1990; Davis, CA. Gen. Tech. Rep. PSW-126. Berkeley, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 64-69.
- Muick, P.C.; Bartolome, J.W. 1985. **Research studies in California related to oaks**. University of California Wildland Resources Center Report No. 7; 37 p.
- Pacific Meridian Resources. 1994. **California hardwood rangeland monitoring final report**. Prepared for Strategic Planning Program, California Dept. of Forestry and Fire Protection. Unpublished report.
- Passof, P.C.; Bartolome, J.W. 1985. **An integrated hardwood range management program**. University of California Wildland Resources Center Report No. 6; 18 p.
- Passof, P.C.; Clawson, W.C.; Fitzhugh, E.L. 1985. **Preliminary guidelines for managing California's hardwood rangelands**. Univ. of Calif. Div. of Agric. and Nat. Res. Leaflet 21413; 92 p.
- Pillsbury, N.H., chair. 1983. **California's hardwood resource**. Preliminary report of the Hardwood Task Force. State Board of Forestry, Sacramento, CA; 67 p.
- Pillsbury, N.H.; DeLasaux, M.J.; Pryor, R.D.; Bremer, W. 1991. **Mapping and GIS database development for California's hardwood resources**. Report to California Dept. of Forestry and Fire Protection Strategic Planning Program. Contract no. 8CA63963; 63 p.
- Pillsbury, N.H.; Oxford, J.K. 1987. **The hardwood management issue: county perceptions of use, change, problems, and regulation**. In: Plumb, Timothy R.; Pillsbury, Norman H., technical coordinators. Proceedings of the symposium on multiple-use management of California's hardwood resources. Gen. Tech. Rep. PSW- GTR-100. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 404-410.
- Riggs, L.A. 1990. **Conserving genetic resources on-site in forest ecosystems**. Forest Ecology and Management 35(1): 45-68.
- Scott, T.A. 1995. **Initial effects of housing construction on birds in an oak woodland along the wildland urban interface**. In: Proc. Symp. The Wildland Urban Interface. Occasional Papers of the Southern California Academy of Sciences.
- Standiford, R.B.; Howitt, R.E. 1993. **Multiple use management of California's hardwood rangelands**. Journal of Range Management 46: 176-181.
- Standiford, R.B.; McCreary, D.; Gaertner, S.; Forero, L. 1996. **Impact of firewood harvesting on hardwood rangelands varies with region**. California Agriculture 50(2): 7-12.
- Standiford, R.B.; Tinnin, P., technical coordinators. 1996. **Guidelines for managing California's hardwood rangelands**. University of California Division of Agriculture and Natural Resources Leaflet no. 3368; 180 p.
- Stewart, W. 1991. **Monitoring values and practices of oak woodland decision makers on the urban fringe**. In: Standiford, Richard B., technical coordinator. Proceedings of the symposium on oak woodlands and hardwood rangeland management; October 31 - November 2, 1990; Davis, CA. Gen. Tech. Rep. PSW-126. Berkeley, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 174-181.
- Swiecki, T.J.; Bernhardt, E.A. 1993. **Factors affecting blue oak sapling recruitment and regeneration**. Report to California Dept. of Forestry and Fire Protection Strategic Planning Program. Contract no, 8CA17358.
- Tietje, W.D.; Barrett, R.H.; Kleinfelder, E.B.; Carre, B.T. 1991. **Wildlife diversity in valley-foothill riparian habitat: north central versus central coast California**. In: Standiford, Richard B., technical coordinator. Proceedings of the symposium on oak woodlands and hardwood rangeland management; October 31 - November 2, 1990; Davis, CA. Gen. Tech. Rep. PSW-126. Berkeley, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 120-125.
- Tietje, W.D.; Berlund, T. 1995. **Land-use planning in oak woodland**. In Newsletter of Integrated Hardwood Range Management Program. Quercus 3(2): 1-9.
- Whittington, J.; Tietje, W.D. 1993. **Oak management in California municipalities**. California Agriculture 46(2) 20-23.
- Wilson, R.A.; Manley, P.; Noon, B.R. 1991. **Covariance patterns among birds and vegetation in a California oak woodland**. In: Standiford, Richard B., technical coordinator. Proceedings of the symposium on oak woodlands and hardwood rangeland management; October 31 - November 2, 1990; Davis, CA. Gen. Tech. Rep. PSW-126. Berkeley, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 126-135.
- Wright, J.; Preister, K. 1986. **Steaks and stakes: extension's linkages on the hardwood range**. Report to the Integrated Hardwood Range Management Program; 42 p.

