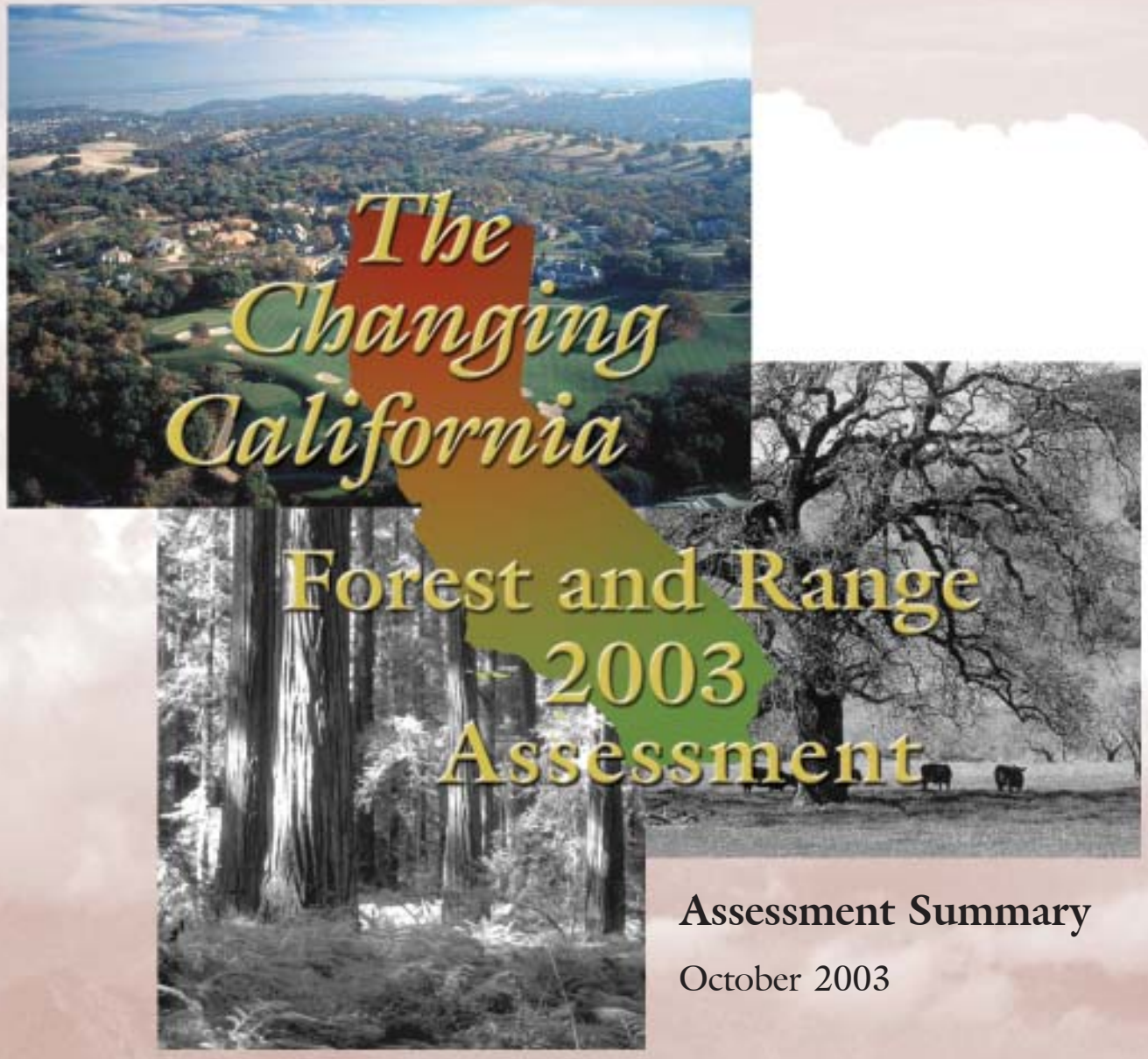

Assessment Summary

October 2003

On-line 2003 Assessment
http://www.frap.cdf.ca.gov/assessment2003

The California Department of Forestry and Fire Protection's (CDF) Fire and Resource Assessment Program (FRAP) was established under the Forest and Rangeland Resources Assessment and Policy Act of 1977. FRAP provides forest and range resource assessment, fire protection planning and analysis, and support for CDF's strategic decision making.

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For additional Forest and Range 2003 Assessment information, visit the FRAP web site at http://www.frap.cdf.ca.gov/assessment2003

PRODUCED BY:

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The Changing California: Forest and Range 2003 Assessment

Assessment Summary

October 2003

State of California
The Resources Agency
Department of Forestry and Fire Protection
Fire and Resource Assessment Program

Messages

Governor Gray Davis

California's environment is precious to us all. My administration has worked hard to craft an environmental policy built upon California's long–standing respect for our natural resources. The protection of our state's forests and rangelands is a top priority as we seek to improve our economic and social well being. The information provided by the Forest and Range 2003 Assessment will help promote the responsible management and preservation of our state's valuable forests and rangelands. Through such efforts, we will leave a priceless legacy for future generations.

Secretary for Resources Mary D. Nichols

The Davis administration has worked hard to improve and develop stewardship programs for California's working landscapes. This involves a variety of approaches including improved communication with landowners. It also requires up–to–date and comprehensive information about the current conditions, trends, and future risks to our forests and rangelands. The Forest and Rangeland 2003 Assessment provides this information, and is an important tool for state agencies to continue their efforts to develop stewardship programs for private landowners, along with the administration's many other programs and projects to protect and preserve our natural legacy.

Department of Forestry and Fire Protection Director Andrea E. Tuttle

The resource demands, ecological pressures, and social debates about California's forests and rangelands grow in proportion to our population and the complexity of our lives. This assessment offers a rich portrait of California's natural, economic, and social environment and presents a new, high level of data needed to better inform our decisions. This volume rests on a deep underpinning of primary data, maps, tables, and reports which are contained in the FRAP web pages. The California Department of Forestry and Fire Protection and our FRAP unit are proud to offer this comprehensive report to all of California's private and public stakeholders who participate in the decision making process and care deeply about our resources, social well being, and natural heritage.

Chairman of the California State Board of Forestry and Fire Protection Stan L. Dixon

By law, the California State Board of Forestry and Fire Protection has the responsibility to provide leadership in developing policies for California's forests and rangelands in partnership with other agencies, landowners, and the public. A primary goal of the Board is to articulate a path that can provide direction, resolve conflict, forge stronger working relationships, and attract the means necessary to ensure sustainability of forest and range resources. The Board's key research and analysis branch, the CDF Fire and Resource Assessment Program, is instrumental in providing the information for attainment of the Board's goals via "The Changing California: Forest and Range 2003 Assessment."

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Programs and Selected Reports from State Agencies and Office of the Governor with Emphasis on Natural Resource Conservation

The Forest and Range Assessment of 2003 is one of a series of programs and reports that bring a sophisticated perspective to the management of California's natural resources. These efforts of the Davis administration paint the portrait of California's current resource conditions and promote a vision of how this priceless legacy may be conserved and managed for the future.

California Department of Conservation

Division of Land Resource Protection, ***Farmland Monitoring and Mapping Program***

http://www.consrv.ca.gov/DLRP/fmmp/pubs/1998_2000/FMMP_1998-00_FCR.htm

The Farmland Mapping and Monitoring Program (FMMP) produces maps and statistical data used for analyzing impacts on California's agricultural resources.

California Department of Fish and Game

Habitat Conservation Planning Branch

http://www.dfg.ca.gov/hcpb

This group includes the Conservation Planning Program (including Natural Community Conservation Planning), CESA/CEQA Permitting Program, and the Species Conservation and Recovery Program.

Wildlife and Habitat Data Analysis Branch

http://www.dfg.ca.gov/whdab

This arm of DFG includes among other things the California Natural Diversity Database, California Wildlife Habitat Relationships information system, and the Vegetation Classification and Mapping Program.

Wildlife and Inland Fisheries Division

This division includes the Enforcement Branch, Fisheries Program Branch, and the Wildlife Programs Branch with programs focusing on Fish and Game regulations, management of the state's lands and facilities, as well as large mammal management programs.

California Department of Parks and Recreation

Planning Division, ***The State Park System Plan 2002; Part I: A System for the Future and Part II: Initiatives for Action***

http://www.parks.ca.gov/default.asp?page_id=797

This fundamental document contains goals, policies, objectives, and proposals for new programs and initiatives needed for the guidance of the State Park System over the course of the next decade.

California Department of Water Resources

Water Use and Planning, ***California Water Plan Update***

http://www.waterplan.water.ca.gov/b160/indexb160.html

The Department of Water Resources' California Water Plan Update 2003 (Bulletin 160–03) supports California's plan and strategy to meet the State's future water needs.

California Environmental Protection Agency

Office of Environmental Health Hazard Assessment, ***Environmental Protection Indicators for California***

http://www.oehha.ca.gov/multimedia/epic/index.html

The Environmental Protection Indicators for California (EPIC) Project was created to support a commitment to use measurable results in judging the effectiveness of the State's efforts directed at environmental protection.

State Water Resources Control Board, ***Total Maximum Daily Loads***

http://www.swrcb.ca.gov/tmdl/tmdl.html

The State Water Resources Control Board (SWRCB) and Regional Water Quality Control Boards have ongoing efforts to monitor and assess water quality and identify waters that do not meet water quality standards and prioritize waters/watersheds for total maximum daily loads (TMDL) development.

California Resources Agency

The California Legacy Project: a Resource Conservation Strategy

http://legacy.ca.gov

The California Legacy Project is a new initiative that involves a broad range of government agencies and citizen organizations working together to help make the important decisions about conserving and protecting California's many landscapes.

The California Environmental Resources Evaluation System (CERES)

http://ceres.ca.gov/index.html

CERES is an information system developed by the California Resources Agency to facilitate access to a variety of electronic data describing California's rich and diverse environments.

California Biodiversity Council

http://ceres.ca.gov/biodiv

The California Biodiversity Council (CBC) was formed in 1991 to improve coordination and cooperation between the various resource management and environmental protection organizations at federal, state, and local levels.

Joint Task Force on California Watershed Management, ***Addressing the Need to Protect California's Watersheds: Working with Local Partnerships***

http://resources.ca.gov/watershedtaskforce

The purpose of this report is to evaluate how effective voluntary, community-based, collaborative watershed efforts or partnerships are in contributing to the protection and enhancement of California's natural resources, and what the State can do to assist them.

Governor's Office of Planning and Research

Environmental Goals and Policy Report

http://www.opr.ca.gov/EnvGoals/EnvGoals.shtml

The Office of Planning and Research is in the process of developing a new state Environmental Goals and Policy Report containing a long-range overview of state growth and state environmental goals, including those directed to land use, population growth, and conservation of natural resources.

Wildlife Conservation Board

http://www.dfg.ca.gov/wcb

The Board administers land acquisition, public access, riparian, wetland, and oak woodland conservation and restoration programs.

Director's Foreword

Ask most Californians about our forests, and powerful images come to mind—redwood giants towering in the mist, sweet smelling pines in the afternoon sun. Forests mean more to us than trees—they also symbolize our need for wild places, for places where nature follows its own dynamics, for expanses where humans do not dominate. Even if we cannot visit wild areas ourselves, we want our forests to be there.

Our forests and rangelands also shape our image of rural California. They form the working landscapes that evoke simpler times of the past. Rangelands and forests have supported generations of Californians raising products from the land—cattle for market, wood that is renewable. On smaller ownerships, timber is a supplement to family income. On larger ownerships, commercial forests sustain whole economies of mill workers, foresters, tree planters, logging contractors, biologists, and a local tax base. When the mill closes and the land is sold, we lose not just the wood products it produces, but also a piece of our heritage.

Ask most Californians who owns the forests and you will find little clarity. National parks are confused with national forests, state parks are blurred with state forests, commercial and non-industrial timberlands are jumbled together, and the management goals of each are unclear. Ecological processes are often misunderstood as well. Tall forests cut and re-grown two or three times since the 1800s may now look untouched. Overstocked stands caused by decades of fire suppression are often perceived as natural. Fears that all old-growth is gone forget the millions of acres protected in parks and wilderness. Few realize that most water from our taps is connected to runoff from distant forests. Simplistic images of timber barons versus treesitters, and clearcuts versus watersheds may make catchy headlines, but Californians deserve more depth to the story.

California is blessed with some of the best soils and climate for growing trees in the world. Compared to the boreal forests of the north, our conifers grow fast and reproduce well. Unlike non-native monoculture plantations on other continents, California grows mixed stands of native species, even on our most intensely managed

Giant Sequoias on Case Mountain, Tulare County. Photo courtesy of Bureau of Land Management.

lands. Our forest species—the pines, the firs, the redwoods, and the hardwoods—can be sustained into the future if we respect their need for sunlight and space.

But the fate of our forestlands is at a crossroads. The threats of the past are not the same as today. In spite of debates that surround particular harvest plans, the harvest practices of today meet strong environmental standards. Managed forests throughout the state have started on a path of recovery—old roads are being relocated away from streams, culverts and crossings repaired, more trees grown than cut, snags and structure

left for wildlife, and large wood is being left in streams to create pools for salmon. With time, sediment from past abuses is clearing out of streams and conditions are improving. Guided by better scientific understanding of watershed dynamics, land managers are already planning at large watershed scales and improving conditions on the ground.

Our focus on watersheds is important, but the conversation urgently needs to expand. While we debate particular management issues, the forest land base is slipping away. California currently grows by half a million new residents each year, who demand more water, recreation, wood products, jobs, open space, and places to live. The combined effects of international markets, increasing land prices, escalating regulatory costs and punitive rather than cooperative attitudes towards timber management are forcing landowners to re-examine their choices. From Santa Cruz to Mendocino, from Shasta to Mariposa, we see fragmentation of parcels and conversion of forest and ranchlands to other uses. This wave of development ripples even into Siskiyou and Humboldt. We need to raise our sights to the broader issue of sustaining the very land base we care about.

Starting the Conversation

This Forest and Range Assessment of 2003 presents an overview of the status and trends in our forests and rangelands to provide a broad factual basis for this discussion. We examine sustainability through the lenses of environmental, economic, and social conditions, with the belief that all can be improved without loss in another. By clarifying the challenges and opportunities, we can select the appropriate tools to move us forward. We use the language of the international Montréal Protocol to frame the analysis in a manner that ensures consistent national and international monitoring. We bring new attention to the issue of global climate change and its enormous implications for forest growth, carbon sequestration, and the distribution of forest ecosystems everywhere.

California has always taken pride in its uniqueness, but we also recognize our place in the larger global context. The decisions we make about sustainability here affect the rest of the globe, not just ourselves. If we choose to manage only for untouched forests, we risk exporting our demand for wood products to other regions with lower environmental standards, and weaken our own rural economies here. Our combination of federal, state and private land ownerships gives us many options for providing a vibrant range of values, services and products. With our strong environmental ethic and sense of obligation to our global responsibilities, Californians can set an example in finding the right mix of wise management and protection.

Blue oak woodland , Sierra foothills, Butte County. Jeff Gnass, photographer.

This overview of California's forests and rangelands provides a positive status report and lays out our challenges. We have the critical elements for problem solving already in place—a strong environmental ethic, well-developed economic and regulatory institutions, and respect for law. These advantages help us envision a landscape where we respect diverse ownerships and goals, and strive for cooperative solutions.

Between the covers of this volume you will find some of the most current information available on California's forests and rangelands. It is supported by a wealth of additional data on in-depth web pages. We hope this will provide a factual basis for the critical discussions we need.

California is blessed with a variety of forests, wildlife species, streams, open spaces, wood products and rural communities. We have landowners who want to manage their lands well. We have professional foresters, biologists, geologists, and other specialists to help advise. We have thoughtful leaders and constructive solution seekers. Our hope is that better understanding, greater trust, and wiser decisions will come from better information. We invite you into the richness of this forest story.

Andrea E. Tuttle

Andrea E. Tuttle, Director
California Department of Forestry and Fire Protection

Jackson Demonstration State Forest

Executive Summary

California's forests and rangelands are a vast and cherished part of the state's heritage and key to its future. These lands cover over 80 percent of the state and are set in the context of a largely urban population with distinct regional economies. These lands provide impressive biological diversity, scenic views, open space, wildlife habitat, recreation, timber, forage, and water. In recent decades, California's economy has grown, diversified, and become integrated into global trade and competition. At the same time, population, income, and mobility have increased, creating greater demands for the goods and services provided by shrinking forests and rangelands.

How is it possible to understand all of the various dimensions of these lands? What policies will lead to optimal use of forest and rangelands while at the same time ensuring their long-term sustainability? The California Department of Forestry and Fire Protection and its partners provide this assessment as the basis of information for a continuing dialog to answer these questions.

Maintaining forest and rangeland sustainability requires addressing environmental, economic, and social factors together.

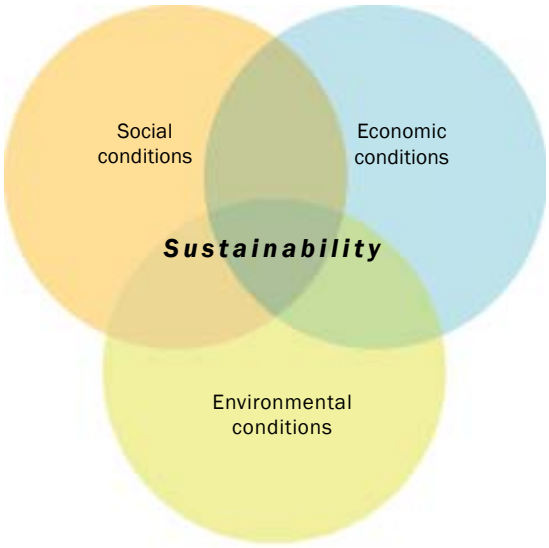
Assessment Content

The Forest and Range 2003 Assessment provides a systematic overview of the status, trends, and challenges to California's forest and rangeland resources. The Assessment is not a plan; it summarizes current knowledge, projects future conditions, and underscores potential problems and opportunities.

The Assessment comprises a comprehensive series of on-line technical reports on over 30 topics relevant to environmental, economic, and social conditions that are the foundation of resource sustainability (Figure 1). The Assessment flagship product, "The Changing California: Forest and Range 2003 Assessment," summarizes information from these technical reports. It focuses on status, trends, and factors affecting sustainability, while framing policy issues and options for consideration by the California State Board of Forestry and Fire Protection as well as other policy makers.

A number of information systems created by the Fire and Resource Assessment Program (FRAP) support the assessment analysis and provide rich information for further research, analysis, and dialogue. This information is available through the FRAP web site and includes Geographic Information System (GIS) data, maps, tabular databases, technical reports, and links to related external publications. All of these will be continually updated as new information and analyses become available.

Figure 1. Sustainability of forests and rangelands



Assessment Framework

FRAP incorporates all the mandated requirements of Public Resources Code 4789 and delivers it in a contemporary framework focused on measurements of sustainability. Fifteen years ago, sustainability was simply defined as "meeting the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland Commission Report, 1987). As many groups began to work on defining sustainability, it became clear that three very different sets of conditions or indicators—environmental, social, and economic—needed to be included (Figure 1). While the desire may be to have very positive indicators for all three themes, objective assessments document a range of current conditions as well as many potential approaches towards improving overall sustainability in the future. The value of an objective framework for sustainability is that it provides all stakeholders with valuable information for assessing future decisions and policies.

For this assessment, FRAP followed the Montréal Process framework that is a set of criteria and indicators used to measure sustainable forest management for non-tropical forests. It was designed under the auspices of the United Nations and is now used by the U.S. Forest Service, the state of Oregon, and a number of other entities (USFS RPA, 2002; ODF, 2003; USFS, 1997). The Montréal Process was the result of initial efforts by the 1992 United Nations Conference on Environment and Development and led to the 1994 formation of the Working Group on Criteria and Indicators for the Conservation and Sustainable Management of Temperate and Boreal Forests in Geneva (see page 30 for more on the Montréal Process).

The assessment indicators are organized around seven themes:

1) biological diversity
2) productive capacity
3) forest health
4) soil conservation and water quality
5) forests and climate change
6) socio-economic benefits
7) governance

California's Forests and Rangelands—A World of Change

In the 1990s, a number of factors altered the context of forest and rangeland issues. Continued population growth, environmental and regulatory costs, global competition, trade, and technology became even stronger forces. While Silicon Valley and Hollywood are the largest and most visible symbols of California's global role, the same forces driving global integration have an impact on the forest and rangeland regions of California. Local availability of natural resources is no longer the major source of competitive economic advantage for the State's forest and rangeland dominated regions. Technology, research and development, and new commodities that add value and adapt to distant markets now give the competitive edge.

California's first Forest and Rangeland Assessment in 1978 did not cover world or national trade trends in detail. The 2003 Assessment cannot avoid it. Markets, production, and investment decisions in the forest products and range livestock industry in California are influenced by global factors. Global production networks and information and trade flows are at the center of many of these influences.

There has been an increasing connection between world trade and environmental issues since World War II. In varying forms, the concept of "sustainability" has come to dominate both environmental and trade discussions. In the early 1990s, there was an upwelling of concern regarding global environmental degradation and the promotion of socio-economic development. Examples of global concerns have been deforestation, loss of biological diversity, climate change, and extinction of species. These concerns led to a series of international conferences and agreements whereby nations set out frameworks to deal with trade and environmental issues. In addition, an intricate interconnected network of governments, international agencies, non-government organizations (NGOs), and multinational businesses has evolved in support of sustainability and related programs.

Stout Grove, Jedediah Smith Redwoods State Park: G. Donald Bain, Geo–Images Project, UC Berkeley

At both the international and national level, the U.S. government has promoted agendas that pursue economic growth in the broader context of sustainable development, integrating economic, social, and environmental policies. Federal agencies have been mandated to pay more attention to ecological, wildlife and watershed considerations in their decision-making. NGOs, especially land trusts and foundations that have an interest in the environment, have grown substantially.

From a legal perspective, each state has also developed its own set of institutions and laws to manage forest and range issues. California's framework is a mix of historical and new approaches. New approaches and tools for managing forests and rangelands are strongly driven by the urban nature of California and its rapidly changing demographics.

Compared to a decade ago, there are hundreds of groups in California with an interest in forests and rangelands. These include landowner groups, watershed groups, restoration groups, land trusts, and fire safe councils. Networking and information sharing over the web are also extensive. A number of these collaborations have worked well while others have been more difficult. When federal or state agencies are required to be involved, new tensions are added to the existing differences among local stakeholders.

During the 1990s, there has been more emphasis on agency cooperation and greater public and multi-stakeholder involvement. Greater collaboration and cooperation has been attempted between all combinations of federal, state and local governmental agencies, the public, and Native American communities in California. This has not always been easy, as stakeholders are sometimes resistant to change and power sharing. Cooperation between federal agencies is often required by law, executive order, memorandum of understanding (MOU), or executive program, and is most successful when organized around common goals.

While Californians possess extremely diverse viewpoints concerning appropriate methods of forest and rangeland use and management, nearly all are supportive of conservation. This fact is reflected in the growth of land trusts during the last decade. Such trusts were created for a variety of protective purposes such as open space, farm and working forests, endangered species and habitat, and watersheds. According to the Land Trust Census, in 2000, California had 132 land trusts protecting 1.25 million acres. Applying national percentages of the proportion of farmland and rangeland trusts (46 percent) to California, between 500,000 and 600,000 acres of trusts are devoted to the protection of farmland and rangelands.

State conservancies also support land trusts. California has authorized seven State conservancies. Each is a subunit of the California Resources Agency. One goal of conservancies is to purchase and protect undeveloped lands that are threatened by development and develop appropriate management plans for their use. A strength of State conservancies is that they apply statewide resources to protect assets in a specific geographical area of high public value.

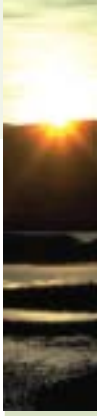
Emerging global changes in California's forests and rangelands include:

- **Competitive global setting**
- **Forestry from sustainability perspective**
- **Ever increasing public interest**
- **Adaptive governance structures**

While money originates from a wide variety of sources, funding for easements or other forms of land conservation usually stems from shared private, non–profit, and public resources. Landowners usually are compensated in the form of cash and/or tax credits for donating conservation easements. Proposition 40 (the California Clean Water, Clean Air, Safe Neighborhood Parks, and Coastal Protection Act of 2002) was passed by 57 percent of the voters in March 2002, despite a recession, and is providing $445 million in funding for these conservancies over five years.

In this context—a competitive global setting, forestry from a sustainability perspective, ever increasing public interest, and emerging adaptive governance structures—the Forest and Range 2003 Assessment is presented.

Old stage road through Sequoia grove, Yosemite National Park: G. Donald Bain



Two Decades of Change on California's Forests

Changing population, society values, and institutions

The social setting of California's forest and rangeland has changed radically since the late 1980s. The State's growing population consumes increasing amounts of forest and rangeland products. At the same time, Californians increasingly demonstrate values and concerns that are redirecting the use of forest and rangeland resources towards more environmental considerations. Accomodating these shifting values requires innovations in resource management, significant reductions in commodity outputs or both.

Continued population growth adds to concerns over water quantity, water quality, preservation of open space and habitat, species extinction, and wildfire risk. Implementation of the Federal Endangered Species Act, Clean Water Act, and Clean Air Act have made the provision of biological diversity, conservation of species habitat, and protection of air and water quality increasingly important forest and rangeland management themes—especially on public lands.

As a result of these emerging themes, the framework of laws and governmental structures that existed in the 1970s and 1980s has been stretched. Through litigation, ballot initiative, private sector innovation, legislative action, and administrative implementation a variety of modified and even new institutions have emerged. These include coordinated agency and private projects, watershed groups, fire safe councils, land trusts, and other non–profit organizations. Additional approaches, such as habitat acquisition, working forest and other conservation easements, forest certification, and trading of carbon credits are also being integrated into business operations.

Understanding how these themes play out requires that analysis be done at the watershed and landscape levels, using information systems to provide the full range of necessary data and analyses. Application of science, research, and technology transfer are becoming increasingly important as the methods are still evolving.

Many of these changes show up in the evolving status of the forest products industry and related employment. They can be seen in the decrease in the area available for timber production, decreased timber harvests, declining mill numbers and capacity, increased unemployment, and restructuring of local economies and revenue.

A major issue for the future of California's forests and rangelands relates to public perceptions of the appropriate mix of private investments, regulation, public investments, and governance processes needed to achieve desired goals. In public opinion polls, an overwhelming majority view overall environmental problems such as air and water pollution, growth, traffic, and water supply as a threat to their health and well-being. Residents also believe that insufficient progress has been made over the past 20 years in solving environmental problems. On forestry-related issues, a 2000 survey by the Public Policy Information Center found that nearly half of the respondents said that urban growth and air pollution damage to the forests in the Sierra Nevada mountains are a "big problem," and an additional third were "concerned." Moreover, approximately one-third had significant concerns regarding the logging of old growth redwoods in the North Coast, while two-thirds of the respondents rated the issue at least "somewhat of a problem." Innovative strategies to address these concerns and communicate successful approaches to the public will be required from both public and private organizations.

Significant changes to California's forests over the last decade include:

- **Increasing consumption of forest products and water**
- **Increasing focus on watersheds, open space, wildfire, and endangered species habitats**
- **Decreasing production of forest products**
- **Increasingly complex interactions among owners, regulators, and stakeholders**

Changing forest conditions and structures

California's forests provide a wide range of values including scenic vistas, recreation opportunities, wildlife habitat, watershed function, commodity forest products, and other uses. A long history of creating parks, wildlife reserves, and wilderness areas in our forests has endowed California with the highest percentage of forests in reserve status of all states, with the exception of Alaska. Old growth forests—primarily in parks, reserves, and national forests—constitute approximately 15 percent of California's conifer forests. In terms of both total area and as a percentage of total forest area, this is roughly twice as large as the equally renowned old growth forests of the Pacific Northwest region.

Across all 31 million acres of California's forests, there is a broad range of tree species, tree sizes, and levels of canopy closure. Conifer forests and woodlands cover over 21 million acres and are most extensive in the Sierra, Modoc, and Klamath/North Coast bioregions of the State. Hardwood forests and woodlands cover nearly 10 million acres and extend along the perimeter of the Sacramento and San Joaquin Valleys and throughout the coastal ranges.

Two dominant characteristics of California's conifer forest are the prevalence of medium size trees and dense forest stands. Forty-five percent of the conifer forest area in California is found in the 11 to 24-inch average stand diameter size class. By comparison, 31 percent of the area is in larger size classes, 17 percent of the area is in smaller size classes, and seven percent is unclassified. In terms of canopy closure, 53 percent of conifer forest is classified as having dense canopy closure (greater than 60 percent closure).

The most productive timber growing portion of California's forests are the 16.6 million acres of public and private timberland—that is, land capable of growing more than 20 cubic feet of wood per acre per year and statutorily available for timber management. In the case of public ownerships (56 percent of timberlands), many lands capable of timber production have been administratively withdrawn over the past two decades for a variety of purposes and have been directed to primary uses other than timber production.

California's forests are improving from a perspective of an increase in growing stocks, sustainable harvesting, and the presense of a wide diversity of forest structures. However, increasingly dense forests can lead to forest health concerns.

California has 7.3 million acres of privately owned timberland, of which 5.4 million acres are classified as timberland production zone (TPZ) where long term tax and regulatory structures favor timber production over potential conversion to other uses. Large private ownerships are most likely to grow and harvest timber on a continuing basis. Smaller owners are much more varied and typically also have numerous non-timber related management goals. Increased planning requirements, operational limitations, and habitat protection have increased the expense of timber growing and harvesting on private land.

While extensive, the total area of timberlands is slowly declining. Between 1984 and 1994, about 250,000 acres of the total timberland base, outside of national forests, were removed from production. The leading cause was change to Reserve status (e.g., wilderness, ecological reserves, parks, and open space uses). A smaller amount (approximately 76,000 acres) was converted to non-timber uses (housing, roads, agriculture) from 1984 to 1994, but many more acres were effectively removed from timber production due to fragmentation of ownerships and growing residential uses. Land use data since 1994 does not specifically separate out timberlands, but the overall trend of conversion is continuing (Waddell and Bassett, 1996 and 1997).

The overall status of California's remaining timberlands in terms of total inventory is improving. While the average volume of growing stock per acre on all ownerships declined from the 1950s through the 1970s, it has been increasing since then. In 1994, California's timberland inventory, the volume of growing stock on timberland, consisted of a net volume of approximately 55 billion cubic feet. National Forest lands have over half of the growing stock, but private industry forests hold the most productive tree growing sites and have higher

growth rates. Overall, private industry timberland volume inventories are growing at a 2.8 percent annual rate, while rates for other owners vary from 2.0 to 2.3 percent.

Whether looked at on a volume basis or an area basis, California's timberlands have significant resources in stands dominated by trees over 100 years old. Across all ownerships, over 22 billion cubic feet (41 percent) is in stands less than 100 years old while, more than 32 billion cubic feet (59 percent) exist in stands greater than 100 years. National Forest timberlands have a higher percentage of their growing stock in stands greater than 100 years (88 percent) as compared to private timberlands (25 percent). Across all ownerships, there are about eight million acres of timberland in stands under 100 years old and eight million acres of timberland in stands older than 100 years. Seventy-nine percent of national forest timberland area is in stands greater than 100 years old and 22 percent of private timberlands is in stands greater than 100 years old (Waddell and Bassett, 1996 and 1997).

Siskiyou Pass, Six Rivers National Forest: G. Donald Bain

The silvicultural methods used by forest managers continue to shape forest conditions. Silviculture is the theory and practice of controlling the establishment, composition, and growth of forest stands. A silvicultural system is a program of forest stand treatments during the life of the stand and includes the development of young trees that will grow over time. Thousands of forest land acres are established or regenerated by natural processes, planting, or seeding each year. Forest composition and growth can be managed by stand improvement practices such as thinning and vegetation control. For example, growth of new or existing trees can often be increased by the removal of adjacent trees that are competing for water, soil nutrients, and light. The Forest Practice Rules (FPRs), which apply to non-federal timberlands in California, describe and regulate standard silvicultural systems with details about regeneration methods, intermediate treatments, alternatives, and limitations.

There is a mixture of uneven and evenaged forest structure on both private and public timberland. In the unevenaged stands, only some of the trees are harvested in any entry and the remaining stand has a mixed aged of trees. Evenaged harvesting practices, which include clearcutting, seed tree, and shelterwood systems, are designed to replace a harvestable stand with well–spaced, growing trees of a uniform age in a single harvest operation (clearcutting) or multiple harvest operations (seed tree and shelterwood). Evenaged harvests represent about half of the total private harvest area in California, and are a controversial issue—particularly by clearcutting. The percentage of total area harvested that was clearcut has increased from 3.6 percent in 1993 to around 15 percent in 2002 (Table 1) (Cunningham, 2003).

On one hand, evenaged harvesting systems can increase habitat for certain species that benefit from open area, reduce the spread of insects by removing brood material, lessen the risk of wildfire by reducing fuel loading and continuity, and improve the growth rate of some types of forest stands. Negative aspects include

Table 1. Total harvest area, clearcut harvest area, and percentage of area clearcut harvested for approved Timber Harvest Plans on private and state lands, 1993–2002 (thousand acres)

Harvest area (thousand acres) or percentage	Year									
	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Total area	276	252	260	390	240	238	271	182	180	208
Clearcut area	10	13	18	24	25	28	47	29	25	31
Percentage clearcut	3.6	5.1	6.9	6.2	10.4	11.8	17.4	15.9	13.9	14.9

Source: Cunningham from Forest Practices Database, 2003.

visual impacts, loss of forest "biological legacies" and habitat structures such as snags and down logs, and localized intensity of harvest operations.

Over coming decades, it is possible that use of clearcutting or other evenaged systems may increase somewhat in the Sierra in stand conditions where current growth is below potential due to past harvesting and wildfire suppression efforts. In many stands, the practice of "high grading" removed most of the valuable pines and larger trees of all species and left diminished vigor in the remaining stand. This harvesting practice, together with successful wildfire suppression efforts, often caused stand composition to shift to less economically valuable species such as white fir and incense cedar. Many stands, especially in the Sierra, are in this condition and some land managers are considering the use of clearcutting or similar techniques to regenerate the stands to achieve better use of the site for desired tree species.

Forest managers are also considering other techniques such as variable retention, mixed evenaged, and small group selection that can achieve similar productivity levels while simultaneously achieving other desired goals of wildlife habitat, visual, aesthetics, and harvesting intensity. Variable retention has been increasingly used in the Pacific Northwest and British Columbia, and involves retaining the structural elements of the harvested stand for at least a full rotation. This harvesting method is flexible and can lead to evenaged, multi-aged, or unevenaged stands. The spatial pattern of the retained trees may follow stream courses, focus on unique wildlife habitats, or be spread throughout the stand.

In all regions of California, net annual growth of timber exceeds annual harvest on both private and public timberlands. The ratios of annual growth to harvest on private timberland are shown in Figure 2. For example, the growth/harvest ratio of 1.52 for the Sacramento region indicates that growth on private timberlands in this region was slightly over one and one-half times as high as harvest. Localized conditions may vary greatly from these generalizations. In some places, large portions of watersheds have been harvested during the recent decades and considerable public concern has been generated in the areas where recent harvest rates

Variable retention silviculture in Jackson Demonstration State Forest.

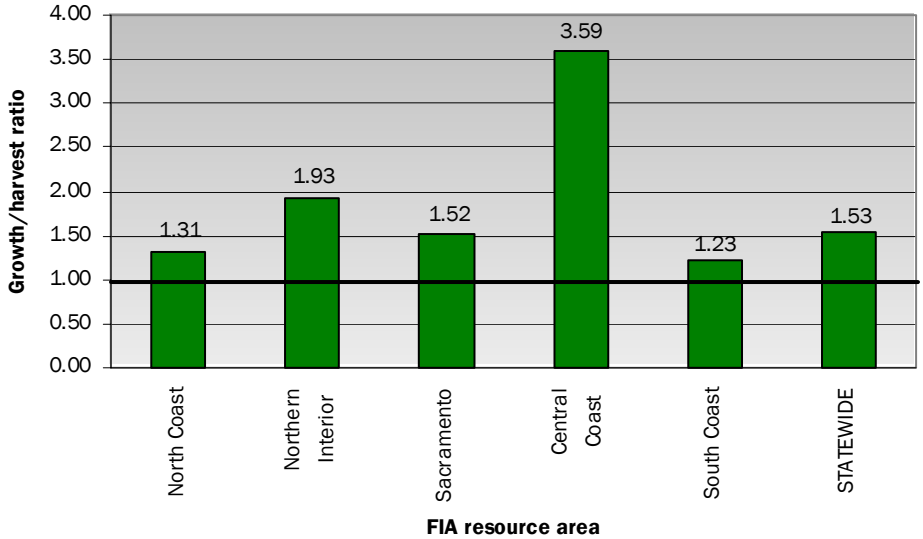
exceed growth rates. In many other areas the continued increase in stand density, and more importantly, in surface fuel levels, presents an increasing challenge to the maintaining healthy forests and minimizing the risk of wildfire. Wildfire threats to urban interface communities, increasing forest density, and the synergistic effects of drought, pests, and other environmental influences are significant challenges to the health of California's forests.

An increasingly important aspect of forests' health is their relationship to protecting and improving water quality of the streams and rivers that travel through them. In addition to requiring higher levels of forest canopy along stream courses, there is increased investment in projects to improve fish habitat and reduce levels of sediment input to watercourses. These investments have been concentrated in watersheds with less stable terrain and where populations of salmonids such as

Wildfire threats to urban interface communities, increasing forest density and syner gistic effects of drought, pests and other environmental influences are significant challenges for the health of California's forests.

Coho salmon, Chinook salmon, and steelhead trout are low. While conditions vary from watershed to watershed, most sediment analyses have identified road systems, and associated stream crossings and drainage systems, rather than the in-harvest operations, as the major sources of additional sediment. New investments are aimed at improving forest road systems to reduce impacts to water quality.

Figure 2. Ratio of growth to harvest on private timberlands by FIA resource area and statewide, 1984–1994



Source: compiled by FRAP from Waddell and Bassett, 1996 and 1997

Changing forest economics

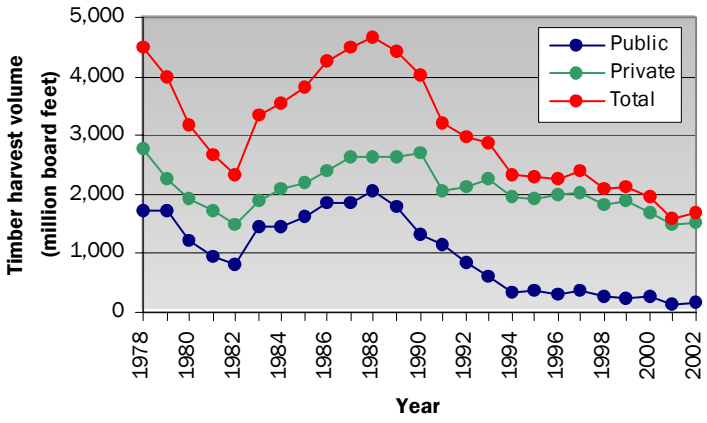
Many broad social changes are affecting the economic status of the forest products industry and related employment. These include increasing consumption, declining timber harvest outside of plantations, declining number and capacity of mills, and declining timber-related employment in forest regions. On the consumption side, Californians use increasingly larger quantities of forest products, water, energy, and other forest values such as recreation. The consumption of lumber and paper products increases as population grows and California's population is projected to increase. California could produce most of the forest products it consumes if the majority of timberlands were managed for wood products production. However, due to a wider set of management goals for public and private forests, most wood products are now supplied by imports from other states and countries.

During the past half century, timber harvesting on both public and private lands in California has fluctuated considerably. Timber harvest volume in California increased from four to six billion board feet between 1948 and 1955, but has declined since then. Timber harvest volume on public lands has declined dramatically since 1989 (Figure 3) and recent harvest levels are now less than 0.2 billion board feet per year. Harvest on private lands has declined since 1990, though not as steeply as on public lands, reaching the lowest level in more than a decade in 2001.

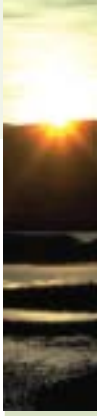
As a result of declining timber supply, global competition, and production efficiencies, production of timber products in California has changed significantly. California imports nearly all of its paper, pulp and structural wood products and although lumber remains the dominant forest product produced from trees grown in California, the number of sawmills has declined from nearly 100 large mills in 1988 to less than 40 in 2002. Related employment has also declined as sawmills have installed more efficient equipment better suited to handling smaller diameter trees and have reduced operating hours as harvest levels declined. Employment related to the forest products industry in most rural counties has also declined as local economies have lost forest products as a viable economic contributor. The negative impacts have been most noticeable in smaller counties far from regional transport corridors.

As sawmill employment has declined, the wood remanufacturing industry has become the major employer of timber–related workers in California. Remanufacturing employment fluctuates with consumer demand and is typically located closer to the final markets in urban areas. Within California, wood remanufacturing employment (e.g. mill work, windows and doors, and moulding) is primarily located in southern California. Almost 70 percent of California's wood products-related employment is now in the five counties of Los Angeles, Orange, Riverside, San Bernardino, and San Diego.

Figure 3. Volume of timber harvested on public and private ownerships, and total, 1978–2002



Source: California State Board of Equalization, 2003



In addition to providing wood products, forests are the source of a significant portion of the state's surface water. While water runoff is not managed as a commodity until it is diverted into reservoirs, canals, or pipelines, it is the state's most important natural resource. The importance of water lies in the fact that it is an essential, non–substitutable commodity needed for human survival. Usable water is a scarce resource in many parts of California, and water deficiencies (droughts) and excesses (floods) are recurring problems. Water represents the state's most economically valuable natural resource and is essential for ecological functions.

Most headwaters of California's streams and rivers are found within forested landscapes, both publicly and privately owned. More than 70 percent of the average annual runoff of 71 million acre-feet originates north of Sacramento. In contrast, about 75 percent of California's urban and agricultural water demands lie south of Sacramento (Department of Water Resources, 1998). Water is often transferred from one watershed or hydrologic region to another to meet these demands which are located in low rainfall agricultural and metropolitan regions.

The supply of water was insufficient to meet all demands in 1995 and is projected to be consistently insufficient by 2020, especially in low rainfall years. Periods of drought will exacerbate problems in meeting demand for water. Since the 1990s, use of water for environmental purposes has gained increased importance, but urban uses are projected to account for nearly all the projected increased demand for water by 2020 (Department of Water Resources, 1998) (Table 2).

From an economic perspective, the sale of wood products remains the only end use that generates the level of funds necessary to cover land ownership and management expenses, yet economic output and the associated employment levels associated with timber harvest have declined during the past decade. While forests will continue to play an important role in provision of water runoff and the protection of water quality, the economic linkages between society's downstream demands and upstream management costs remain weak.

Table 2. Applied water use in average water year conditions, 1995 and 2020 (million acre-feet)

Water use	1995	2020 *(projected)*	Change
Urban	8.8 (11%)	12.0 (15%)	+3.2 (+4%)
Agricultural	33.8 (43%)	31.5 (39%)	–2.3 (–4%)
Environmental	36.9 (46%)	37.0 (46%)	+0.1 (0%)
Total	79.5	80.5	+1.0

Source: Department of Water Resources, 1998

Two Decades of Change on California's Rangelands

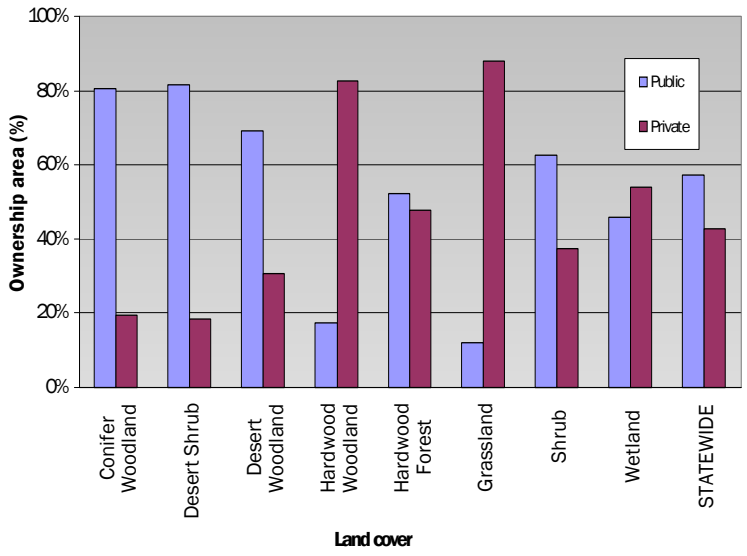
On an area basis, rangelands are the largest resource use designation in California. The State's total area of primary rangeland most suitable for grazing exceeds 57 million acres, or over one-half of the state. Approximately 34 million acres are actually grazed and are a vital part of the cattle and sheep industries in California. In addition to seasonal grazing, rangelands provide benefits such as wildlife habitat and recreational opportunities, at relatively little cost to Californians. In particular, near urban areas rangelands provide open space, viewsheds, and related values.

Cattle grazing in Hardwood Woodland and Grassland land covers

Significant shifts in plant species composition of rangelands have occurred since the late 1800s. Early changes were driven by heavy grazing, severe drought, introduction of large fires for forage improvement, and livestock impacts to aquatic/riparian areas (Kinney, 1996). Over the last two decades, large scale change in livestock management has substantially contributed to recovery of previously degraded landscapes. Where threatened or endangered wildlife and plant species overlap rangelands, some lands have been set aside or restricted in use in an effort to prevent further species loss. Riparian habitat and water quality issues are being addressed on some private ranches as part of Rangeland Water Quality Management Plans, developed by landowners to improve water quality under the federal Clean Water Act.

Rangeland ownership is dominated by public ownership (57 percent) in terms of total area, but productivity and use rates are considerably higher on private lands. Rangeland consists of different vegetation cover types and the ownership of these types differs between the private and public sector (Figure 4).

Figure 4. Percentage area of primary rangelands in public and private ownership by land cover class



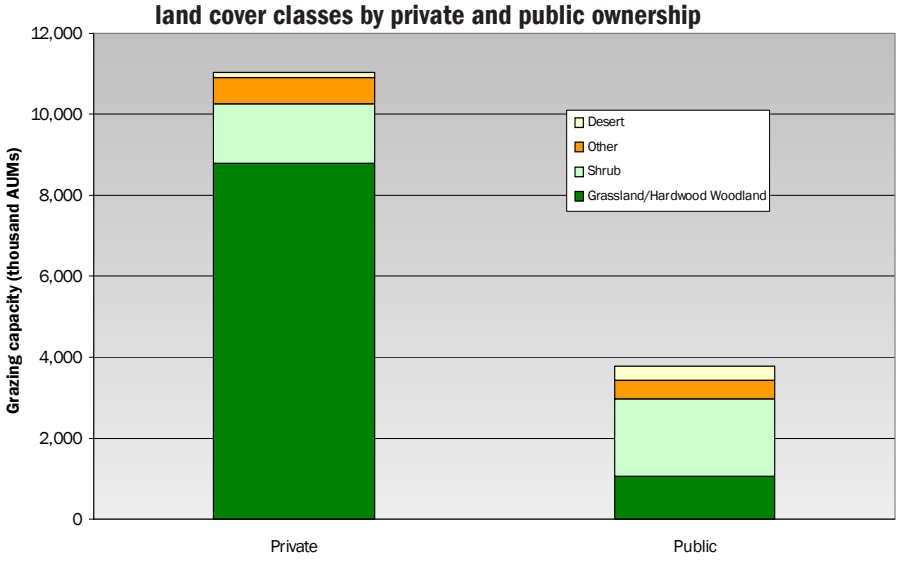
Source: FRAP 1999; FRAP, 2002d

Annual grasslands (including those within Hardwood Woodland types) are the most important source of range forage and provide over two-thirds of the forage for domestic livestock. California's hardwood rangelands also have historically been one of the most important rangeland areas in the State, providing a substantial portion of California's rangeland grazing capacity. Private lands provide the dominant amount of forage for grazing, as expressed by Animal Unit Months (AUMs) of grazing capacity (Figure 5). While the area of rangelands available for grazing is evenly distributed between private and public land, private lands provide nearly three times more AUMs for livestock and wildlife grazing.

With the exception of deer migration and other wildlife habitat, rangelands have been seen traditionally in the context of the State's cattle and sheep industries. In 1990, 40 of the State's 58 counties listed cattle and beef among the top five agricultural commodities in terms of gross value. Major rangeland commodities include animals, meat, wool, and a host of related byproducts. Despite widespread diversification of California's economic base over the past decade, cattle and beef were still among the top five commodities in 33 counties in 1999. California's cattle and sheep industries remain significant compared to those in other states.

California is a net importer of beef and other major rangeland commodities. Beef consumption in America has declined as consumers turn to chicken, turkey, and fish although this decline seems to have stabilized in recent years (U. S. International Trade Commission, 1999). Based largely on increases in population growth, total consumption of beef in California is projected to increase over the next decade. Livestock is increasingly a global industry, with many countries importing and exporting livestock and livestock related products. This global movement of animals and meat makes the livestock industry very susceptible to transport of disease. Concerns over two diseases have recently dominated the U.S. and international arena: foot–and–mouth disease and mad cow disease. Neither disease currently exists in the United States. California has taken extra precautions to be able to detect and respond to any potential outbreaks.

Figure 5. Grazing capacity in Animal Unit Months (AUMs) of land cover classes by private and public ownership



Source: CH2M-Hill, 1998; FRAP, 1999; FRAP, 2002d; National Agricultural Statistics Service, 2001a;

Cattle sales exceeded $630 million in 1997, much of which came from larger ranches in the San Joaquin and southern California desert regions.

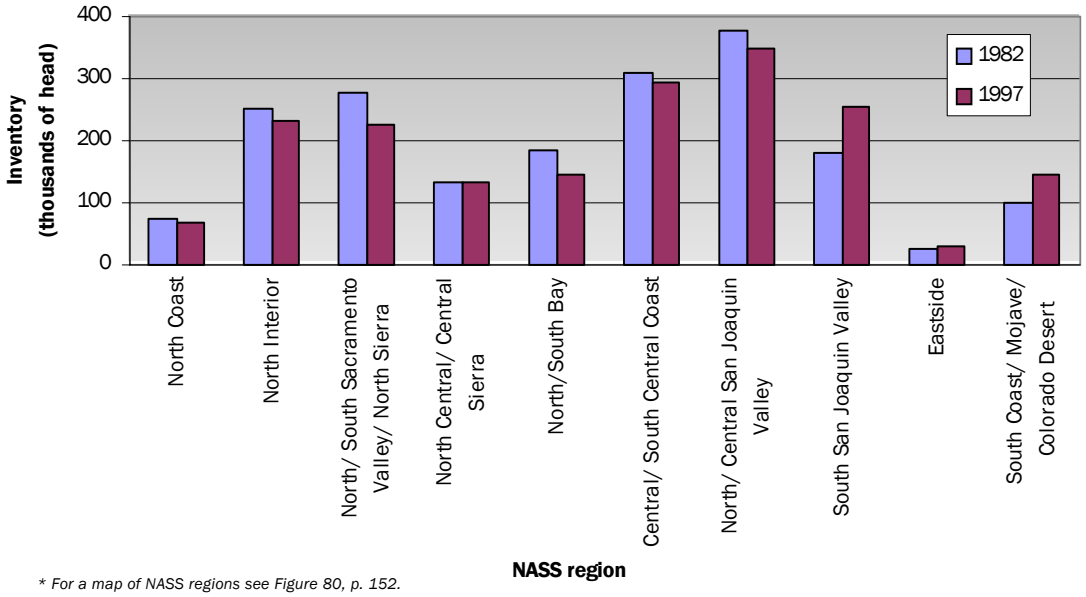
Livestock production from forest and rangelands consists primarily of beef cattle and some sheep and lambs not in feedlots. Over half of the beef production is concentrated on larger farms and ranches. According to the National Agricultural Statistics Service (NASS), the total number of rangeland farms declined 22 percent between 1982 and 1997, with the majority of the decline being in farms less than 500 acres in size (NASS, 2001a). During this time the inventory on rangeland beef cattle farms varied by region, but statewide has remained stable with approximately two million head (Figure 6). Sales from rangeland farms were almost $630 million in 1997, a four percent decrease from the 1992 levels. Almost half of total sales value comes from farms 2,000 acres or larger.

The inventory of sheep and lambs in California fluctuated over the last decade, ranging from a high of 1.1 million animals in 1994 to a low of 800,000 in 1998. Total production of sheep and lambs in California for all farm types over the last decade varied from 92 million pounds in 1993 to 47 million pounds in 1999. Roughly half of the sheep and lamb crop is sold annually. Wool production declined from 7.6 million pounds to four million pounds between 1990 and 2000. Total gross income declined from $85 million in 1996 to $42 million in 1999.

In the opinion of some observers, California's range industry is at a crossroads. Many operators are nearing retirement age and could soon exit the industry. At least four key factors drive change and uncertainty on California's rangelands. One is the generally challenging economic context of ranching, which is common to the livestock industry in other parts of the United States. Another is changes in management of public rangelands with a marked decline in availability. A third is increasing cost of regulations for a variety of public goals. A fourth is the impact of population growth on land values, on perceptions of ranching, and on redefining the goods and services that are expected of rangelands. This impact is more noticeable in urbanized states such as California.

Within the context of California's range economy, grazing enterprises can be quite risky. Livestock, hay, and other input prices fluctuate annually. In addition, forage production may vary greatly due to differences

Figure 6. Cattle and calf inventory on beef cattle farms excluding feedlots by NASS region*, 1982 and 1997



** For a map of NASS regions see Figure 80, p. 152.*
Source: National Agricultural Statistics Service, 2001a

in rainfall and temperature. These factors create substantial annual variation in returns. The ability of a rancher to deal with the risk depends upon available financial resources, borrowed capital, interest rates, and management approaches. Additionally, the processing sector remains outside of California and market opportunities, especially for smaller producers, may be limited.

As one measure of profitability, prices received for cattle have declined about 10 percent over the last decade while costs of inputs (primarily feed and livestock acquisition costs) used by domestic cattle producers have risen about 12 percent. To a degree, California and other American producers have been able to offset lower costs in other nations by increasing efficiency and productivity, creating new products, and developing niche markets. However, costs are still well above those in other competing countries.

In some cases, viability of existing ranching operations has been affected by changes in grazing policies by public agencies. As part of a broader policy of ecosystem and watershed management, public agencies have placed less emphasis on commodity production and more emphasis on rangeland restoration through limitations on grazing and implementation of restoration projects. This approach has decreased the availability of forage allotments from federally owned lands and increased the uncertainty of forage supply to ranchers who have historically depended on it.

Operating in an increasingly urban state, California agriculture faces public concerns over food safety, health, pesticide use, clean water, clean air, groundwater contamination and replacement, open space, worker safety, and ecosystem and wildlife preservation. At the State level, ranchers face increased health requirements, management practice limitations, and acquisition of habitat by public agencies or other entities. At the local level, impacts include increased land use conflicts; more complaints over noise, traffic, odor, and dust; livestock damage from stray pets; and more restrictions on management options. The net result is usually additional costs of ranching. While many ranchers are very adept at dealing with these pressures, the probability of conversion to residential or commercial uses increases when ranching becomes no longer cost effective.

Photo courtesy of Natural Resources Conservation Service.

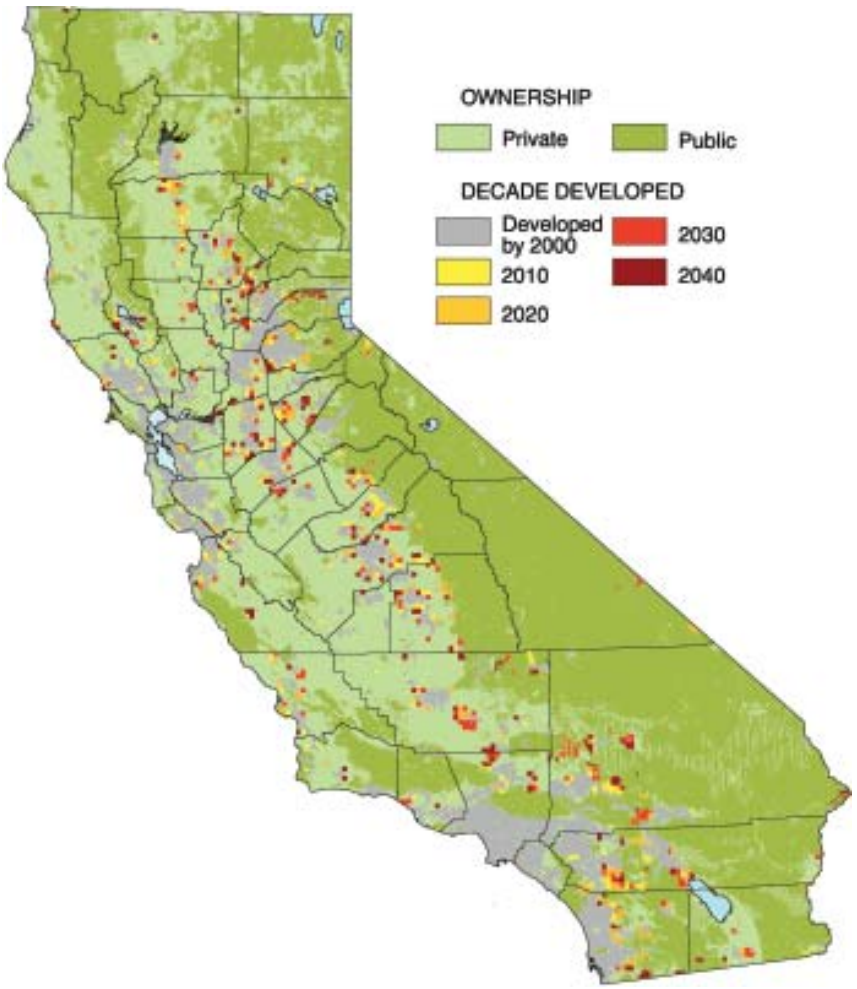
California's population continues to grow, spread geographically, and change socially. Although some rangeland areas of the state have not experienced heavy growth, residential development over the last decade has expanded into many other rangeland areas. Development of rangelands into parcels between five to 20 acres typically fits within most local zoning regulations but still represents a shift away from rangeland management. As a result of residential development, rangeland area has declined by tens of thousands of acres per year over the last decade. It is projected to continue to decline at similar levels through 2040 (Figure 7).

As this development occurs, rangelands in many locations provide added values beyond being a source of forage for grazing.. Rangelands buffer urban growth and provide open space and a variety of other values to metropolitan populations at relatively low cost. In an ef-

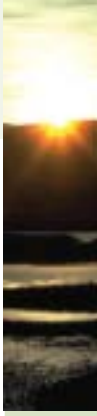
Several factors drive change on California's rangelands:

- **Low profitability of ranching**
- **Population growth impacts on land values**
- **Perceptions of the goods and services that are expected of rangelands.**

Figure 7. Projected housing development* by decade to 2040



** housing density of one or more units per 20 acres*
Source: FRAP, 2001; FRAP, 2002d; FRAP, 2003b



fort to maintain these values, there has been increased focus on keeping rangelands in larger tracts near urban areas. In some cases, efforts are providing opportunities for ranchers to continue operations and preserve the many ecological and social values offered by operating ranches.

In some cases, keeping larger tracts intact involves outright purchase. These large tracts often continue grazing operations at a reduced level and serve other rangeland values. A number of large ranching tracts have been acquired in recent years by governmental agencies, conservancies, and private parties that do not make a living from ranching. The taxpayer costs of acquisition and ongoing resource management are significant when the land is transferred to the public. In other cases, only the development rights are being purchased from the rancher while they maintain the use and control of the land for existing ranch uses. Ranchers themselves formed the California Rangeland Trust in 1997 to help maintain sustainable rangelands. Finally, preferential zoning and tax assessment laws such as Williamson Act contracts can provide a lower but often effective level of support to existing operations.

A variety of approaches are being tried to help maintain the range industry:

- **Preserving larger rangeland tracts**
- **Management of conflicts from urban pressure**
- **Improving economic opportunities**
- **More funding for restoration projects**
- **Help in meeting health requirements**
- **Facilitation of meeting public safety and environmental requirements.**

In addition to the preceeding approaches to keeping larger rangeland tracts intact and in production, a variety of other approaches is being tried to help maintain the range industry. These include management of conflicts from urban pressure; improved economic opportunities; more funding for restoration projects; help in meeting health regulations; and facilitation of meeting public safety and environmental requirements.

Even with a variety of available policy tools, urban pressure takes a toll on the attitudes of ranchers. A recent survey of ranchers in urban Contra Costa and Alameda Counties, and in rural Tehama County, suggests that urban ranchers fear local land use planning most and expect that if their ranch is sold it would be converted to urban land uses. In contrast, rural ranchers felt less threatened by local land use planning and wanted their property to be a productive ranch even if sold. Most of the ranchers enjoyed ranching and its associated family life, but felt that urban California was becoming more hostile to the livestock industry.

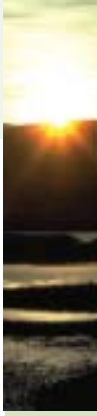
The range landscape in the coming decades could well entail a dynamic mix of larger ownerships devoted to livestock production intermixed with smaller ownerships managed for a wide variety of both livestock and non-livestock goals. Outside sources of income will be increasingly important. Development, especially in the form of the break-up of larger parcels into smaller parcels, will proceed. At the same time, more rangeland area will be controlled by governmental agencies, conservancies, and private parties that are not dependent on livestock production for revenue. In some cases, ranchers will continue to own the land and manage livestock on ranches where development rights have been ceded to a third party via conservation easements.

Even with the traditional ingenuity of California ranchers, ranching for the next decade will remain a challenge in some regions of the State. Still, many ranchers, especially in areas less subject to development pressure, will continue livestock operations. As such, they will be a critical factor in supporting working landscapes.

Highlighted Themes

Keeping pace with the changing California requires both an understanding of the complexities of forests and rangelands and the ability to continuously adapt to a growing and changing population. In addition to topics of historic and current interest, a number of new themes demand attention. Eight crosscutting themes have been identified by the 2003 Assessment. They are vital to sustainability and will continue into the next decade and beyond.

- **Integrate environmental, economic, and social goals:** The environmental sustainability of California's forest and rangelands is improving with growing inventories, diverse forest structure, and a greater attention to maintaining valuable biological legacies. Continued progress will require continued investment and innovation in resource management from both the private and public sectors. Private sector investment in land ownerships and businesses selling goods and services generates employment and local government revenues in rural areas but is dependent on continued market-based profitability. Public sector investments are dependent on the financial support of an increasingly urban population especially their social values to both urban and rural communities and stakeholders.
- **Conserve the Working/Private landscape:** The Working/Private landscapes are those lands managed for a wide range of purposes with commodity production as the major economic basis for ownership. Historically, the Working/Private landscape has provided commodities, jobs, open space, and ecological services to the public at little direct cost. These lands have a history of investment and active management. With limited public understanding of management activities, low profitability for timber and livestock operations, and increasing regulatory costs the strong pressures for parcelization, fragmentation, and land use conversion accelerate. New ways to keep the Working/Private landscape viable while providing a wide range of public values are necessary.
- **Improve watershed conditions:** Improving watershed conditions is vital to restoring functional ecosystems across California. Many watersheds have historic legacy impacts, ongoing land use changes, and episodic intense wildfire that degrade water quality and aquatic habitat conditions. In degraded watersheds, a key policy challenge includes addressing linkages between current land uses, natural catastrophic events, and investments in restoration.



- **Reduce wildfire threats:** High fuel loads, the growing extent and intensity of wildfires, and increased population in forests and rangelands all increase the risk of wildfire to people and resources. This threat requires continuing focus on the management of forest and rangeland fires, both catastrophic wildfire and prescribed burns.
- **Reduce loss of productivity and forest health from increased stocking levels:** Timberland growing stock volumes and densities have been increasing as a result of reduced harvesting (most noticeably on federal lands) and exclusion of wildfire. While this trend has had beneficial impacts for many terrestrial and aquatic habitats it has also led to an increasing inventory of unutilized timber and dense forest stands. This results in a lost opportunity to generate wood products used by Californians, and also increases detrimental impacts such as insect and pest outbreaks, catastrophic fire, and the loss of biological diversity for species dependent on open, less dense forest settings.
- **Meet the complexities of management in metropolitan forests and rangelands:** Forests and rangelands near urban centers, along with those adjacent to rural communities, are the most visible and are of the greatest value to the people near these areas. Management is needed for forest health improvement and wildfire risk reduction. Addressing the diverse social concerns is necesary to integrate positive experiences into the lives of neighbors.
- **Address continued residential land use pressures:** Land conversion for new housing continues on rangelands and forests near metropolitan areas and in the wildland urban interface. Most of the development has a low density of houses per acre so the land impact is considerably greater than the population impact. This type of development removes natural vegetation and breaks rangelands and forests into smaller units. This reduces habitat value for wildlife species dependent on unfragmented natural vegetation and makes it more difficult to manage the remaining larger parcels. California's population will continue to expand and will need to be accommodated with the least negative impact to a high quality and safe environment.
- **Improve policy coordination and integration:** Multiple regulations often impede progress towards desired goals, discourage investment, incur substantial taxpayer funded regulatory costs, and add uncertainty that increases costs to landowners and other stakeholders. Better coordination and integration will be essential to effectively match appropriate tools to the many challenges.

Policy Challenges and Options

Policies that surround forest and rangeland issues in California address two different but related facets. One is to maximize the amount and usefulness of services and commodities for all Californians. The second focuses on protecting, maintaining, and improving the underlying ecosystems. In each case, two questions arise concerning equity, for both today and the future. Who will pay for these programs and who will benefit?

The most general goal of forest policy can be described as finding a mix of investments and programs that are widely acceptable and lead to levels of biological diversity, commodity production, social well being, and environmental quality that are widely acceptable. To keep abreast of the many challenges to sustainability, California's forest and rangeland policy must improve by utilizing a wide range of options and tools (Figure 8).

Figure 8. Policy challenges and options

	Challenges	Options and Tools
1 Biological Diversity	Gaps in wildlife habitat structure Decline in some native species Using all landscapes to meet biological diversity goals	Acquisition or partial purchase Application of new technology Collaborative decision making processes Conservation easements Conservation incentives and cost share programs Cooperative management Education and technical assistance Increased reliance on imports Information development and sharing Joint monitoring
2 Productive Capacity	Declining land base and administrative withdrawals of land available for timber and range production Risks and Impacts from increased forest stocking levels Decline in rangeland area and availability	
3 Forest Health	Managing forest structure for productivity, habitat, and forest health goals Management of metropolitan and interface forests and rangelands Public understanding of management practices Forest and rangeland conversions Fuels buildup risks to ecosystems and human assets Elevated pest damage related to forest stocking levels Emerging pest and disease threats to unique habitats and livestock health Impacts of exotic and invasive species to biological diversity and rangeland productivity Increasing air pollution in several regions	
4 Soil Conservation and Water Quality	Measuring cumulative watershed impacts Improving watershed condition and restoring fish habitat	
5 Forests and Climate	Understanding and responding to climate change	Land use planning Long-term plans
6 Socio–Economic Well Being	Increasing consumption and statewide limitation on California commodity output Meeting changing demands for recreation and open space Meeting costs of resource protection Incentives for private production of ecosystem services Maintaining large landholdings in resource industries Weak economies in rural communities	Market agreements Multiple-commodity management Private management and investment
7 Governance	Complexity of regulatory oversight Limited policy integration Conflicts over forest and rangeland management practices Coordination in research and information sharing Standardized, comprehensive information systems	Regulatory innovation Revenue from new goods and services

Introduction

In 1977, legislation identified the need and gave direction for the content of this assessment. State law (Public Resource Code 4789) requires the California Department of Forestry and Fire Protection (CDF) to periodically assess California's forest and rangeland resources. The Forest and Rangeland 2003 Assessment is the fourth edition required by this legislation. A central goal of this assessment process is for the California State Board of Forestry and Fire Protection to issue a policy statement based on published analysis and public hearings. The Assessment was conducted by the Fire and Resource Assessment Program (FRAP) during the period of 2000–2003, in cooperation with many external academic, government, and private resource professionals.

Assessment Goal:

To provide the California State Board of Forestry and Fire Protection, the public, and other policy makers information on environmental, economic, and social conditions that support forest and rangeland resource sustainability.

Geographic Scope

California covers a vast landscape of over 100 million acres, of which over 80 percent are defined as forests and rangelands (Table 3, Figure 10). The geographic scope of forests and rangelands are addressed by statute as those suitable for timber production or grazing by domestic livestock, and other forested lands (Figure 9). The broad land cover classes encompassing forests and rangelands have been identified using the FRAP Multi-Source Land Cover (v02_1) information system (FRAP, 2002c) and include the following:

- Conifer and Hardwood Forests;
- Conifer and Hardwood Woodlands;
- Shrubs;
- Grasslands;
- Desert Shrub and Woodlands; and
- some Wetlands.

Table 3. Area of land cover classes by major ownership (thousand acres)

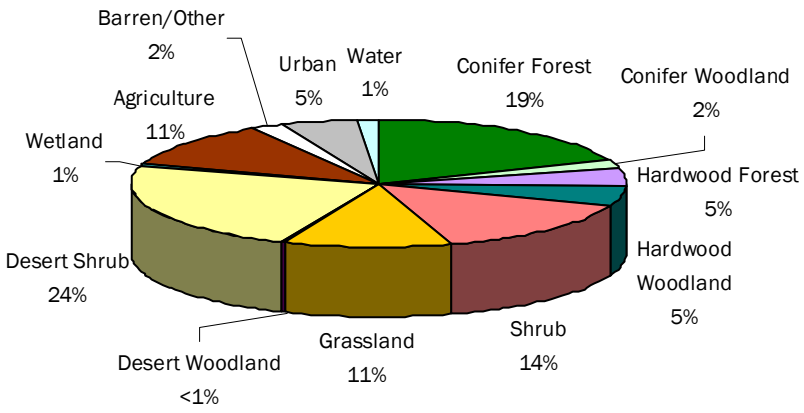
Land cover class	Private	USFS	BLM	NPS	Other public	Total
Conifer Forest	6,432	10,644	394	1,108	426	19,004
Conifer Woodland	458	1,051	482	220	151	2,363
Hardwood Forest	2,901	1,287	176	134	193	4,691
Hardwood Woodland	4,292	310	239	36	309	5,188
Shrub	5,433	5,673	2,261	319	878	14,565
Grassland	9,621	233	496	43	526	10,919
Desert Woodland	42	3	55	22	12	134
Desert Shrub	4,256	197	10,198	4,656	4,106	23,414
Wetland (F&R)*	145	69	11	20	23	268
Forest and Rangeland Total	33,582	19,468	14,312	6,558	6,626	80,545
Wetland (non F&R)*	189	(L)	1	2	80	272
Agriculture	11,201	4	42	(L)	174	11,421
Barren/Other	229	918	203	680	254	2,283
Urban	4,606	17	29	8	250	4,909
Water**						1,486
Statewide Total	49,805	20,406	14,587	7,247	7,384	100,915

** Only the Wet Meadow CWHR habitat type is considered forests and rangelands. See Appendix.*
*** Areas classified as water are not assigned an ownership.*
(L) – less than 500 acres; BLM – U.S. Bureau of Land Management; NPS – National Park Service; USFS – U.S. Forest Service; F&R – forests and rangelands
Source: FRAP, 1999; FRAP, 2002d

Figure 9. Forests and rangelands of California

Source: FRAP, 2002d

Figure 10. Percentage area of land cover classes, statewide



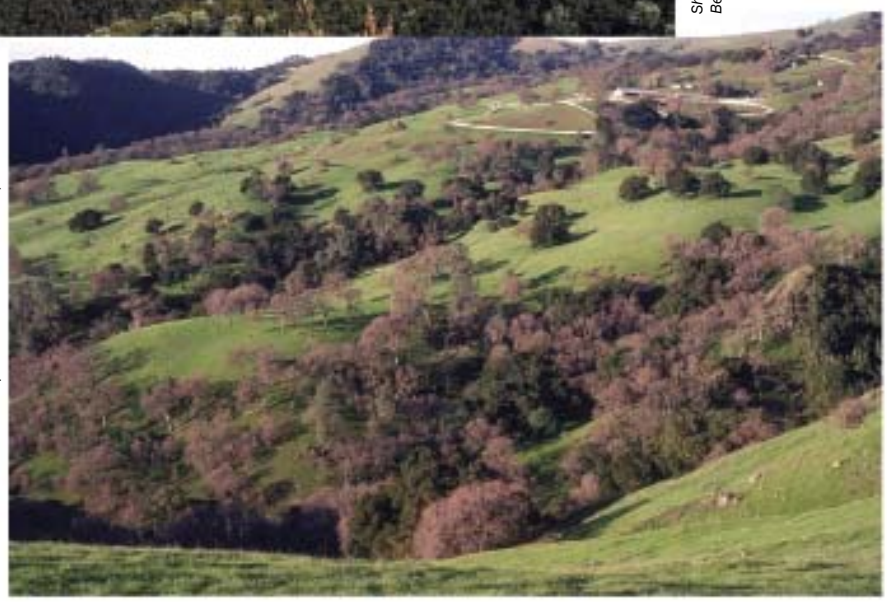
Source: FRAP, 2002d

Desert Shrub (Photo: Bureau of Land Management)

Conifer Forest. (Photo: G. Donald Bain, Geo-Images, UC Berkeley.

Shrub lands (Photo: G. Donald Bain, Geo–Images Project, UC Berkeley)

Wet Meadow (Photo: Marc Hoshovsky, Department of Fish and Game)



Hardwood Woodland (Photo: G. Donald Bain, Geo–Images Project, UC Berkeley)

Regional and County Perspectives

California is a land of great variety and contrasts that defies simple descriptions. This diversity covers many cultural, physical, economic, and biological characteristics. California's size and diversity ensures that statewide averages do not accurately represent diverse localities. To address this diversity, the Assessment provides statewide, regional, and county level information.

For regional perspectives, the Assessment uses various geographic designations called bioregions. The two most commonly used bioregion designations are the California Biodiversity Council (CBC) bioregions (Figure 11) and county-based bioregions. CBC bioregions reflect unique physical and biological characteristics, such as climate, topography, vegetation, and wildlife. In contrast, county-based bioregions follow jurisdictional boundaries and place whole counties in the most representative region. It is in the context of these unique bioregional characteristics that this assessment explores the environmental, economic, and social conditions of forests and rangelands.

Figure 11. California Biodiversity Council bioregions

Source: California Biodiversity Council, 1992; FRAP, 1998

Sample landscapes in California's bioregions

Klamath/North Coast (Jackson Demonstration State Forest)

Bay Area/Delta (Ring Mountain Preserve, near Tiburon)

Central Coast (Jalama Creek, near Gaviota)

South Coast (Inland Empire, Lake Elsinore)

Sacramento Valley (Sacramento River at Dunsmuir)

San Joaquin Valley (Tulare County)

San Joaquin Valley photo courtesy of Gary Kramer, USDA NRCS. All remaining photos courtesy of Geo-Images Project, Department of Geography, University of California, Berkeley

Modoc (near Tule Lake, Modoc County)

Sierra bioregion (Yosemite Valley)

Mojave (Fort Piute, East Mojave National Scenic Area)

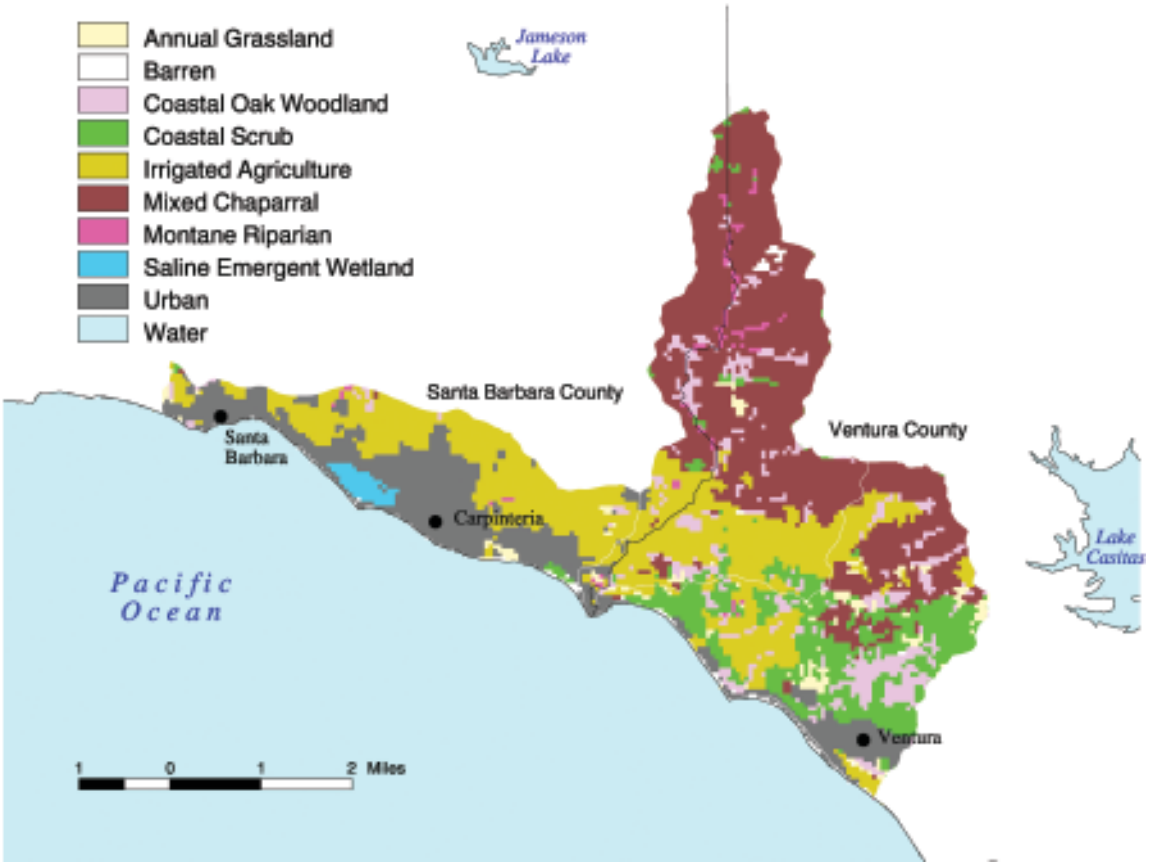
Colorado Desert (Titus Canyon, Death Valley National Monument)

Integrating Spatial Information at Local Levels

A key feature of the Assessment is the ability to bring together detailed information on natural, economic, and social dimensions at a wide range of spatial scales. FRAP provides detailed, consistent statewide data across all of California's forests and rangelands. This provides decision makers and other stakeholders the ability to use common information applicable to their particular needs at the state, regional, county, and watershed scales.

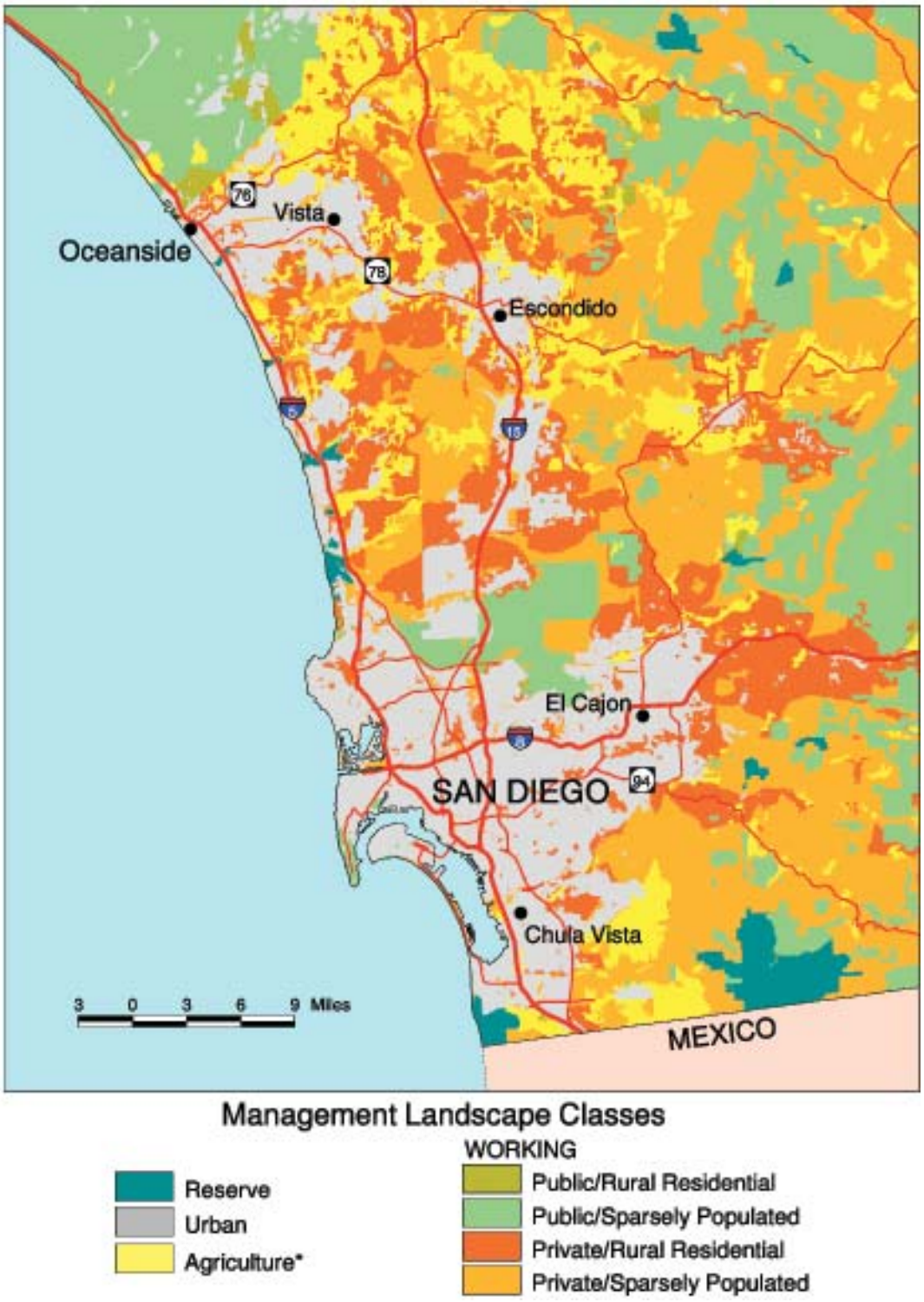
An example of this feature is the data in FRAP's web-based Coastal Watershed Mapping Tool (Figure 12). The figure below illustrates detailed habitat types for Rincon Creek, a small coastal watershed south of Santa Barbara The mapping tool provides information for all watersheds draining to the ocean. When combined with other available data such as rainfall, wildland fuel characteristics, current and projected housing densities, and land uses (Figure 13), decision makers can develop reasonable initial assessments of such issues as potential non-point source pollution from new land uses, fire threats, and residential development.

Figure 12. California Wildlife Habitat Relationship (CWHR) types, Rincon Creek watershed



Source: FRAP, 2002d

Figure 13. Management Landscape classes depicting the combination of land use, housing density, and ownership in western San Diego County



** includes Rural Residential and Sparsely Populated*
Source: FRAP, 2002b

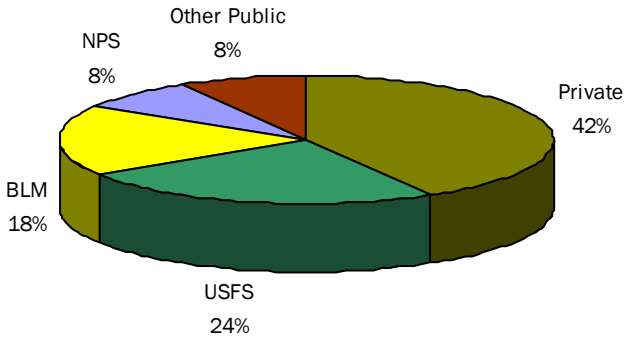
Ownership

California is a patchwork of public and private land ownership that continues to change with new land acquisitions, trades, and divestments. Half of all land in the State is under public ownership.

Federal agencies such as the U.S. Forest Service (USFS), Bureau of Land Management (BLM), and National Park Service (NPS) have responsibility for the care and management of natural resources on public lands. Additional owners in the Other Public group include local agencies (cities, counties, and water and park districts); state agencies (Department of Fish and Game, State Lands Commission, Department of Forestry and Fire Protection, Department of Parks and Recreation, and other state departments); and other federal agencies (Bureau of Indian Affairs, Bureau of Reclamation, Army Corps of Engineers, Department of Defense, and U.S. Fish and Wildlife Service). The remaining half of California is privately owned by individuals, corporations, or conservancies.

The area of forests and rangelands is also roughly split evenly between private and public ownership, but varies among bioregions (Table 4). Forty-two percent of forests and rangelands is in private ownership while 58 percent is in public ownership (Figure 14, Figure 15).

Figure 14. Percentage area of forests and rangelands by major ownership



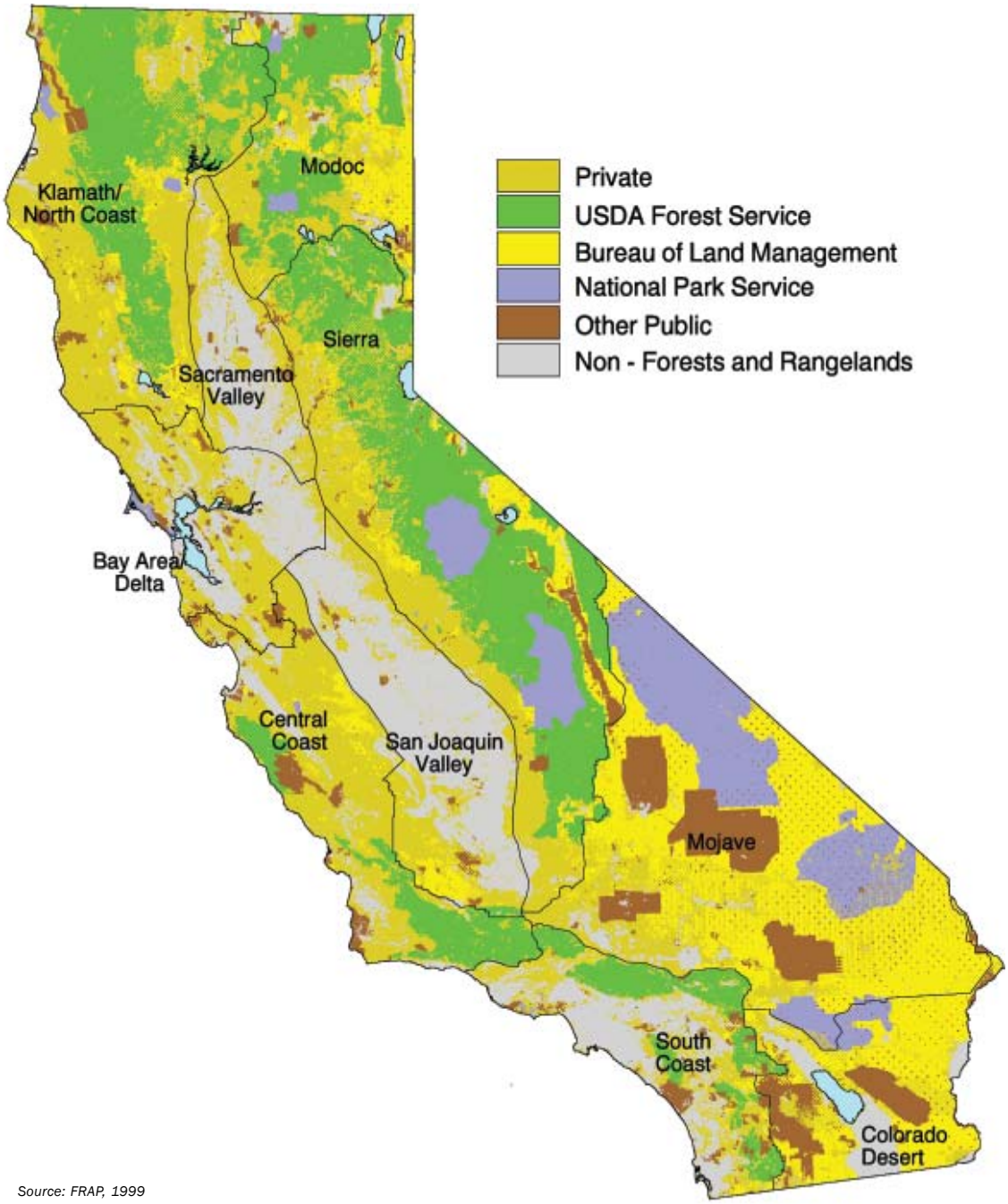
Source: FRAP, 1999; FRAP, 2002d

Table 4. Area of forests and rangelands by major ownership and bioregion (thousand acres)

Bioregion	Private	USFS	BLM	NPS	Other Public	Total
Bay Area/Delta	2,754		48	76	255	3,134
Central Coast	4,786	1,671	311	15	461	7,244
Colorado Desert	1,071	9	2,696	326	1,304	5,406
Klamath/North Coast	6,997	5,613	583	117	371	13,681
Modoc	2,840	2,773	1,363	140	211	7,327
Mojave	3,548	84	7,692	4,709	2,885	18,918
Sacramento Valley	1,549	(L)	28		70	1,648
San Joaquin Valley	2,219	69	300		118	2,706
Sierra	5,740	7,543	1,144	1,158	487	16,072
South Coast	2,076	1,707	146	18	465	4,410
Forest and Rangeland Total	33,582	19,468	14,312	6,558	6,626	80,545
Statewide Total*	49,805	20,406	14,587	7,247	7,384	100,915

(L) less than 500 acres
** areas classified as water are not assigned an ownership*
Source: FRAP, 1999; FRAP, 2002d

Figure 15. Major ownership of forests and rangelands



Source: FRAP, 1999

Management Landscape

The Management Landscape is a conceptual framework that describes how land is used and managed. Identifying and understanding the Management Landscape in California is fundamental to addressing the complexities associated with natural resource management and potential impacts.

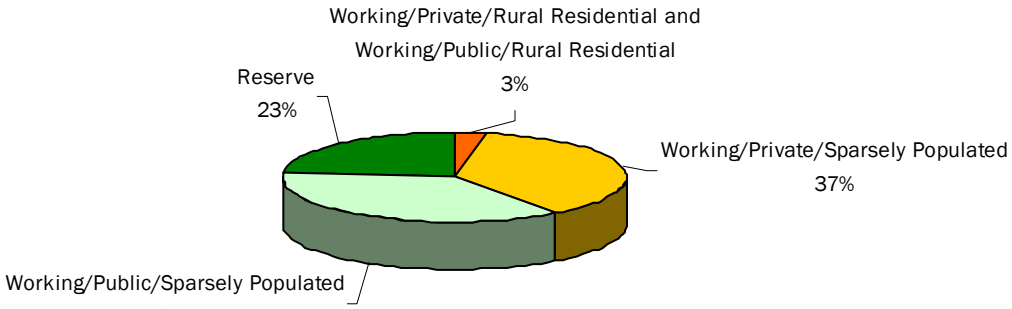
Three major components comprise the Management Landscape of California:

- land use;
- ownership; and
- housing density.

These three components combine into a database than can be represented by a single, although visually complex, map called the Management Landscape (Figure 16 and Appendix). The Management Landscape is the basis for much of the Assessment and contains several management classes including Reserve, Urban, Agriculture, and Working (Table 5). Agriculture and Working are further subdivided by housing density into Rural Residential and Sparsely Populated. Additionally, the Working classes have Public and Private ownership designations.

Lands in the Working management class are managed for a wide range of purposes, often with commodity production as the economic base for ownership and management. Reserve lands are generally managed consistent with statutory designations such as wilderness, wild and scenic, national parks, and national monuments, often with strict limits on management activities. Most of California's forests and rangelands are in the Working/Sparsely Populated (both Public and Private) classifications (74 percent) with nearly all the balance in Reserve (23 percent) (Figure 17).

Figure 16. Percentage area of forests and rangelands by Management Landscape class



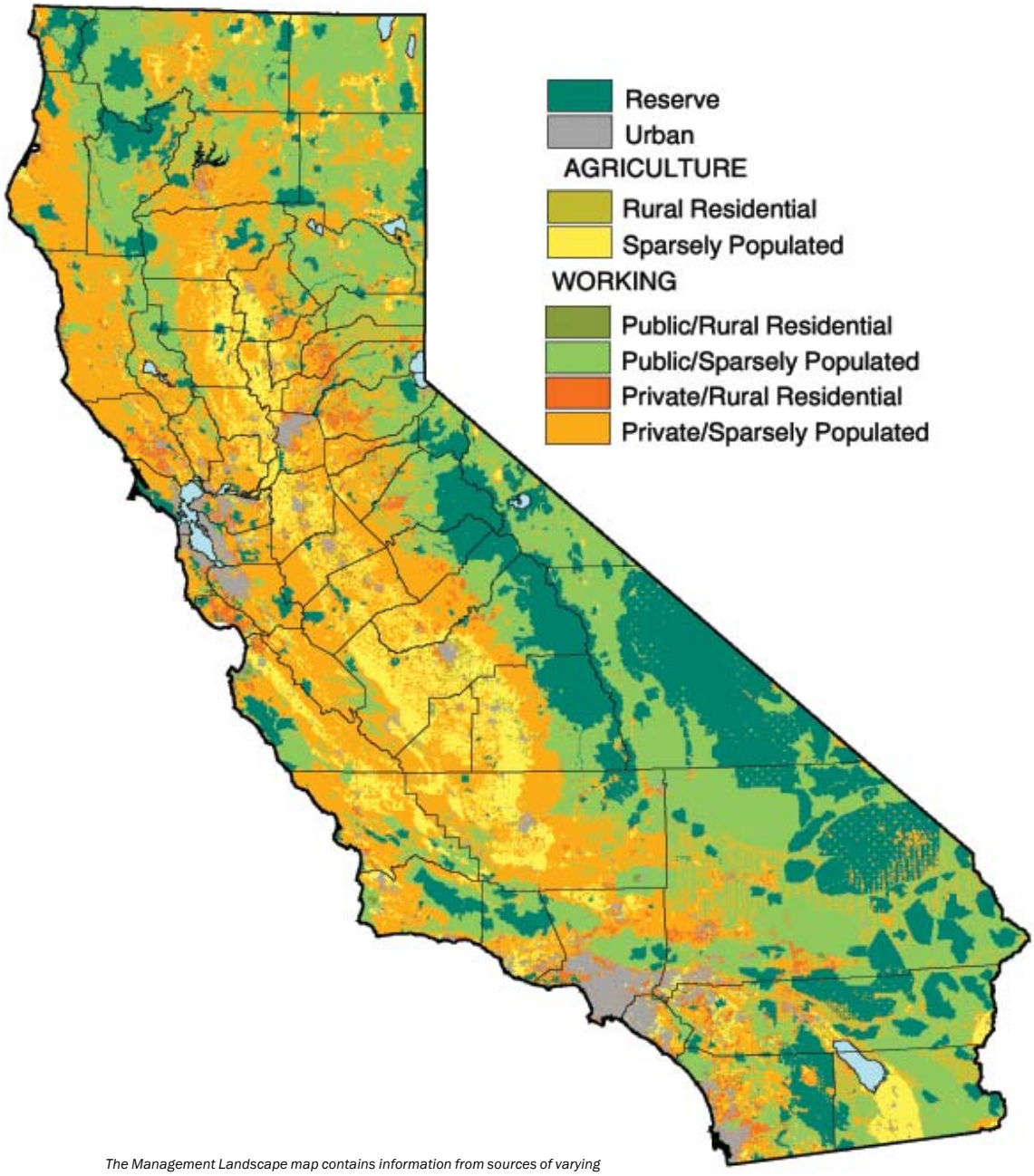
Source: FRAP, 2002b

Table 5. Management Landscape class profile, all land covers, statewide

Management classifications	Area (million acres)	Management emphasis
Reserve	20	Consistent with these designations: wilderness, wild and scenic, national parks, national monuments. Commodity production prohibited or greatly restricted.
Working/Public/Sparsely Populated	31	Lands under public administration with management consistent with agency mandates. Commodity production allowable. Housing density less than 1 unit per 20 acres.
Working/Private/Sparsely Populated	33	Lands under private ownership with management and commodity production consistent with governmental regulations. Housing density less than 1 unit per 20 acres.
Working/Public/Rural Residential	<1	Lands under public administration with management consistent with agency mandates. Commodity production allowable but more complex due to surrounding people and structures. Housing density of one or more units per 20 acres and less than 1 unit per acre.
Working/Private/Rural Residential	3	Lands under private ownership with management and commodity production consistent with governmental regulations but more complex due to surrounding people and structures. Housing density of one or more units per 20 acres and less than 1 unit per acre. Often readily available for conversion to more intensive uses.
Agriculture/Sparsely Populated	10	Fully dedicated to irrigated agriculture. Housing density less than 1 unit per 20 acres.
Agriculture/Rural Residential	1	Fully dedicated to irrigated agriculture. More complex due to surrounding people and structures. Housing density of one or more units per 20 acres and less than 1 unit per acre.
Urban	3	Dedicated to high-density residential and commercial uses. Housing density of one or more units per acre.
Total	101	

Source: FRAP, 2002b

Figure 17. The Management Landscape of California



The Management Landscape map contains information from sources of varying dates. While most data used in the map is circa 1990–1999, some information is from the 1970s.
Source: FRAP, 2002b

Gateway to Assessment Products

The principal media used for presentation of the 2003 Assessment is the world wide web rather than a large print-based report. Rapid changes in the natural resource arena of California require the ability to broadly and quickly deliver information. Use of the web provides a unique opportunity for this assessment to be a "living document" allowing easier and faster updating of the technical reports, thus keeping them current and relevant. Additionally, the related information links included throughout the on-line assessment documents provide in-depth focus on specific topics. This approach allows users to access the most current information through internet access to spatial data, databases, literature, and external sources of information on topics of interest.

On-line Technical Reports

These are the complete, expanded evaluations of the environmental, economic, and social conditions and threats to California's forests and rangelands. In-depth narratives, statistics, methodologies, and interpretations are displayed for over 30 topics used to describe forests and rangelands. Information is available on–line and on compact disc (CD). A list of reports is shown on page 33.

Related Information

Perhaps the most important part of the Assessment is the information created or used by FRAP and made available to users for their specific needs. Four types of related information have been compiled and are available.

- **Data:** Spatial data in the form of Geographic Information Systems (GIS) files, databases, and tables from which users can extract information and develop their own analyses.
- **Maps:** A variety of Assessment-related maps are available including wildlife habitat, management complexity, ownership, wildfire characteristics, and development patterns.
- **Related links:** external links to publications and data authored by various academic, non-profit, and government agencies.
- **Interactive products**: on-line mapping services in which users can display and query spatial information.

Updated Information

By periodically updating the Assessment products (on-line technical reports and related information), discrepancies may result between the published Assessment Summary and the updated Assessment products. By referring to the Assessment website, the most up-to-date information can be obtained.

http://www.frap.cdf.ca.gov/assessment2003

On-line Technical Reports

Chapter 1: Conservation of Biological Diversity

- Habitat Diversity
- Special Habitat Elements: Snags and Down Logs
- Old Growth Forests
- Hardwoods
- Population Status of Native Species
- Species of Concern

Chapter 2: Maintenance of Productive Capacity

- Forest Land Base
- Timberland Inventory Characteristics
- Maintenance of Productivity of Forest Lands by Zoning
- Rangeland Area and Condition

Chapter 3: Maintenance of Forest and Rangeland Health and Vitality

- Habitat Loss and Alteration
- Wildfire Risks to Assets
- Trends in Wildland Fire
- Forest Pests and Diseases
- Non-native Invasive Species
- Air Quality Influences

Chapter 4: Soil Conservation and Water Quality

- Protection of Soil
- Watershed Quality and Assessment

Chapter 5: Forest Contribution to Global Carbon Cycles

- Forests and Climate Change

Chapter 6: Maintenance of Socio-Economic Benefits

- Socio-Economic Characteristics
- California's Economic Conditions and Structure
- Forest and Range Related Energy Industry
- Recreation
- Range Livestock Industry
- Forest Products Industry
- Water Supply and Use
- Contributions of Timber-Related Revenue to Local Governments

Chapter 7: Legal, Institutional, and Economic Framework for Forest and Rangeland Conservation and Sustainable Management

- Legal Frameworks
- Institutional Shifts During the 1990s
- Infrastructure and Services in Support of Forest and Range Communities
- Resource Investments
- California's Wildland Fire Infrastructure
- Information Collection, Monitoring, and Research

The 2003 Assessment and the Montréal Process

The Forest and Range 2003 Assessment is organized around the emerging worldwide forest management concept of sustainability. It is a common sense concept that resonates with the public. While it has many definitions, the Assessment uses a widely ascribed definition of meeting the needs of the present without comprising the ability of future generations to meet their needs.

To help organize the 2003 Assessment and to provide a common language and framework for evaluating sustainability, FRAP has adopted the seven internationally recognized criteria for conservation and sustainable forest management. These criteria, called the "Montréal Process" are based on discreet measurements, or indicators, that have been adopted internationally beginning with the 1992 Earth Summit, or United Nations Conference on Environment and Development. During subsequent meetings, initiatives were launched among non-European countries with temperate and boreal forests to develop and implement internationally agreed criteria and indicators for sustainable forest management.

The Montréal Process began in June 1994, in Geneva, with the first meeting of the Working Group on Criteria and Indicators for the Conservation and Sustainable Management of Temperate and Boreal Forests. The criteria and indicators derived from this process are being used by twelve countries covering over 90 percent of the world's temperate and boreal forests (as well as areas of tropical forests) (Montréal Process Working Group, 1998).

The criteria and indicators cover broad topics relevant to sustainable management. They recognize the interdependence of environmental, economic, and social goals. The seven criteria identified by the Montréal Process include vital functions and attributes (biological diversity, productivity, forest health, the carbon cycle, and soil and water protection), socio-economic benefits (timber, recreation, water, forage, and cultural values), and the laws and regulations that constitute the forest policy framework. Within these criteria are 67 indicators (Appendix, A–8) that measure the status and trends of forest conditions and help focus attention on factors affecting sustainability.

The Montréal Process

The 2003 Assessment uses the Montréal Process indicators but also adapts and expands them to meet the many different conditions within the State. California is a very diverse state with extensive forests, rangelands, metropolitan interfaces, and open space values. Often, the conditions of these components of the forests and rangelands are not expressly considered in the Montréal Process. To address this need, FRAP has used or modified the Montréal Process indicators as well as crafted descriptive, qualitative statements addressing conditions specific to California. These qualitative descriptors are used in cases where FRAP does not have enough information to make a definitive assessment or show established trends.

The broad groupings of Montréal Process indicators, along with list of adapted indicators and descriptors, used by FRAP for the Assessment Summary are shown on the following pages. The list of indicators used by FRAP reflects only a portion of the measurements, indicators, and descriptors documented in the web-based technical reports that more thoroughly cover information on the seven Montréal Process criteria.

1 Conservation of biological diversity

Ecosystem Diversity (Montréal Process Indicators 1-5)
Species Diversity (Montréal Process Indicators 6-7)
Genetic Diversity (Montréal Process Indicators 8-9)
FRAP Adaptation

- Historical Loss of Forests and Rangelands;
- Parcelization of Forests and Rangelands;
- Area and Distribution of Habitat Types;
- Conifer Forest Structural Characteristics—Size and Density;
- Old Growth Forests;
- Area and Distribution of Hardwoods;
- Management Classification and Distribution of Habitats;
- Population Status of Native Species;
- Status of Endangered, Threatened, and Sensitive Flora and Fauna

2 Maintenance of productive capacity of forest ecosystems

Area of forest land and growing stock (Montréal Process Indicators 10-12)
Removal of wood and non-timber forest products (Montréal Process Indicators 13-14)
FRAP Adaptation

- Actual and Potential Growth of Trees on Timberland;
- Forest Land Available for Timber Production;
- Characteristics of Timberland Growing Stock;
- Timber Growth Versus Harvest between 1984 and 1994;
- Rangeland Available for Grazing;
- Rangeland Grazing Capacity Compared to Use

3 Maintenance of forest ecosystem health and vitality

Area of forest land beyond the range of historic variation (Montréal Process Indicators 15–17)

FRAP Adaptation

- Land Management and Resource Outputs;
- Metropolitan Forests and Rangelands;
- Location of Range Livestock Management Activities;
- Impacts from Timber Production;
- Lands in Reserve Status;
- Projected Loss and Alteration of Land Cover Due to Housing Development;
- Projected Loss and Alteration of Hardwood Land Cover Due to Development;
- Wildland Fire Threat;
- Proportion of Forests and Rangelands Susceptible to Ecosystem Health Risk from Wildfire;
- Proportion of Housing Units in the Wildland Urban Interface at Significant Risk from Fire;
- Proportion of Conifer Forest Areas at High Risk to Pest Damage through 2015;
- Identification of Emerging Pests and Diseases;
- Presence or Absence of Range Livestock Diseases;
- Presence of High Impact Non-native Invasive Plants;
- Proportion of Non-native Animal Species Relative to Total Species;
- Presence of Weed Control Programs;
- Trends of Air Pollution Levels Expressed in Non-attainment Days

4 Conservation and maintenance of soil and water resources

Area of forest land with dimished soil quality (Montréal Process Indicators 18, 19, 21, 22)
Area of forest land with dimished water quality (Montréal Process Indicators 20, 23–25)

FRAP Adaptation

- Land Use in Watersheds;
- Regulatory Status of Water Quality Impairments;
- Trends in Salmon Populations;
- Monitoring Results of Private Timber Management Practices;
- Monitoring, Watershed Assessment, and Cumulative Watershed Effects

5 Maintenance of forest contribution to global carbon cycles

Total forest ecosystem biomass and carbon budget (Montréal Process Indicators 26–28)

FRAP Adaptation

- Impacts of Climate Change on Forest and Rangeland Resources
- Effects of Forests on Carbon Levels
- Trends in Greenhouse Gas Emission Reduction
- Programs to Reduce Emissions of Greenhouse Gases

6 Maintenance and enhancement of long-term multiple socio-economic benefits to meet the needs of societies

Production and Consumption (Montréal Process Indicators 30–34)
Recreation and Tourism (Montréal Process Indicators 35–37)
Investment in the Forest Sector (Montréal Process Indicators 38–41)
Cultural, Social, and Spiritual Needs and Values (Montréal Process Indicators 42–43)
Employment and Community Needs (Montréal Process Indicators 44–47)

FRAP Adaptation

- Income and Well Being Index;
- Regional Job and Wage Growth Trends;
- Commodity and Non-commodity Production and Use Trends;
- Water Quality and Use, Status of Forest Products Industry, Status of Range Livestock Industry, Status of Forest and Rangeland Energy-Related Resources, and Status of Recreation Industries;
- Timber and Rangeland Contributions to Funding Rural Infrastructure Needs

7 Legal, institutional, and economic framework for forest conservation and sustainable management

Legal Framework (Montréal Process Indicators 48–52)
Institutional Framework (Montréal Process Indicators 53–57)
Economic Framework (Montréal Process Indicators 58–59)
Capacity to Measure and Monitor Changes (Montréal Process Indicators 60–62)
Research and Development (Montréal Process Indicators 63–67)

FRAP Adaptation

- Regulatory Jurisdictions Over Management Activities;
- Level of Conflict;
- Level of Cooperation, Information Sharing, and Education;
- Governmental Resource Investments

Californians care deeply about the quality of the vast array of forest and rangeland resources. They appreciate their beauty and depend on these natural resources for the basics of life and as part of the State's economy.

In order for Californians to familiarize themselves with the complexities surrounding forests and rangelands, they need to understand the status and trends of the environmental, economic, and social conditions vital to long-term sustainability. This summary of status and trends will help identify regions where California has been most successful in forest and rangeland sustainability and where threats remain.

While forest and rangeland conditions continue to recover from historic land use legacies, new emerging forest health concerns have arisen.

Biological Diversity Status and Trends

Measurements of biological diversity are indications of environmental conditions. Simply defined, biological diversity is the variety of life over some spatial unit. It can be measured at several levels. These include ecosystem diversity (the variety of habitats and communities), species diversity (the number and mix of species within an ecosystem), and genetic diversity (variation within a species).

This assessment focuses on ecosystem and species diversity and, where data is available, on species population status and trends. Within any given landscape, the mix and relative diversity of species supported is frequently determined by the arrangement and types of habitat. Habitat conditions change over time and within a range of different plant communities (successional stages) that are determined by a number of factors, such as environmental conditions and historical and current land management activities. Some factors, such as permanent conversion of natural vegetation to development or agriculture have long lasting and obvious impacts on habitat and the mix of associated fish and wildlife. Other factors , such as competition between species, predation and disease, and the effect of environmental conditions during species migrations are more difficult to measure. Nevertheless, habitat based measures are frequently used—both with and without supportive wildlife population data—to make observations on the status of current and future biological diversity.

Biological Diversity Indicators

- Historical Loss of Forests and Rangelands
- Parcelization of Forests and Rangelands
- Area and Distribution of Habitat Types
- Conifer Forest Structural Characteristics—Size and Density
- Old Growth Forests
- Area and Distribution of Hardwoods
- Management Classification and Distribution of Habitats
- Population Status of Native Species
- Status of Endangered, Threatened, and Sensitive Flora and Fauna

Yosemite Valley, California.

Biological Diversity

Representative Goal

Protect forest lands and terrestrial and aquatic resources by focusing on protection of habitat, [including] connectivity, riparian habitats, oak woodlands, ecological old growth forests, and other key forest types…that are poorly represented [to avoid] threatened or endangered species designation *(California Fish and Game Commission policy on endangered and threatened species, California Fish and Game Code, Section 2050, California Public Resources Code, Section 12210, and California Forest Legacy Program Act of 2000).*

Findings

- California has lost 15 percent of its presettlement era native landscapes to urbanization and intensive agriculture. While expansive landscapes are still relatively intact, the extent of some habitats has declined significantly: riparian forests and woodlands (95 percent loss of historical statewide extent) and needlegrass steppes (99 percent loss).
- Low density, rural residential housing, called parcelization, affects 3.2 percent of forests and rangelands. Several bioregions have substantially higher levels (more than 10 percent), particularly in the South Coast, Central Coast, and Sacramento Valley bioregions.
- California has a wide range of forest conditions. Dense forest conditions where large trees contributed to a closed canopy, make up 24 percent of conifer forest land. Forests with smaller tree sizes (less than 24" in diameter) are the most extensive forest condition, covering 45 percent of conifer forests.
- Several unique habitats, such as old growth forests, have retained only a portion of their original extent. Old growth forests extent is currently aground one quarter of its historic level. Other valued forest structural elements such as snags and down logs and open canopies are also reduced in extent and distribution.
- Twenty-three percent of forests and rangelands are managed for ecological protection and other non-consumptive recreational and aesthetic values (Reserve status). The remaining 77 percent are managed for a wide range of ecological and commodity uses (Working status). Some Lands in Working/Private status, with limited extent and future risks of additional land use impacts, are of particular concern.
- Regulatory listings of species as threatened or endangered continue to rise, particularly for plant and fish species.
- Population numbers of many species are stable; however, some large mammal, bird, and amphibian species once considered common are declining in population.

Historical Loss of Forests and Rangelands

On-line Technical Report:
http://frap.cdf.ca.gov/assessment2003/Chapter3_Quality/habitat.html
Data Quality: Partial data ◐

One of the regional indicators used to measure the status of biological diversity relates to the change in extent (area) of forests and rangelands over time (Figure 18). The analysis estimates the percentage of presettlement native landscapes (forests and rangelands) lost to urbanization or agriculture uses since settlement in California began in the 1500s–1600s. This date reflects the general time frame of initial exploration and the onset of European settlement in California (Kinney, 1996). The analysis does not consider lands with low density, rural residential housing. It considers only intensive agriculture and urbanization (housing density of one or more units per acre or commercial/industrial use).

Losses have been most evident in the San Joaquin Valley, Sacramento Valley, South Coast, and Bay Area/Delta bioregions (Figure 18). These changes exemplify California's transition from a state known for utilizing its abundant natural resources to one of a mostly urban population living among these resources.

Parcelization of Forests and Rangelands

On-line Technical Report:
http://frap.cdf.ca.gov/assessment2003/Chapter3_Quality/habitat.html
Data Quality: All necessary data ●

Parcelization is defined as low density rural residential development—housing density of one or more units per 20 acres but not exceeding one housing unit per acre. While the conversion of land to urban uses has relatively obvious and straightforward impacts due to the nearly complete loss of natural vegetation, the more extensive parcelization at the fringes of urban areas retains at least some ecologically important characteristics.

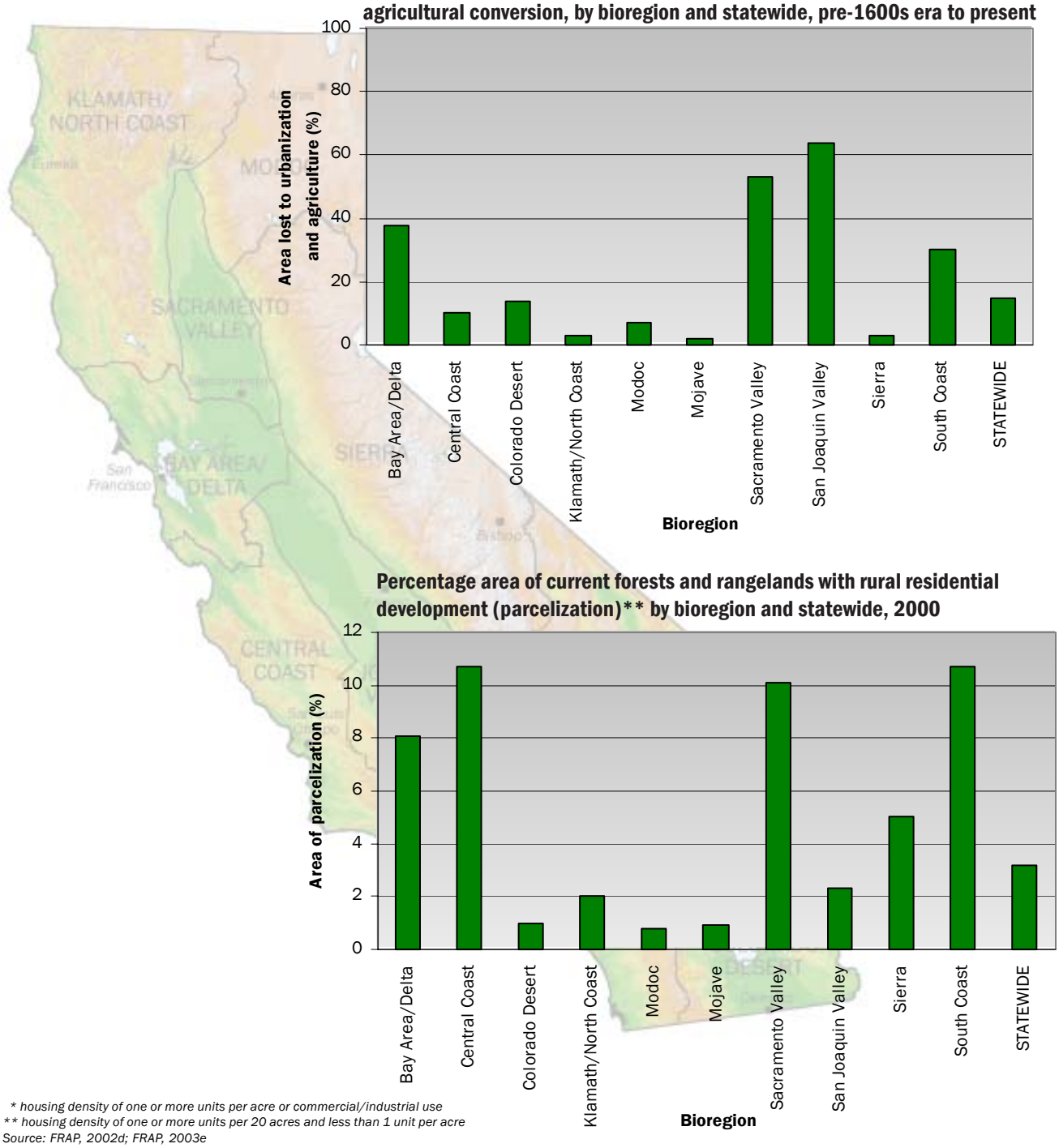
Parcelization is also an indicator of probable future urbanization. FRAP has conducted studies of historical housing growth in California that show parcelized areas are highly likely to densify toward urban levels. By understanding where and how such parcelization occurs, land use planners, stakeholders, and other decision makers can prioritize measures to protect biological diversity and other values.

Overall, less than five percent of forests and rangelands are parcelized. The highest current levels of parcelization occur in the South Coast, Central Coast, and Sacramento Valley bioregions, affecting more than 10 percent of the forest and rangeland extents. The Bay Area/Delta bioregion is also highly parcelized (approximately eight percent). Least parcelized are the Modoc, Mojave, Colorado Desert, and Klamath/North Coast bioregions (all with less than two percent of area parcelized). The San Joaquin Valley bioregion has significant parcelization within agricultural lands, but not within the remaining forests and rangelands.

Photo courtesy of Bureau of Land Management.

Figure 18. Regional Biological Diversity Indicators

Large scale land conversion and development during California's recent history has negatively influenced biological diversity on a regional basis. As new land uses alter the extent and arrangement of the forest and rangeland landscape, biological diversity will be further challenged.



** housing density of one or more units per acre or commercial/industrial use*
*** housing density of one or more units per 20 acres and less than 1 unit per acre*
Source: FRAP, 2002d; FRAP, 2003e
Map: California Biodiversity Council bioregions.

Additional analysis of recent historical progression of housing development further describes regional declines in land cover. Using the Weislander vegetation data from the 1940s (Pacific Forest Trust, 1998), FRAP analyzed the progression of development (housing density of one or more housing units per 20 acres) from 1940 to 2000. During this period, 3.1 million acres (10 percent) of forests and rangelands became developed (Figure 19). Rangeland development has been substantial over this time frame with over two million acres developed (Table 6). Bioregional differences show that the South Coast has experienced the largest total and percentage change in forest and rangeland land cover due to housing development (Table 7).

The current status and projected trend of the extent of forests and rangelands has implications for the conservation of biological diversity (see Chapter 3, Forest Health - Development). Some areas have experienced relatively little change. For example, while their vegetation characteristics are markedly different, bioregions such as the Modoc, Klamath/North Coast, and Central Coast, maintain a high percentage area of their original plant and wildlife communities. Conversely, within the South Coast and lower elevations of the Sierra and Central Coast bioregions, there is increasing development pressure that will be a challenge for the conservation of biological diversity over the coming decades.

Table 6. Area and percentage area of private, undeveloped lands that became developed* between 1940 and 2000, by land cover type (thousand acres)

Land cover type	1940 undeveloped land base area	Area developed 1940–2000	Percentage area developed 1940–2000
Forest	7,550	724	10
Range	24,346	2,358	10
Agriculture	11,860	2,740	23
Barren*	7,297	563	8
Total	51,052	6,384	13

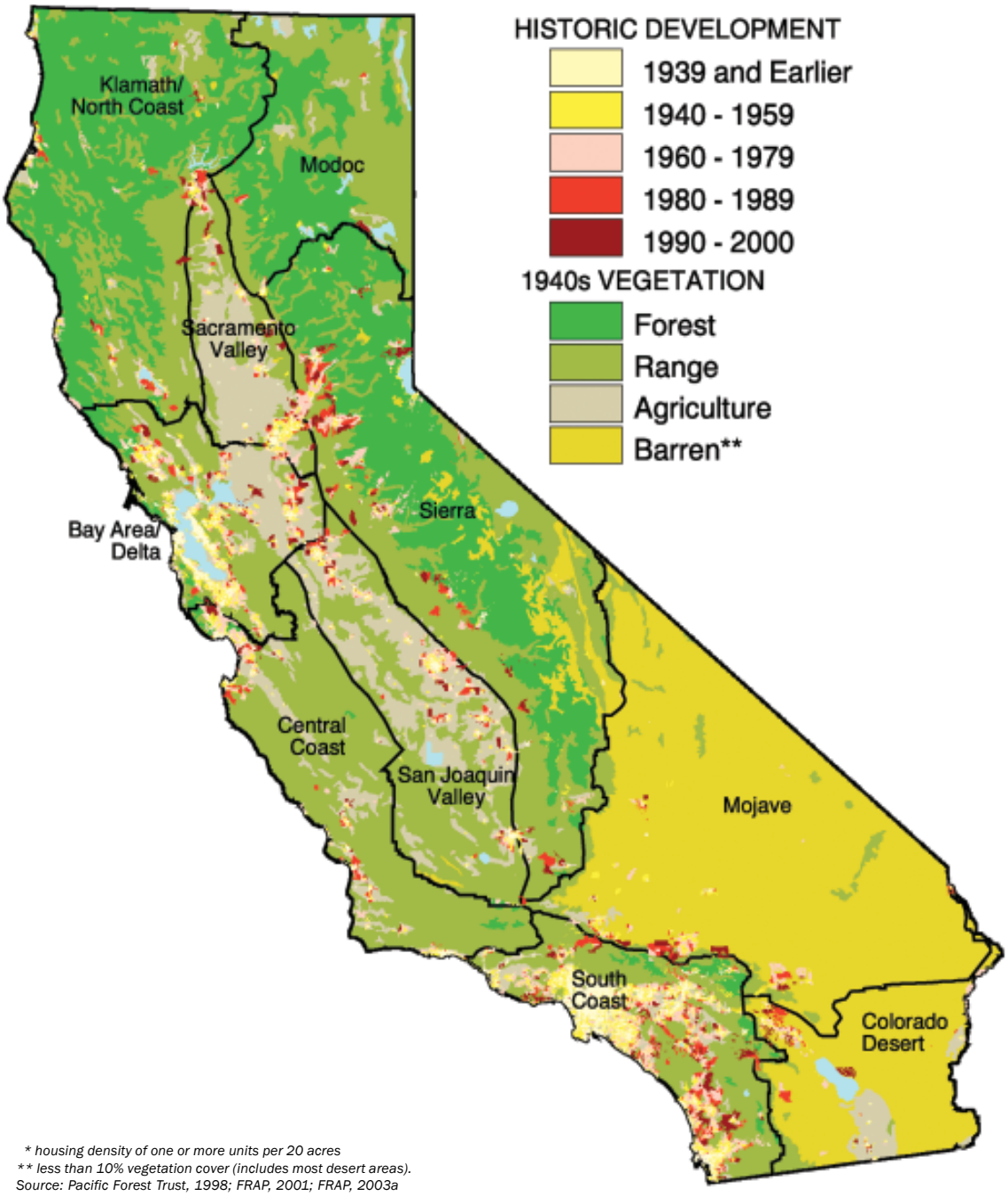
** housing density of one or more units per 20 acres*
Source: Pacific Forest Trust, 1998; FRAP, 2001; FRAP, 2003a

Table 7. Area and percentage area of private, undeveloped forests and rangelands that became developed* between 1940 and 2000, by bioregion (thousand acres)

Bioregion	1940 undeveloped area of F & R	Area of F & R developed 1940–2000	Percentage area developed 1940–2000
Bay Area/Delta	2,458	287	12
Central Coast	4,701	238	5
Colorado Desert	160	9	6
Klamath/North Coast	7,116	248	3
Modoc	3,005	56	2
Mojave	538	86	16
Sacramento Valley	1,488	196	13
San Joaquin Valley	3,774	44	1
Sierra	5,928	932	16
South Coast	2,678	985	37
Total	31,845	3,081	10

** housing density of one or more units per 20 acres*
F & R - forests and rangelands
Source: Pacific Forest Trust, 1998; FRAP, 2001; FRAP, 2003a

Figure 19. Historical progression of development*



** housing density of one or more units per 20 acres*
*** less than 10% vegetation cover (includes most desert areas).*
Source: Pacific Forest Trust, 1998; FRAP, 2001; FRAP, 2003a

Area and Distribution of Habitat Types

On-line Technical Report:
http://frap.cdf.ca.gov/assessment2003/Chapter1_Biodiversity/habitatdiversity.html
Data Quality: All required data

FRAP uses the California Wildlife Habitat Relationship System (CWHR) to classify natural vegetation into habitat types for its Multi-Source Land Cover dataset (v02_1). The CWHR system provides a means to classify vegetation by wildlife habitat condition and species use.

Forests and rangelands include a wide variety of habitats. Conifer, Hardwood, Shrub, Grassland, Desert, and Wetland land covers contain 42 different CWHR habitats and cover over 80 million acres (Table 8, Figure 20). Forests are defined as lands with greater than 10 percent tree cover and include the Conifer Forest, Conifer Woodland, Hardwood Forest and Hardwood Woodland land cover classes. Typical Conifer Forest habitats include Sierran and Klamath Mixed Conifer, while Juniper is a common habitat in Conifer Woodland. Typical Hardwood Forest and Hardwood Woodland habitats include Montane Hardwood and Blue Oak Woodland, respectively.

Rangelands include Conifer Woodland, Hardwood Woodland, Shrub, Grassland, Desert, and some Wetland land cover classes. Typical habitats include Coast Oak Woodland, Mixed Chaparral, Annual Grassland, Desert Scrub, and Wet Meadow (see Appendix for a complete table of habitat types and a detailed map of distributions).

Some of the CWHR types are relatively rare such as Valley Oak Woodland (137,000 acres), Aspen (40,000 acres), and Joshua Tree (84,000 acres). Furthermore, specific species within broader CWHR habitat types such as Monterey Pine (*Pinus radiata*), Giant Sequoia (*Sequoiadendron giganteum*) and Engelmann Oak (*Quercus engelmannii*) also have low abundance. From a public policy perspective, any substantial reduction in these habitats from conversion, natural catastrophes, or habitat simplification would be potentially significant given their limited current extent.

Table 8. Area of forests and rangelands by land cover class (thousand acres)

Land cover class	Area
Conifer Forest	19,004
Conifer Woodland	2,363
Hardwood Woodland	5,188
Hardwood Forest	4,690
Shrub	14,565
Grassland	10,919
Desert Shrub	23,461
Desert Woodland	87
Wetland*	268
Total	80,545

** Only the Wet Meadow CWHR habitat type is considered forests and rangelands. See Appendix.*
Source: FRAP, 2002d

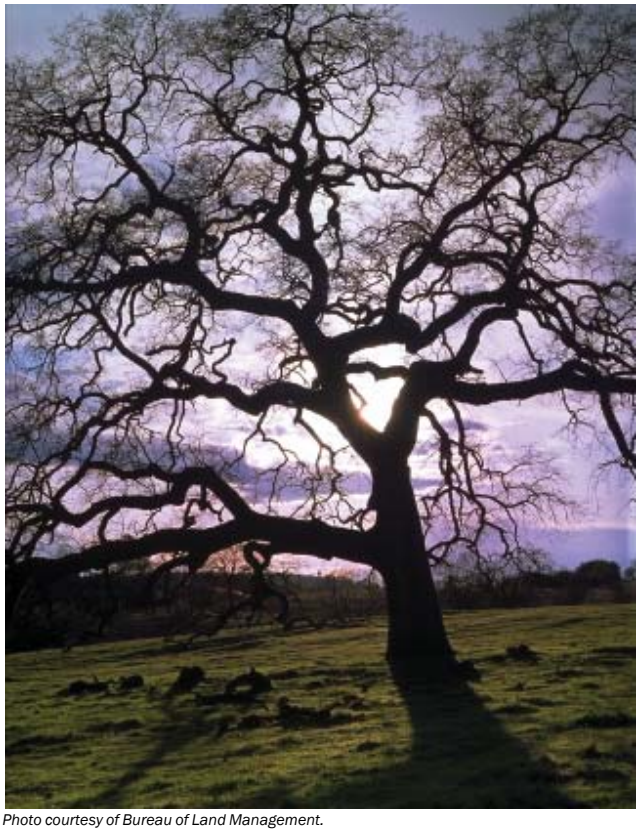
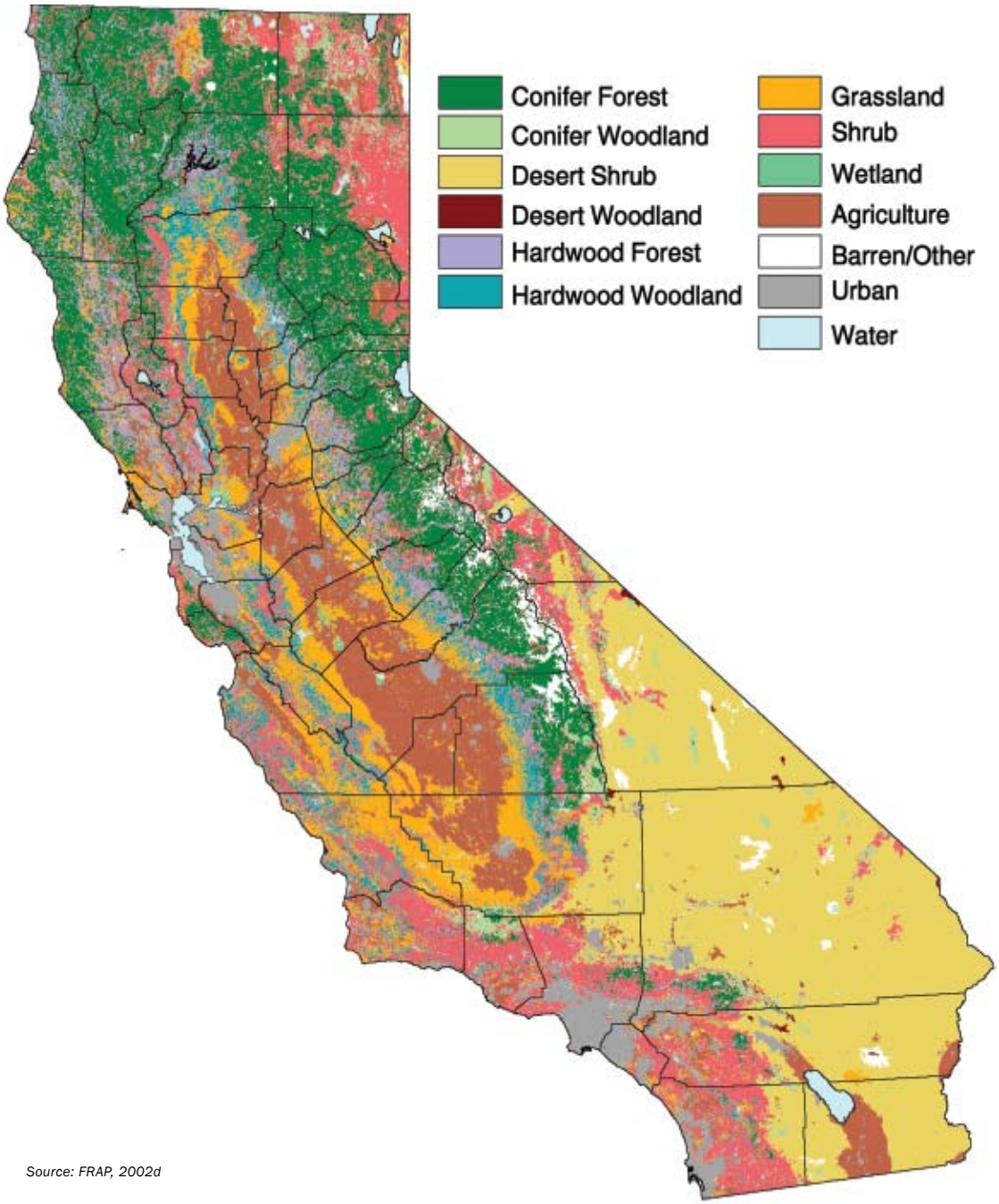


Photo courtesy of Bureau of Land Management.

Figure 20. Land cover of California



Source: FRAP, 2002d

Conifer Forest Structural Characteristics—Size and Density

On-line Technical Report:
http://frap.cdf.ca.gov/assessment2003/Chapter1_Biodiversity/habitatdiversity.html
Data Quality: All required data

Data on the size, density, and age of forests in California help provide an understanding of current and future habitat conditions related to fish and wildlife. Ecosystem processes and associated biological diversity are related in part to different characteristics of vegetation structure (age, diameter, height, density) and successional stages (progression of plant community development). Other structural elements, such as individual snags and down logs, cannot be mapped at the scale used here but play important roles in defining habitat quality for animal species.

Forest management and natural agents have changed the structural characteristics of California forests over time. These characteristics are dynamic and at any point in time, what was true a decade earlier may have changed due to growth, removals, fire, competition, and/or decline of vegetation. The picture from today's perspective is that conifer forests are dominated by trees over 10 inches in diameter at breast height (DBH) in size and in dense or moderately dense stands (Table 9). About two-thirds of all conifer forests fit this description in terms of tree size and canopy closure measurements.

One impact of this pattern is concern over the lack of open forest stands (10 to 39 percent canopy closure) and associated plant communities in some areas. Fire exclusion policies and timber management practices have reduced the extent of open forest canopy conditions that foster grass or shrub development in the forest understory. Where closed canopy conditions are widespread, they have contributed to the decline in species associated with these open canopy habitats. Most forests currently in the open canopy class will grow into moderate canopy closure and not thin out without harvesting programs or extensive wildfire.

Another concern is the maintenance of sufficient area of forest habitat containing large trees in addition to

Table 9. Percentage area of Conifer Forest by tree size and canopy closure

Canopy closure	Seedlings and Saplings <10" dbh	Small trees 11" to 24" dbh	Medium to large trees >24" dbh	Unclassified	Total
Open (10-39% CC)	6	11	2	1	20
Moderate (40-59% CC)	4	14	4	1	23
Dense (>60% CC)	7	21	24	1	53
Unclassified	<1	<1	<1	4	5
Total	17	45	31	7	100

CC – canopy closure; dbh – diameter at breast height (4.5 ft); <1 – less than one percent; Note: totals may not add due to rounding
Source: FRAP 2002d

Conifer forest stand. Photo courtesy of G. Donald Bain, Geo–Images Project, UC Berkeley.

those classified as "old growth." Of the 19 million acres of Conifer Forest, 31 percent are dominated by medium to large trees (over 24 inches) (Table 9). An additional 45 percent are in the 11 to 24–inch range, and could be recruited into the larger class over the next few decades.

Old Growth Forests

On-line Technical Report:
http://frap.cdf.ca.gov/assessment2003/Chapter1_Biodiversity/oldgrowth.html

Data Quality: Partial data ◐

Old growth forests represent the other end of the spectrum of forest development. Old growth has attracted much public attention and over a million acres of these forests have been designated parks and reserves. These forests provide a variety of ecological and social values that are hard to quantify. Consequently, defining and measuring the extent and quality of this resource can be problematic. For example, the significance of a single large tree will have a markedly different value when seen from ecological, cultural, or inspirational perspectives.

The USFS defines old growth by identifying the structural characteristics that indicate the onset of an old growth forest seral stage (Beardsley et al., 1999). In addition to stand size greater than 20 acres, the principal structural characteristics, which vary by forest type and site class, include the following measures:

- stand age;
- size and density of large trees;
- size and density of large snags and logs;
- degree of multiple canopy layers; and
- degree of decay in live trees.

The California State Board of Forestry and Fire Protection uses a broader definition to identify late successional forest (LSF). This definition, contained in the Forest Practice Rules (FPRs), uses tree size, canopy cover, functional characteristics (snags and down logs), and a minimum patch size of 20 acres. In general, late successional forest stands have considerable structural and ecological overlap with old growth forest stands and may, in time, provide a number of the values attributed to old growth forests.

Approximately 2.7 million acres (14 percent) of Conifer Forests are classified as old growth based on statistical assessments of field plots on public and private lands (Table 10). The vast majority (over 96 percent) is in public ownership where protection is required by law or is a probable management objective (Table 11). A substantially larger amount of Conifer Forests (6.2 million acres) are classified as LSF based on canopy cover and tree size characteristics, but ignoring smaller components such as snags, down logs, and other habitat elements. Many of these acres, particularly those on public lands, will be managed to achieve older forest structure over time. The extent and location of these stands in the future will depend on management objectives, catastrophic events (e.g., wildfire, insects, disease), and growth potential.

Table 10. Area of late successional* and old growth forests by type (thousand acres)

General forest type	Total Conifer Forest cover	Late successional*	Old growth stands
Mixed conifer	7,848	2,240	553
Douglas-fir	3,335	1,662	414
True firs	2,240	878	602
Redwood	1,297	608	95
Pine	3,642	715	929
Sub-alpine	642	97	137
Total	19,004 (100%)	6,200 (33%)	2,730 (14%)

** approximate estimate of late successional forests excludes consideration of 20 acre minimum patch size and presence of functional characteristics (decadent trees, snags, and large down logs)*
Source: compiled by FRAP from Warbington and Beardsley, 2001; Bolsinger and Waddell, 1993; Franklin and Fites-Kaufmann, 1996; FRAP, 2002d

Table 11. Percentage of total old growth area by ownership

Owner	(%) of old growth area
National Forest Wilderness and Reserves	29
National Forest	49
Other Public Reserves	17
Other Public	1
Private, Industrial	1
Private, Non-Industrial	2
Total	100

Source: compiled by FRAP from Warbington and Beardsley, 2001; Bolsinger and Waddell, 1993; Franklin and Fites-Kaufmann, 1996; FRAP, 2002d

Area and Distribution of Hardwoods

On-line Technical Report: http://frap.cdf.ca.gov/assessment2003/Chapter1_Biodiversity/hardwoods.html

Data Quality: All required data

Hardwood forests and woodlands are some of the most biologically rich vegetation types in terms of the number of vertebrate species supported. FRAP estimates over 9.8 million acres of Hardwood Woodland and Hardwood Forest exist statewide (Table 12, Figure 21). Hardwood Woodland comprises approximately 53 percent of these acres. Within Hardwood Woodlands, Blue Oak Woodland habitat has the most extensive distribution covering 29 percent of all Hardwood extent. Of the Hardwood Forest types, Montane Hardwood habitat has the most extensive distribution covering about 45 percent of total Hardwood area.

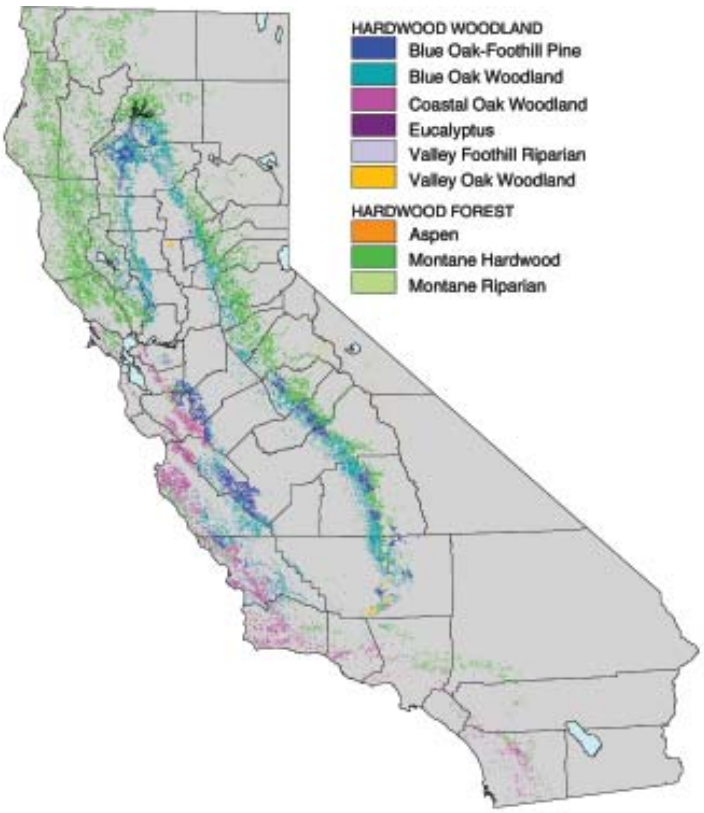
Management Classification and Distribution of Habitats

On-line Technical Report: http://frap.cdf.ca.gov/assessment2003/Chapter1_Biodiversity/FindingsHabitatOwnrshpMgmt.pdf

Data Quality: Partial data

California's species and habitats are protected by a variety of laws, regulations, and land use designations. Examples include national and state parks, wilderness areas, and public and private ecological reserves. In addition, numerous habitats on private ownerships, such as Blue Oak Woodland, remain relatively large and intact even though they have been actively managed for more than a century. Each land cover or habitat type can be classified using FRAP's Management Landscape groupings.

Figure 21. Extent of Hardwood Woodland and Hardwood Forest CWHR types



Source: FRAP, 2002d

Table 12. Area of CWHR types and percentage of total hardwood area (thousand acres)

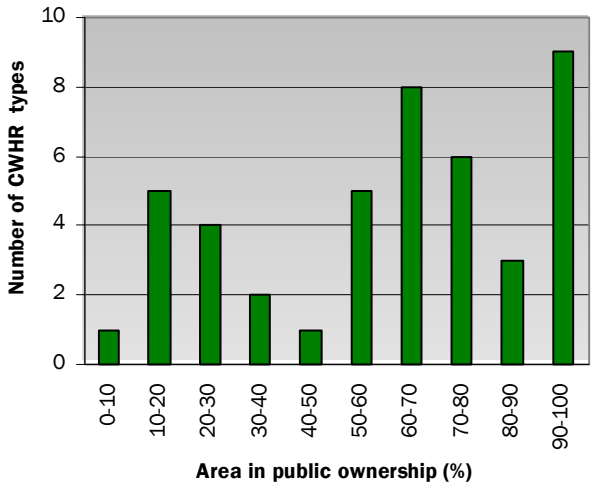
Habitat type (CWHR)	Area	Percentage of total hardwood area
Hardwood woodland		
Blue Oak Foothill Pine	979	10
Blue Oak Woodland	2,819	29
Coastal Oak Woodland	1,095	11
Eucalyptus	11	<1
Valley Foothill Riparian	147	1
Valley Oak Woodland	137	1
Total	*5,188*	*53*
Hardwood forest		<1
Aspen	40	<1
Montane Hardwood	4,439	45
Montane Riparian	211	2
Total	*4,691*	*47*
Total hardwoods	9,879	100

Source: FRAP, 2002d

The distribution of the nine major forest and rangeland land cover types by management class provides insight to the land use objectives afforded to each type. A similar analysis can be applied to individual habitats (Table 13). For example, Hardwood Woodlands are predominately found in the Working/Private class while Desert Shrubs are predominately in the Public or Reserve classes.

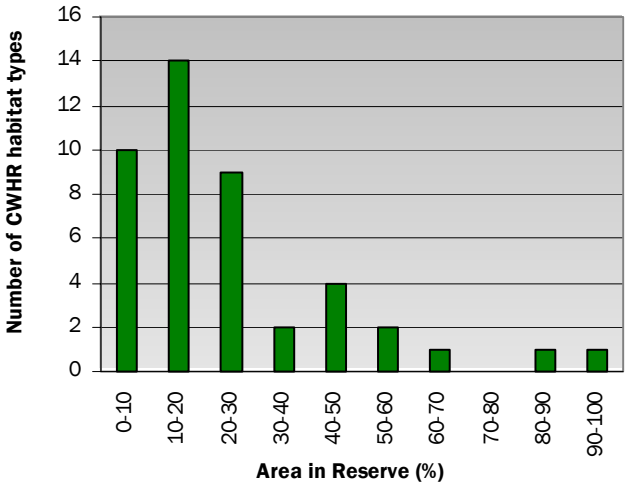
For public lands, 26 habitats of the 44 forest and rangeland habitat types have extensive (greater than 60 percent) area in public ownership (Figure 22). Lands in Public ownership are rarely converted to more intensive land uses and management shifts to Reserve status do not involve loss of private property rights. In contrast to public ownership, many habitats are not well represented in the Reserve class (Figure 23), with 33 having less than 30 percent of their area in Reserve. While Reserve status may provide a high level of protection from intensive land uses, other threats such as wildfire ignore administrative boundaries. Increasing the area of underrepresented habitats in Reserve status is one strategy to protect land from intensive use. However, this typically requires Congressional approval or acquisition of new land. For the majority of habitat types, biological diversity has depended upon—and will continue to depend upon—sustainable management within the Working/Public, Working/Private, as well as Reserve management classes.

Figure 22. Number of CWHR types by percentage area in public ownership



Source: FRAP, 1999; FRAP, 2002d

Figure 23. Number of CWHR types by percentage area in Reserve Management Landscape class



Source: FRAP, 2002b; FRAP, 2002d

Table 13. Area of land cover classes by selected Management Landscape classes* (thousand acres)

Land cover class	Reserve	Working/ Private**	Working/ Public**	Rural Residential***	Total
Conifer Forest	3,827	5,901	8,810	437	18,975
Conifer Woodland	757	414	1,166	20	2,356
Hardwood Woodland	344	3,783	624	263	5,013
Hardwood Forest	505	2,560	1,312	256	4,633
Shrub	2,750	4,685	6,477	477	14,389
Grassland	504	7,860	872	431	9,667
Desert Shrub	9,070	3,604	10,472	228	23,374
Desert Woodland	53	23	9	2	87
Wetland	65	125	60	4	253
Total	17,875	28,953	29,802	2,117	78,747

** Due to mapping differences between Management Landscapes (v1.0) and the Multi-Source Land Cover (v02_1) for the Urban and Agriculture classes, total forest and rangeland area numbers do not agree.*
*** Sparsely Populated*
**** includes Working/Public/Rural Residential and Working/Private/Rural Residential*
Source: FRAP, 2002b; FRAP, 2002d

Population Status of Native Species

On-line Technical Report:
http://frap.cdf.ca.gov/assessment2003/Chapter1_Biodiversity/population.html

Data Quality: Partial data

Biological diversity may also be assessed by examining population trends of a species or species group or by examining trends in formal listings under state and federal endangered species laws. California's forests and rangelands support many species (Table 14). Conifer Forests provide optimal, or at least suitable, breeding habitat for 354 wildlife species including 114 mammals, 177 birds, and 63 reptile and amphibian species. The California Department of Fish and Game and other agencies monitoring animal populations have identified three key findings on population trends regarding big game, bird, and amphibian species.

Population numbers and trends of large mammals are varied. On a local herd assessment unit basis, marked declines and increases in deer species numbers, habitat quality, and availability are evident. In recent years, deer (*Odocoileus hemionus*) populations have shown the most marked declines in northeastern California and the northern and central Sierra Nevada. Bighorn sheep (*Ovis canadensis spp.*) numbers have decreased from the effects of habitat loss, disease, and predation. Information on trends in furbearer and non–game mammal populations is limited in California. Currently, only the bobcat (*Lynx rufus*) shows potentially downward trends in population over the last 10 years.

Bird species within cavity nesting, open cup nesting, and neotropical life history groups (groups of species with similar life history requirements) are frequently the object of conservation and management initiatives. Managers are concerned over the loss of snags, nest parasitism by other bird species, and habitat loss. Smaller percentages of bird species were considered stable in the period of 1980–99 than from 1966–1979. Some bird species previously considered common in forested habitats, but also requiring open shrub and herbaceous conditions within their habitat type, have shown marked long term population declines (Table 15). These trends may be indicative of the general reduction in open forest canopy conditions and, in particular, the herbaceous and shrub understory components.

Over the last decade, many amphibian species in California have shown general population declines. Frog and toad species have exhibited the most significant declines. Forty percent of the toad species (four of 10) and 88 percent of the native frog taxa (seven of eight) have been lost from at least 45 percent of their historic California distribution. Extensive rangelandwide surveys are continuing across most habitat and owenership classes.

Table 14. Species richness by land cover class*

Land cover class	Number of species				
	Amphibians	Reptiles	Birds	Mammals	Total
Agriculture	9	12	194	61	276
Conifer Forest	32	31	177	114	354
Conifer Woodland	6	51	141	85	287
Desert Shrub	11	53	102	85	251
Desert Woodland	13	50	156	67	286
Hardwood Forest	30	26	175	102	333
Hardwood Woodland	30	45	205	98	378
Grassland	20	38	135	114	307
Shrub	27	68	186	133	414
Urban	4	8	169	43	224
Wetland	29	22	186	89	326

** Optimal (High) or Suitable (Medium) breeding habitat suitability ratings*
Source: California Department of Fish and Game and California Interagency Wildlife Task Group, 2001

Table 15. Number of bird species with stable or decreasing population trends by life history groups

Bird species	1966-1979		1980-1999	
	Stable	Decreasing	Stable	Decreasing
Neotropical migrants	79	---	73	---
Open cup nesters	83	14	73	24
Cavity nesters	85	5	65	27

Source: Sauer et al., 2000

Status of Endangered, Threatened, and Sensitive Flora and Fauna

On-line Technical Report: http://frap.cdf.ca.gov/assessment2003/Chapter1_Biodiversity/speciesofconcern.html

Data Quality: Partial data

California has a rapidly growing population and is also the most biologically diverse state in the contiguous United States. As a result, threats to the continued existence of native species and existence of their habitats on which they depend are also increasing. The California Department of Fish and Game ranks species degradation and loss of habitat from urbanization as the greatest threat to the continued existence of the state's listed flora and fauna.

Examining biological diversity from a regulatory perspective reveals the total number of federal or state listed species in California has increased from 195 in 1987 to 389 in 2000 (Table 16). Plant species show the largest increase in number of formal listings.

Table 16. Cumulative number of officially listed* taxa, 1987–2000**

Year	Plants	Gastropods	Crustaceans	Insects	Fish	Amphibians	Reptiles	Birds	Mammals	Total
1987	118	-	-	-	18	8	9	20	22	195
1990	215	1	2	12	18	8	9	26	25	316
1993	218	1	2	13	18	8	13	28	26	327
2000	254	2	8	20	26	10	13	28	28	389

** Officially listed animal species refers to state listed as threatened or endangered (T&E), federally listed as threatened or endangered or on both the state and federal list as threatened or endangered. Officially listed plant species refers to those that are state listed as threatened, endangered, or rare (TE&R), federally listed as threatened or endangered, or both state and federally listed as threatened or endangered.*
*** includes species, subspecies, distinct populations, and evolutionary significant units (ESU)*
Source: California Department of Fish and Game, 2001a

*California Red-legged frog (*Rana aurora draytonii*). Photo courtesy of U.S. Fish and Wildlife Service.*

2 Productive Capacity

Productive Capacity Status and Trends

Productive capacity refers to the capability and availability of forests and rangelands to produce products for society. In order to maintain the productive capacity of forests and rangelands, Californians must know how much of these lands exist and how much is being actively managed.

Several factors are particularly important measures of the sustainability of productive capacity. These factors include the area of land base producing products, the inherent growing capability of this land base, and the management intensity.

Productive capacity measurements using inventories and outputs reflect the influences of harvesting, land use changes, and natural disturbances. However, these measures can mask other influences such as disease and climate change that may have long–term effects on productive capacity (U.S. Forest Service, 2000).

Productive Capacity Indicators

- Actual and Potential Growth of Trees on Timberland
- Forest Land Available for Timber Production
- Characteristics of Timberland Growing Stock
- Timber Growth Versus Harvest Between 1984 and 1994
- Rangeland Available For Grazing
- Rangeland Grazing Capacity Compared to Use

Skyline yarding used in timber harvesting

Productive Capacity

Representative Goal

Achieve Maximum Sustainable Production on timberlands and improve rangelands while maintaining other values *(paraphrased from Z'Berg–Nejedly Forest Practice Act, California State Board of Forestry Handbook, Chapter 0335).*

Findings

- Approximately 16.5 million acres of timberland in California are capable of growing more than 20 cubic feet of wood per acre per year. Of this, 56 percent is in public ownership and 44 percent is privately owned. On public lands, areas capable of timber production have been administratively withdrawn for a variety of purposes and have been redirected to uses other than those primarily devoted to timber production.
- Timberland area, outside national forests, has decreased by about two percent from 1984 to 1994 (the most recent monitoring period). Over 70 percent of this decline is attributable to transfers to reserve status, where timber production is not emphasized. Relatively less area of timberland has been converted to non–timber uses such as urban and low–density residential during this same period (76,000 acres).
- Timberland growing stock volume has increased by 16 percent between 1977 and 1997, following a period of decline between 1950 and 1977.
- Growing stocks of merchantable timber are evenly split between stands with average ages of less than 100 years and of greater than 100 years. Stands greater than 100 years of age are far more prominent on public lands than on private lands.
- Annual growth on timberlands is about 70 percent of potential growth capability. Increasing hardwood components, biodiversity considerations and restrictions on intensive management contribute to realized growth falling short of potential growth.
- Growth of trees on private timberlands far exceeds harvest levels. Harvests have been 64 percent of growth between 1984 and 1994, indicating sustainable levels of resource use.
- Approximately 41 million acres of rangelands are currently available for grazing, representing 72 percent of all suitable rangelands in the state. Approximately 34 million acres are actually grazed.
- Rangeland forage production (grazing capacity measuring animal unit months) seems to exceed use, but several other factors affect available forage and viable rangeland grazing operations.

Actual and Potential Growth of Trees on Timberland

On-line Technical Report:
http://frap.cdf.ca.gov/assessment2003/Chapter2_Area/timberland.html
Data Quality: All required data

The regional indicator used to measure productive capacity is actual timber growth compared to growth potential (Figure 24). This indicator reveals how effectively the lands available for growing timber are being used for this purpose. Each region's growth potential is the innate capacity to grow trees based on soil and climate characteristics and is expressed in cubic feet per acre per year.

The dominant regions in California for growing timber are the North Interior, Sacramento, and North Coast as defined by the U. S. Forest Service Forest Inventory and Analysis (FIA) resource areas. Of these, the North Coast has the land with greatest total potential growth. The Central Coast also has very high potential growth but fewer acres of timberland to grow trees.

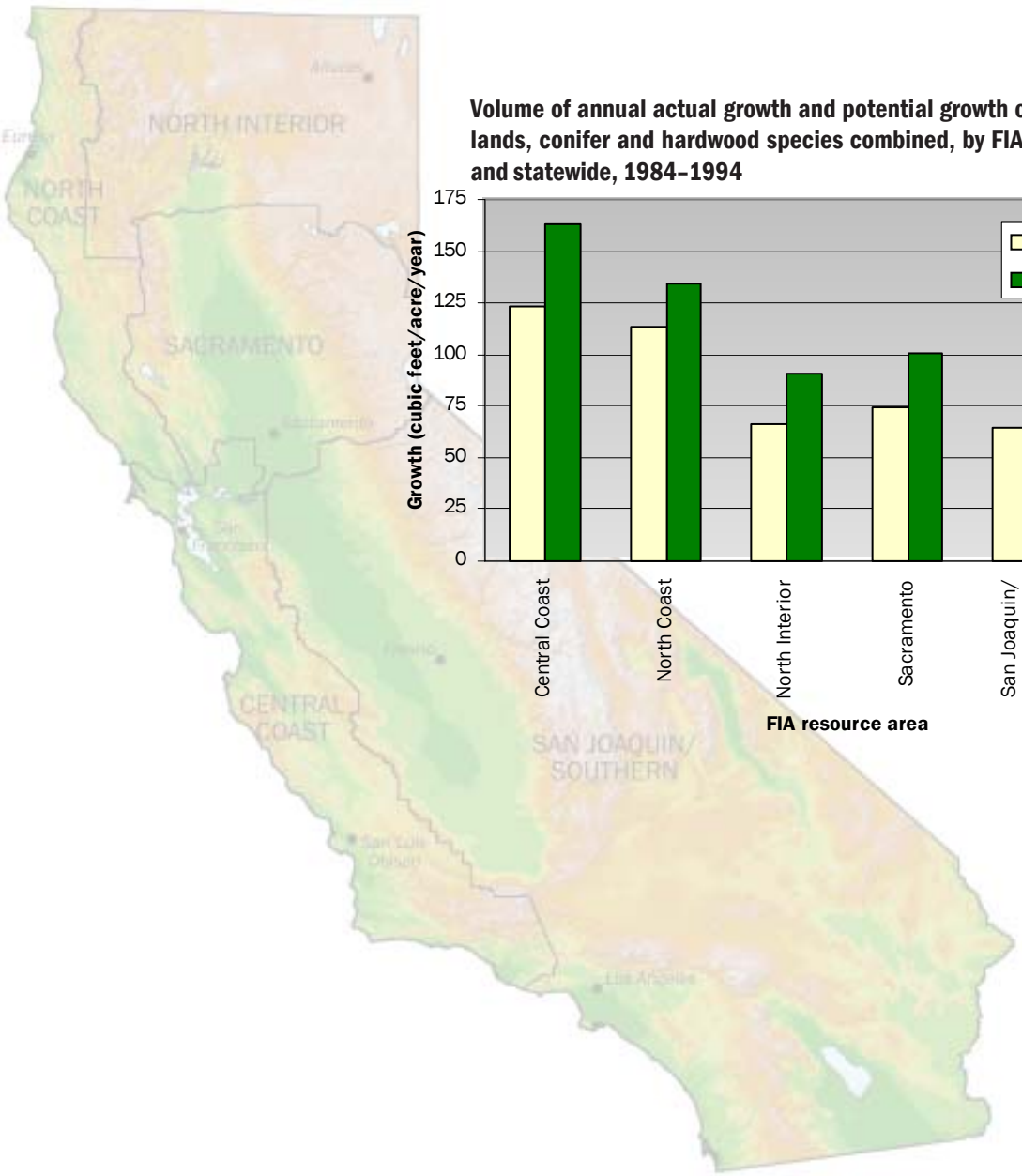
During the most recent monitoring period (1984 to 1994), the North Coast most closely utilized growth potential with actual growth being 85% of potential (Figure 24). Other bioregions grew approximately 70 to 75 percent of their potential growth. This suggests:

- most regions are not fully utilizing the timber growing capability of their lands, although this may be appropriate based upon economic, ecological, and biological diversity concerns such as streamside protection buffers or special wildlife habitat requirements;
- productive lands occupied by hardwoods are likely to grow less volume than if occupied by conifers; and
- current conditions would require additional investments to increase production beyond current levels.

Jackson Demonstration State Forest. Photo by Chris Keithley, Department of Forestry and Fire Protection.

Figure 24. Regional Productive Capacity Indicators

Actual growth rates are significantly lower than potential growth rates in all regions, primarily due to allocation of growing space and nutrients to small trees, non-commercial tree species, and other vegetation. Actual tree growth rates vary by region and are highest in the high rainfall, low elevation forests along the coast.



Volume of annual actual growth and potential growth of trees on timberlands, conifer and hardwood species combined, by FIA resource area and statewide, 1984–1994

Source: Compiled by FRAP from Waddell and Bassett, 1996 and 1997
Map: FIA resource area boundaries.

Forest Land Available for Timber Production

On-line Technical Report:
http://frap.cdf.ca.gov/assessment2003/Chapter2_Area/forestlandbase.html

Data Quality: All required data

Thirty–one million acres are forested in California, which includes all hardwood and conifer lands with tree cover greater than 10 percent (Figure 25). Approximately half of forest land (16.6 million acres, 53 percent) is classified as timberland, where lands are administratively available for timber management and where growth potential exceeds 20 cubic feet per acre per year (Table 17). These lands are capable of producing commercial timber crops on an ongoing basis. The North Interior, Sacramento, and North Coast resource areas have the greatest areas of timberland and are the regions where most timber is produced (Figure 26).

Although 16 million acres are productive and statutorily available for timber production, much of the land is not "suitable" due to public agency mangement plan designations or regulation constraints on private lands. In the case of the 9.2 million acres of timberland in public ownership, substantial portions have been in effect administratively withdrawn and have been redirected to uses other than those primarily devoted to timber production. In most resource areas, very limited amounts of public timberland are available for harvests under existing or proposed national forest management plans. No areas in Southern California national forests are primarily devoted to timber production.

Table 17. Area of timberland* by FIA resource area, 1994 (thousand acres)

Resource area	Private	Public	Total
Central Coast	245	62	307
North Coast	2,738	675	3,413
North Interior	2,276	3,669	5,945
Sacramento	1,663	2,635	4,298
San Joaquin/Southern	515	2,173	2,688
Statewide	7,437	9,214	16,651

** administratively available for timber management and growth potential exceeds 20 cubic feet per acre per year*
Source: Compiled by FRAP from Waddell and Bassett, 1996 and 1997

Figure 25. Forest land* and FIA resource areas

** greater than 10 percent tree cover*
Source: FRAP, 2002d

Figure 26. Approximate distribution of timberlands* and FIA resource areas

** administratively available for timber management and growth potential exceeds 20 cubic feet per acre per year*
Source: FRAP, 2002d

In the case of private lands, California has 7.3 million acres of timberland, of which 5.4 million acres distributed throughout 32 counties are classified as Timberland Production Zone (TPZ). Larger TPZ owners form the category most likely to grow and harvest timber on a continuing basis. Smaller owners are much more varied and many hold timberlands for non-timber growing reasons. Increased planning requirements, operational limitations, and habitat protection have also increased the expense of timber growing on private land, potentially further limiting timber growing on all ownerships.

Timberland is permanently removed from production when it is converted to other uses such as development or intensive agriculture. Timberland can also be removed from production through transfers to another administrative status such as reserves in either public or non–profit ownership. The primary goal of these land shifts from timber production is the enhancement of ecosystem services and related open space and recreational uses.

Based on available estimates from 1984 to 1994, the total decrease in timberland area (outside national forests) due to all causes was 246,000 acres, or three percent of the 1984 timberland base (Table 18). Nearly 70 percent (171,000 acres) of the decrease in the timberland base was a result of land transferred to a reserve status (e.g., wilderness, ecological reserves, parks, and open space designations).

Table 18. Changes in area of timberland outside national forests by FIA resource area, 1984–1994 (thousand acres)

	North Coast	San Joaquin/ Southern	North Interior	Sacramento	Central Coast	Total
Timberland area, 1984	3050	558	2507	1807	295	8217
Physical change (land conversion)	-47	-14	-8	-7	0	-76
Change in administrative status	-64	-13	-42	-16	-36	-171
Timberland area, 1994	2939	531	2457	1784	260	7971
Net change	-111	-27	-50	-23	-35	-246

** Values may not sum to totals due to rounding..*
Source: Compiled by FRAP from Waddell and Bassett, 1996 and 1997

Characteristics of Timberland Growing Stock

On-line Technical Report:
http://frap.cdf.ca.gov/assessment2003/Chapter2_Area/timberland.html

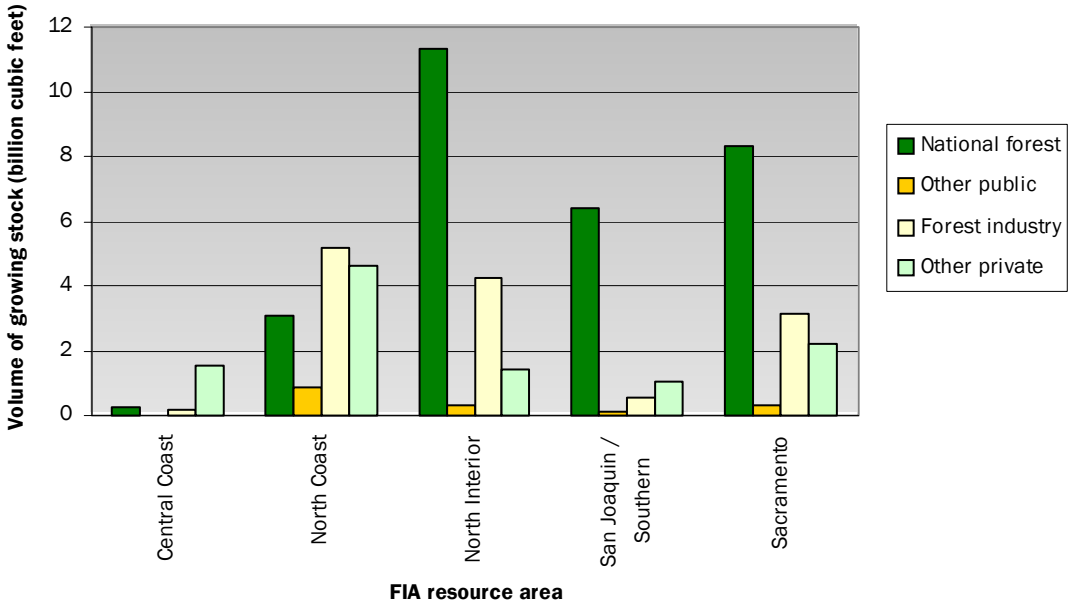
Data Quality: All required data

Estimates of growing stock volume (measured by trees greater than five-inches in diameter at breast height (DBH)), and how it changes are central to assessments of sustainable timber production. Decreases in volume due to losses from wildfires or changes in age structures due to timber management affect productive capacity in the current decade as well as for future decades.

In 1994, California timberlands contained an estimated 55 billion cubic feet of wood. Fifty-three percent (29 billion cubic feet) of the total net volume of growing stock was on national forest land, 24 percent (13.3 billion cubic feet) on forest industry, 20 percent (10.8 billion cubic feet) on other private, and the remaining three percent (1.6 billion cubic feet) on other public lands (Figure 27). The North Interior, Sacramento, and North Coast areas have the highest growing stock volumes.

Large scale inventory measurements are now stated more often in cubic feet rather than board feet to better account for increased milling efficiencies and new products. One cubic foot of standing timber volume is roughly equivalent to six board feet of dimensional quality lumber and the raw materials for other end products based on chips, strands, and smaller pieces.

Figure 27. Volume of timberland growing stock (conifer and hardwood species combined) on major ownerships, by FIA resource area, 1994

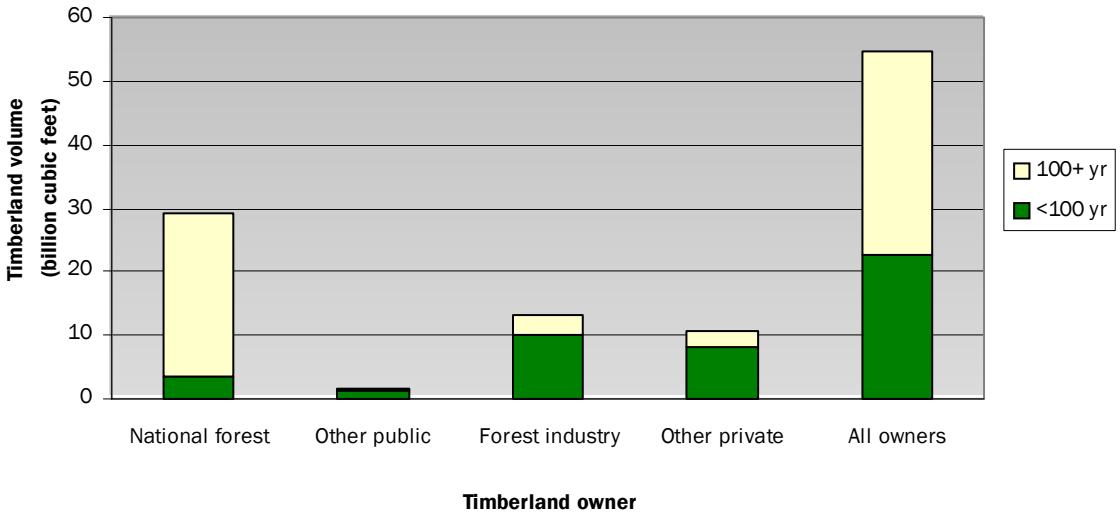


Source: Compiled by FRAP from Waddell and Bassett, 1996 and 1997

The distribution of age classes or successional stages of timberlands provides information about the future availability of trees of different sizes that can be used for different purposes. As of 1994, California had a wide age class distribution of timberland volume with a large proportion of the growing stock dominated by trees greater than 100 years of age (Figure 28). More than half of all volume on timberlands is in stands greater than 100 years of age.

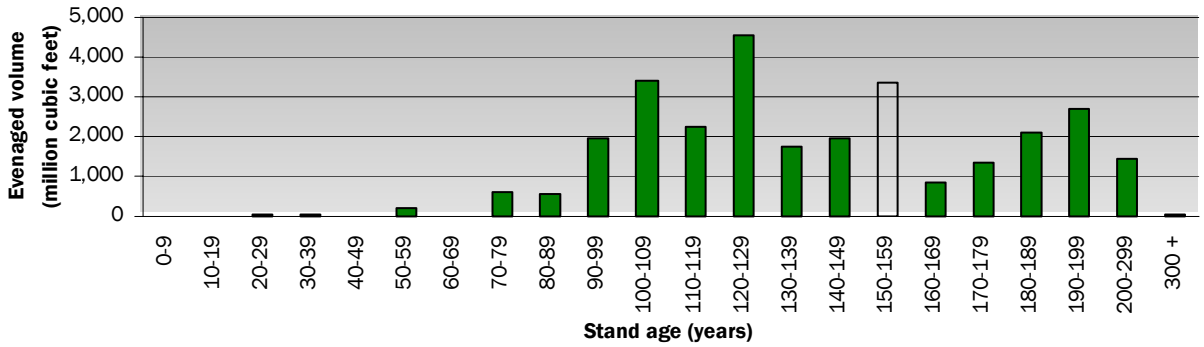
Viewing the pattern of timberland age distribution by ten–year age class groups reveals that the two largest ownership classes show different age class structures for evenaged forests (stands where more than 70 percent of the volume is in trees within a 30–year age band) (Figures 29 and 30). For example, national forests consist of greater proportions of growing stock in older age classes than do forestry industry lands, which have nearly 76 percent of evenaged growing stock volume in stands less than 100 years old. While forest industry and other private lands are predominantly in younger stands, substantial volumes are in unevenaged stands, where a range of tree ages are represented (Figure 31).

Figure 28. Volume of timberland by ownership and age class, 1994



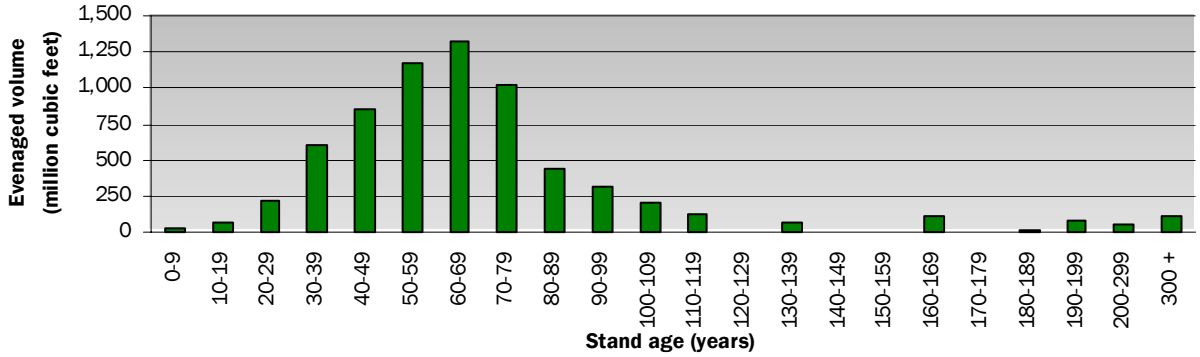
Source: Compiled by FRAP from Waddell and Bassett, 1996 and 1997

Figure 29. Volume of evenaged growing stock by age class, national forest, 1994



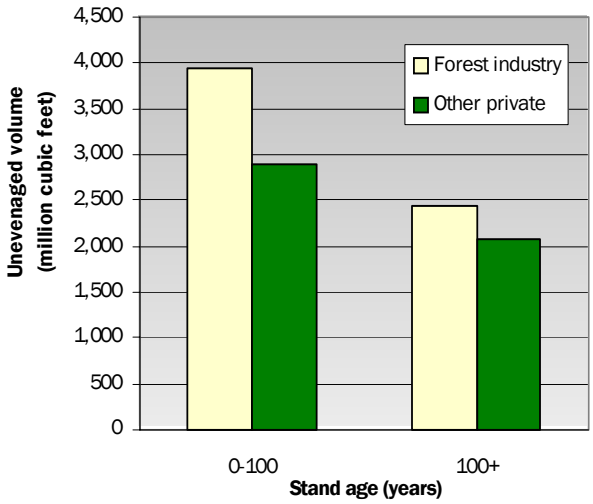
Source: Compiled by FRAP from Waddell and Bassett, 1996 and 1997

Figure 30. Volume of evenaged growing stock by age class, forest industry, 1994



Source: Compiled by FRAP from Waddell and Bassett, 1996 and 1997

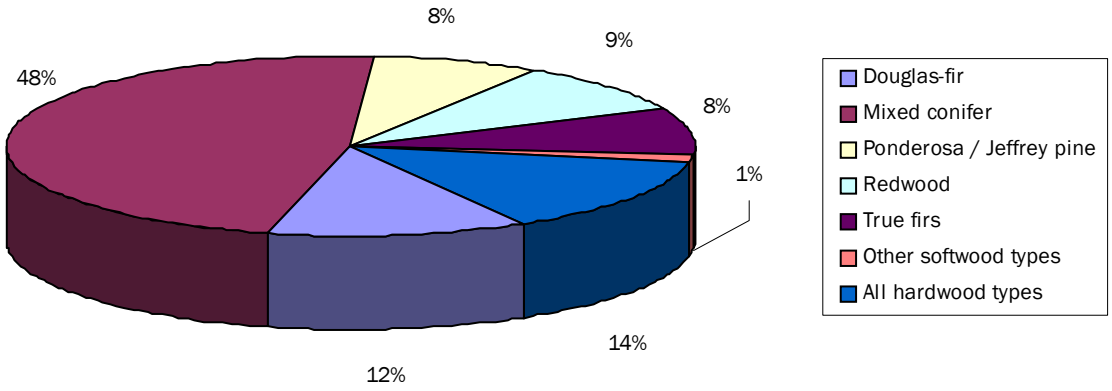
Figure 31. Volume of unevenaged growing stock by age class, forest industry and other private, 1994



Source: Compiled by FRAP from Waddell and Bassett, 1996 and 1997

Forest composition is another descriptor of forests and refers to tree species grouped into forest types. Softwood forest types (stands dominated by coniferous tree species, usually evergreen with needle-like leaves) dominate California's timberlands across all ownerships. Approximately 86 percent of the net volume of growing stock on California timberlands is composed of softwood forest types while hardwood types comprise 14 percent. The forest types on timberlands have been grouped into seven general categories (Figure 32), and a detailed listing of timberland growing stock volume by forest type and ownership is included in Table 19. The mixed conifer forest type is the most dominant, comprising nearly half of all timberland volume.

Figure 32. Percentage volume of timberland by forest type, statewide, 1994



Source: Compiled by FRAP from Waddell and Bassett, 1996 and 1997

Table 19. Volume of timberland by forest type and ownership (million cubic feet)

Forest type	National forest	Other public	Forest industry	Other private	All owners
Softwood types					
Douglas Fir	4,616	147	548	1,399	6,710
Mixed Conifer	16,902	438	5,961	2,530	25,830
Ponderosa/ Jeffrey Pine	2,901	81	567	669	4,217
Redwood	127	633	2,763	1,565	5,086
True Firs	3608	64	790	79	4540
Other softwood types	450	17	99	192	759
Total, softwood types	*28,602*	*1,381*	*10,728*	*6,432*	*47,140*
Total, hardwood types	*490*	*258*	*2,540*	*4,338*	*7,625*
Total, Nonstocked	*220*	*1*	*18*	*19*	*256*
Total, all types	29,311	1,641	13,283	10,787	55,021

Source: Compiled by FRAP from Waddell and Bassett, 1996 and 1997

Concerns over forest composition include changing species compositions resulting from harvest practices, fire suppression, regulatory impediments to intensive timber management and desires for more diverse forests. The changes are causing a shift to shade tolerant species, such as true firs, incense-cedar and some hardwoods, and declines in commercially preferred pine forests that support more open understories. Summarized evidence from several historical field plot studies suggests a changing forest composition towards more shade tolerant species, particularly in the Sierra and Modoc bioregions (Helms and Tappeiner, 1996; Centers for Water and Wildland Resources, 1996; U.S. General Accounting Office, 1999; Bonnickson and Stone, 1981; Parsons and DeBenedetti, 1979). Additional information from the USDA Forest Service Forest Inventory and Analysis, documented as part of the national Resource Planning and Assessment (Smith et al., 2001), indicates substantially increased levels of hardwoods as a percentage of total volume, slightly declining volumes of shade intolerant pine species, stable levels of shade tolerant true fir, and increasing levels of shade tolerant incense-cedar.

When combined with trends of increasing stocking levels, high levels of understory trees serve as ladder fuels and raise the risk of unnaturally severe fires. Additional effects involve increased mortality and pests, and decline in commercial species growth rates.

Timber Harvest Versus Growth between 1984 and 1994

On-line Technical Report:
http://frap.cdf.ca.gov/assessment2003/Chapter2_Area/timberland.html

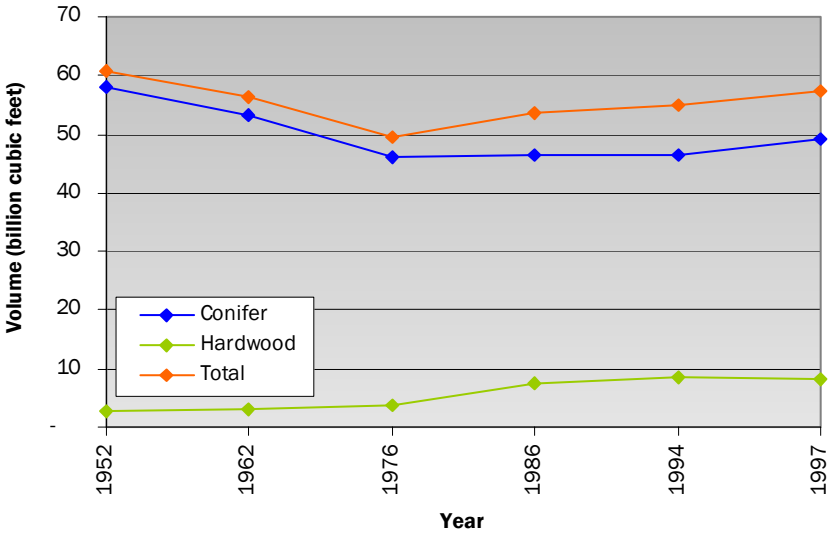
Data Quality: All required data

A standard measure of sustainable timber production is the comparison of harvest to growth over time. In terms of growth, the standing volume of California's timberland inventory continues to increase and is approaching pre–1950 levels (Figure 33, next page). As large volumes of old growth timber were harvested between 1952 and 1977, the net volume of growing stock declined by 18 percent across all ownerships. Over the next twenty years, the net volume increased by 16 percent to 57 billion cubic feet. During the most recent decadal measurement period (1984 to 1994), the net volume of growing stock increased 11 percent.

Harvesting has decreased from nearly five billion board feet in 1978 to less than two billion board feet in 2002. Both private and public lands show declines in harvesting over the past decade including an 80 percent decrease on public lands between 1990 and 2002.

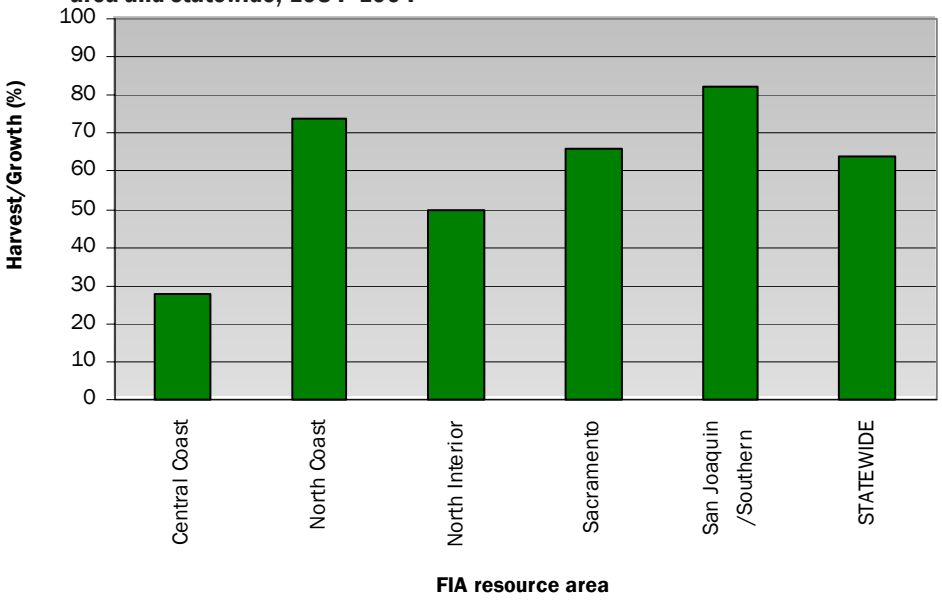
Over the period of 1984 to 1994, harvest volume was 64 percent of growth on private timberlands for all resource areas (Figure 34, next page). However, harvest as a percentage of growth varied by resource area. The San Joaquin/Southern and North Coast resource areas had harvests most closely equaling growth.

Figure 33. Net volume of conifer and hardwood growing stock on timberland, statewide, 1952–1997



Source: 1994 data compiled by FRAP from Waddell and Bassett, 1996 and 1997; all other years by Smith et al., 2001

Figure 34. Harvest as a percentage of growth* on private timberland by resource area and statewide, 1984–1994



** Growth equals harvest at 100 percent.*
Source: Compiled by FRAP from Waddell and Bassett, 1996 and 1997

Rangeland Available for Grazing

On-line Technical Report:
http://frap.cdf.ca.gov/assessment2003/Chapter2_Area/rangelandarea.html
Data Quality: Partial data

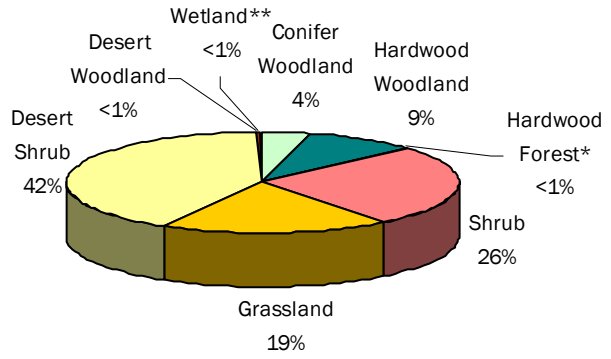
Primary rangelands are those lands that are suitable for grazing, regardless of administrative status. Rangelands cover a variety of ecological regions characterized by the presence of natural plant communities. Rangeland vegetation types include any natural grasslands, savannas, shrublands, deserts, wetlands, or woodlands that support a vegetative cover of native grasses, grass-like plants, forbs, shrubs, and non-native naturalized species. Although conifer forests provide some level of forage for grazing, by the definition used in the Assessment they are not considered primary rangelands.

Identifying the specific land covers most important to grazing provides a broad estimate of rangelands (Figure 35). The total area of primary rangelands is approximately 57 million acres, or nearly 57 percent of the State (Table 20).

A majority of the primary rangelands are in public ownership. Forty–three percent of rangeland habitats within California are privately owned while 57 percent are publicly owned (Figure 36). This ownership pattern varies among bioregions. A majority of private ownership exists in four bioregions (Bay Area/Delta, Klamath/North Coast, Central Coast, and South Coast) (Table 20). The largest areas of private rangeland are found in the Sierra and Central Coast bioregions.

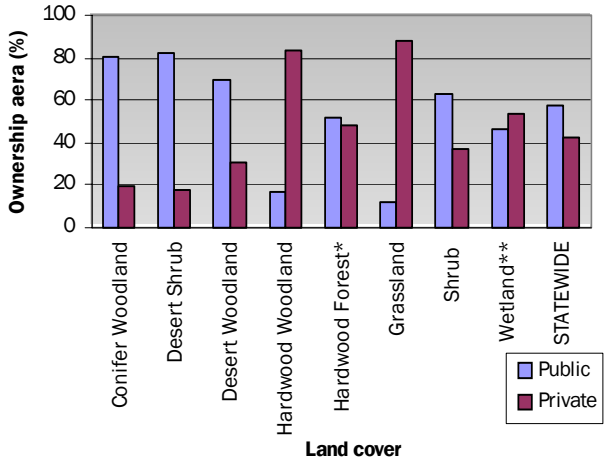
Ownership of rangeland types is not evenly distributed. A majority of Hardwood Woodland, Grassland, and Wetland habitats are privately owned. In contrast, a majority of Conifer Woodland, Shrub, Desert Shrub, and Desert Woodland habitats are publicly owned (Figure 36).

Figure 35. Percentage area of primary rangelands by land cover class



** Montane Hardwood Conifer CWHR type is not considered primary rangelands.*
*** Only the Wet Meadow CWHR habitat type is considered primary rangelands. See Appendix.*
Source: FRAP, 2002d

Figure 36. Percentage area of primary rangelands in public and private ownership by land cover class



** Montane Hardwood Conifer CWHR type is not considered primary rangelands.*
*** Only the Wet Meadow CWHR habitat type is considered primary rangelands. See Appendix.*
Source: FRAP, 1999; FRAP, 2002d

Table 20. Area of primary rangelands by major ownership and bioregion (thousands of acres)

Owner	Bay Area/ Delta	Modoc	Klamath/ North Coast	Sierra	Central Coast	South Coast	All others*	Statewide
BLM	38	1,297	283	982	309	140	10,694	13,743
NPS	58	54	18	162	15	18	5,033	5,359
Other public	177	193	63	382	420	426	4,373	6,034
Private	2,031	1,549	2,457	3,396	4,598	1,992	8,328	24,350
USFS		1,325	829	2,512	1,474	1,305	132	7,577
Total	2,304	4,420	3,650	7,434	6,815	3,881	28,559	57,062

BLM - U.S. Bureau of Land Management; NPS - National Park Service; USFS - U.S. Forest Service
** includes Mojave, Colorado Desert, Sacramento Valley, and San Joaquin Valley*
Source: FRAP, 2002d

Of the 57 million acres of primary rangeland with suitable forage, only about 41 million acres are actually available for grazing (Table 21). This is due to management statutes and/or agency policies that do not allow grazing of domestic livestock..

In contrast to the area that is available for grazing, the area of land in California that actually has grazing of livestock is termed grazing area. Field sampling conducted by the Natural Resources Conservation Service and allotment use records submitted by the U.S. Forest Service and Bureau of Land Management determine the amount of grazing area. The USDA Economic Research Service (ERS) is the only federal group that tallies the total land grazed across all ownerships throughout the State (Economic Research Service, 2001). When comparing grazing area (34.1 million acres) with primary rangelands (approximately 57 million acres), it would appear that primary rangeland area far exceeds the land base actually grazed (Table 22).

A large proportion of available rangelands (82 percent or 34.1 million of 41.7 million acres) are already being grazed. This results in limited opportunities for new grazing activities especially when considering the on-going decline in the available rangeland base in California.

On public lands, large areas are not available or used at minimum levels for grazing due to exclusion by administrative designations and relatively poor forage production. Approximately 17 million acres of the nearly 33 million acres of public primary rangelands are grazed (52 percent). Over half of the 17 million acres is in desert land cover types that produce little forage and are very susceptible to environmental damage from overgrazing. Private rangeland is used for grazing at a much higher level than public lands. Seventeen million of the 24 million acres of private primary rangeland is grazed (71 percent).

Table 21. Area of available rangelands by ownership and land cover class (thousands of acres)

Land cover class	Private	Public	Total
Conifer Woodland	434	1,166	1,599
Desert Shrub	3,804	10,500	14,304
Desert Woodland	25	9	34
Hardwood Woodland	4,036	634	4,669
Hardwood Forest*	85	43	128
Grassland	8,273	889	9,163
Shrub	5,135	6,504	11,638
Wetland**	129	60	189
Total	21,920	19,805	41,725

** Montane Hardwood Conifer CWHR type is not considered primary rangelands.*
*** Only the Wet Meadow CWHR habitat type is considered primary rangelands. See Appendix.*
Source: FRAP, 1999; FRAP, 2002d

Table 22. Various rangeland area estimates by ownership, 1997

	Private	Public	Total
Primary rangelands (FRAP)*	24.4	32.7	57.1
Rangeland (NRI)**	18.3	***	18.3
Available rangeland (FRAP)	21.9	19.8	41.7
Grazing area (ERS and RPA****)	17.4	16.7	34.1

** excludes Conifer Forest types*
*** excludes any hardwood or conifer forest types*
**** NRI measure some non-federal public lands but are included in private in this table*
***** RPA (Mitchell, 2000) estimates used to derive area on public land*
ERS - Economic Research Service; FRAP - Fire and Resource Assessment Program; NRI - National Resource Inventory; RPA - The Forest and Rangeland Renewable Resources Planning Act of 1974
Source: Mitchell, 2000; ERS, 2001; NRCS, 2000; FRAP, 1999; FRAP 2002d

Rangeland Grazing Capacity Compared to Use

On-line Technical Report:
http://frap.cdf.ca.gov/assessment2003/Chapter2_Area/rangelandarea.html

Data Quality: Partial data

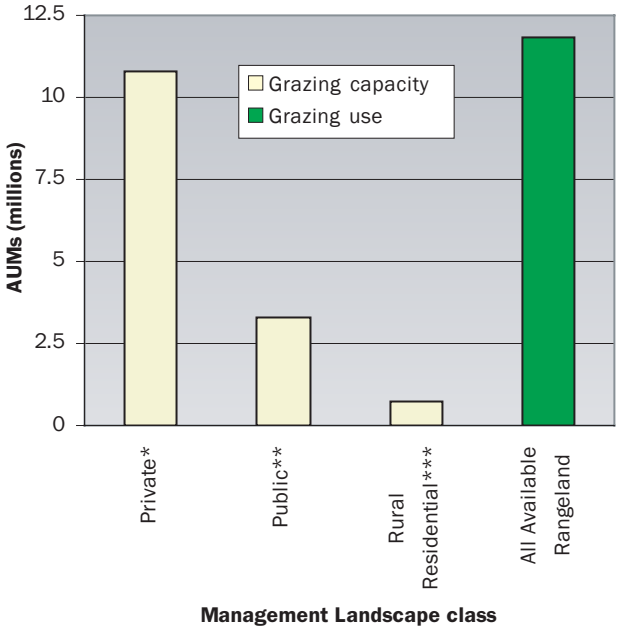
Forests and rangelands provide grazing forage (browse and non-woody plants) used by livestock and wildlife. Landowners rely on forage from a variety of vegetation types on both public and private lands. Grazing capacity is a proxy for forage production and is the maximum stocking rate possible without inducing damage to vegetation or related resources. Grazing capacity is measured in Animal Unit Months (AUMs), the amount needed to sustain one mature cow and her calf, five sheep, or six deer for one month. An AUM is approximately 800 to 1,100 pounds of dry biomass.

Grazing capacity on available rangelands in places exceeds the amount used for grazing of domestic livestock (Figure 37). However, excess forage for grazing may not be available because of the seasonal nature of forage availability resulting in ranchers seeking additional feed sources.

The current estimate of grazing capacity on rangelands available for grazing is 14.8 million AUMs. The majority of forage available for grazing exists in the Management Landscape class Working/Private/Sparsely Populated (10.8 million AUMs). Domestic livestock grazing use in all classes is estimated at 11.8 million AUMs based on the approximately two million head of cattle that periodically graze on private rangelands.

These profiles of grazing capacity and use suggest that lands are currently being grazed at a sustainable level and productivity is being maintained. However, specific factors raise questions on the capability of California's rangelands to sustain grazing activities at this level in the future. These concerns include a declining rangeland area, encroachment of invasive non-native species, and grazing use reductions on public lands resulting in potential increased demand for grazing on private lands.

Figure 37. Grazing capacity by Managament Landscape class and total grazing use, available rangelands



* Working/Private/Sparsely Populated
** Working/Public/Sparsely Populated
*** includes Working/Public/Rural Residential and Working/Private/Rural Residential
Source: CH2M HILL, 1989; National Agricultural Statistics Service, 2001; FRAP, 200b; FRAP, 2002d

Land Management Impacts on Forest and Rangeland Resource Sustainability

A multitude of land management activities occur on California's forests and rangelands. These include tree planting, timber management, vegetation management, prescribed burning, cattle and sheep grazing, road and drainage infrastructure construction and maintenance, public access facilities construction and maintenance, erosion control projects, and fish and wildlife habitat improvement projects. The goals of sustainable land management are to produce socially desired commodities and services, avoid significant environmental impacts, and ensure long-term sustainability of the resource base. Assessing how land management activities affect long-term sustainability across California requires both an understanding of how different types of land are managed currently and how practices may change in the future through changes in ownership, new technologies and management, and new investments.

Jackson Demonstration State Forest.

In the long term, the impact of land management on sustainability can be positively influenced by the following factors.

- **Technological innovations:** Improvements in information systems, land management systems, and raw material utilization, as well as the develpoment of higher value products can result in greater efficiencies, profitability, and lower land use impacts.
- **Integration of regulatory and market linkages into management activities:** Reducing duplicative procedures and costs as well as integrating sustainability premiums into commodity and service prices could both increase net profitablity.
- **Investments in forest and rangeland resources:** Public, private, and cost-share investments can improve the net production of all outputs, especially ecosystem services. Private investments require profitable opportunities from the total output of commodities and services.
- **Reliance on imports:** Californians now rely heavily on imports of forest and rangeland related products available from other states and countries. Increased imports will have the least environmental impacts in California but will still generate environmental impacts based on the standards used at the place of production.

Land Management Activities Indicators

- Land Management and Resource Outputs
- Metropolitan Forests and Rangelands
- Locations of Range Livestock Management Activities
- Impacts from Timber Production
- Lands in Reserve Status

Land Management Activities

Representative Goal

Enhance productive capacity of soils, stock and increase growth of young stands, fully use mature stands and mortality from young stands, encourage efficient harvesting and processing of wood products (*paraphrased from California State Board of Forestry Handbook, Chapter 0334).*

[Provide funding] for acquisition, development, rehabilitation, restoration, and protection of habitat that promotes the recovery of threatenend and endangered species, that provides corridors linking separate habitat areas to prevent habitat fragmentation, and that protects significant natural landscapes and ecosystems such as old growth redwoods and oak woodlands and other significant habitat area *(California Public Resources Code, Section 5096.650(a)).*

Findings

- Managed forests and rangelands often simultaneously provide protection to ecological services and socio-economic values while retaining the land in a naturally vegetated condition. These sparsely populated lands form a major part of California and are managed for a variety of purposes. Changing this land use pattern will result in changes in the mix of outputs and the protection of ecological values derived from these lands.
- Metropolitan forests and rangelands, the interface of urban areas and forests and rangelands, are highly dependent on the economic feasibility of continued commodity-based land management to provide socially desired amenities.
- With cattle inventory levels generally stable and area of beef cattle farms decreasing, commercial range livestock management activities are likely to continue on larger farms (greater than 500 acres) primarily in the central coast, northeastern, San Joaquin and desert regions of the State.
- Locations of timber management activities continue to be concentrated on forest industry lands zoned for timber production in the Klamath/North Coast and Modoc bioregions. Decreasing emphasis on timber production is likely to continue on federal lands, although those areas adjacent to Wildland Urban Interface are likely to have increased timber management as part of fuel reduction activities.
- Recent timber harvest trends show a decline over the last ten years. Silvicultural methods used on private lands are distributed between evenaged, unevenaged, and thinning methods. Evenaged silvicultural methods were used on about half of the 208,000 acres approved for harvest on private lands in 2002.
- Lands reserved from most intensive land management, but typically allowing recreation uses, cover over 23 percent of California's forests and rangelands. While extensive, reserves are not evenly distributed among geographic areas, land covers or habitats.

Land Management and Resource Outputs

On-line Technical Report:
http://frap.cdf.ca.gov/assessment2003/Introductory_Materials/population.html
Data Quality: Partial data

At the individual parcel level, similar forest or rangeland areas often have significant differences in terms of management influences and the mix of outputs. One way to make sense of the complexity of California's current array of forests and rangelands is to illustrate it in a schematic as in Figure 38. This diagram illustrates the different types of land management in terms of the overall mix of management influences and the overall mix of outputs they produce.

The *Resource Outputs* box at the top of the diagram summarizes the range of outputs produced. The most important commodities are timber, forage, and biomass. Traditional services refer primarily to recreational opportunities, open space, and fish and wildlife habitats. Ecosystem services refer to concepts that are more difficult to measure such as biological diversity, habitats for threatened or endangered species, carbon sequestration, high rates of water and air purification, and enhanced soil development. In general, there are clear market prices for most commodities, limited direct markets for many traditional services, and weak or non-existent markets for ecosystem services.

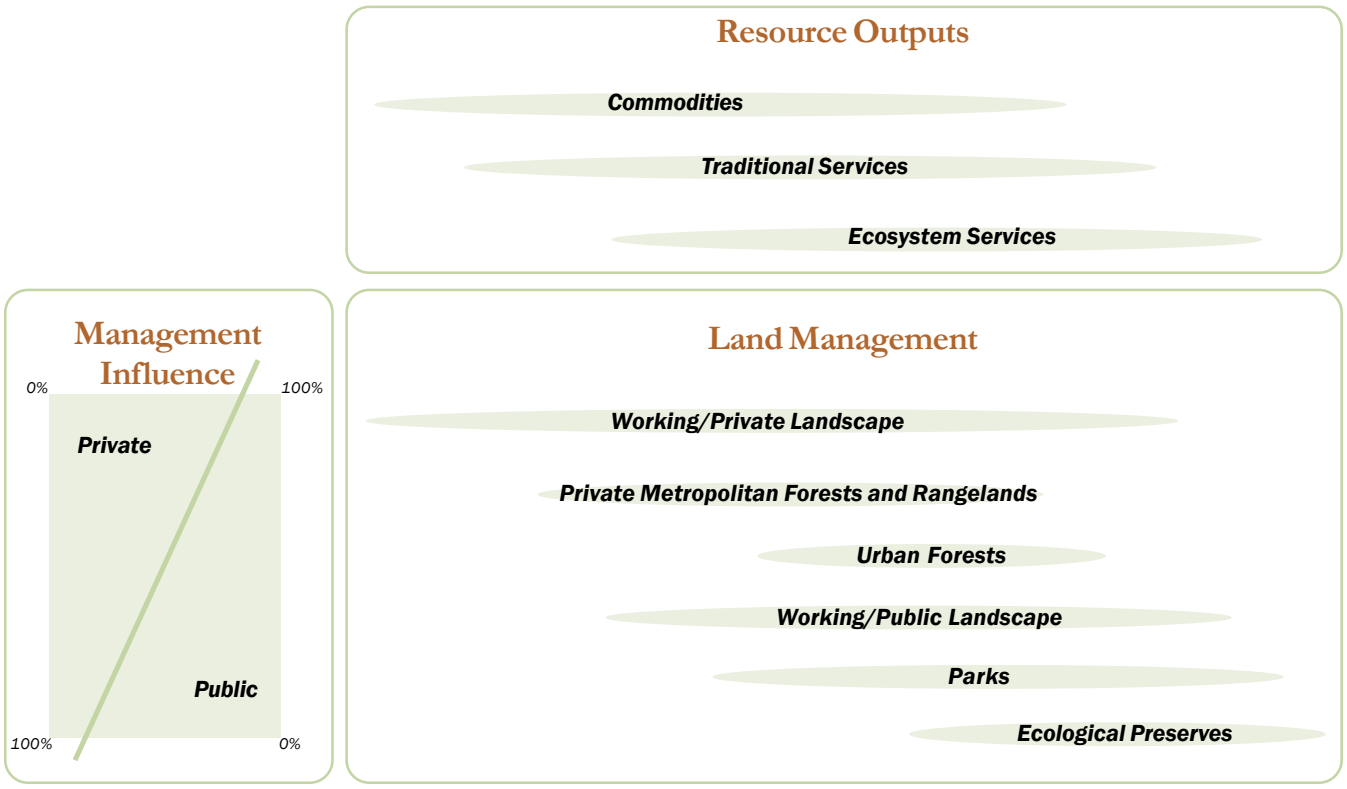
The *Management Influence* box to the left of the diagram summarizes the range of the mix of private and public management influence, which is a combination of ownership, investment, technical expertise, on the ground management, and regulatory oversight.

The *Land Management* box in the center of the diagram is designed to illustrate the complex nature of the many different types of parcels in California. The typical range of management influences is suggested by reading from the left box and the typical range of outputs is suggested by reading from the top box. For example, the Working/Private landscapes symbol reflects the dominance of private management influence and a mix of outputs strongly weighted towards commodities and services that can be sold. These lands also produce considerable levels of additional traditional services and ecosystem services. Metropolitan forests are generally subsets of the larger Working/Private landscape but typically have both greater public influence over their management (through regulations, tax credits, and direct investments) and generally lower levels of commodity outputs. Urban forests include street trees, greenbelts and smaller parks within the urban footprint. They typically provide high levels of traditional services with a variety of public and private managment influence.

The national forests comprise most of the Working/Public landscape and are managed less for commodities than the Working/Private landscape. The large and unfragmented nature of these parcels also provides considerably more traditional and ecosystem services. While the level of commodity production varies considerably across Working/Public lands, it is lower than levels of most Working/Private landscapes. There are still considerable private management influences through timber and biomass contractors, grazing permittees, recreational concessionaires, and many private recreational users. Finally, parks and ecological preserves have nearly no commodity production (with the exception of tree removal for public safety and grazing to promote desired vegetation) and are oriented primarily towards ecosystem services.

This portrait illustrates that resource outputs used by Californians come from a wide array of landscapes, each of which has a different mix of management influences. In the short term, changes in the relative mix of resource outputs can come from incremental changes within a single land management type, from a shift of parcels between management types, or a combination of both. For example, in order to create more regional recreational oppurtunities, managers might develop recreational easements on Working/Private lands, purchase private lands for new parks, and/or increase the recreational activities allowed in ecological preserves (e.g., wilderness areas.).

Figure 38. Diagram of land management as a function of management influence and resource outputs



The conceptual framework that describes land management as a function of management influences and resource outputs can be measured using the FRAP Management Landscapes classes. Combining land use, ownership and housing density results in eight distinct classes of management that are critical to addressing the complexities associated with managing natural resources. The forests and rangelands of California are comprised of these classes—Working/Private/Sparsely Populated, Working/Public/Sparsely Populated, Reserve, and Rural Residential (both Working/Public and Working/Private) (Figure 39). The following describes these forest and rangeland Management Landscape classes in greater detail.

Working/Private/Sparsely Populated: The Working/Private landscape encompasses the greatest diversity of resource outputs. These lands cover approximately 36 percent of California's forests and rangelands. Because the basic property value of most units within the Working/Private landscape is based on the net revenue from commodity production, such as timber and forage, this class is the major producer of forest and rangeland commodities. Large unfragmented ownerships also provide considerable traditional services such as recreational opportunities and open space, as well as ecosystem services such as diverse wildlife populations and habitats dependent on large extents, plant and animal genetic diversity, and carbon sequestration.

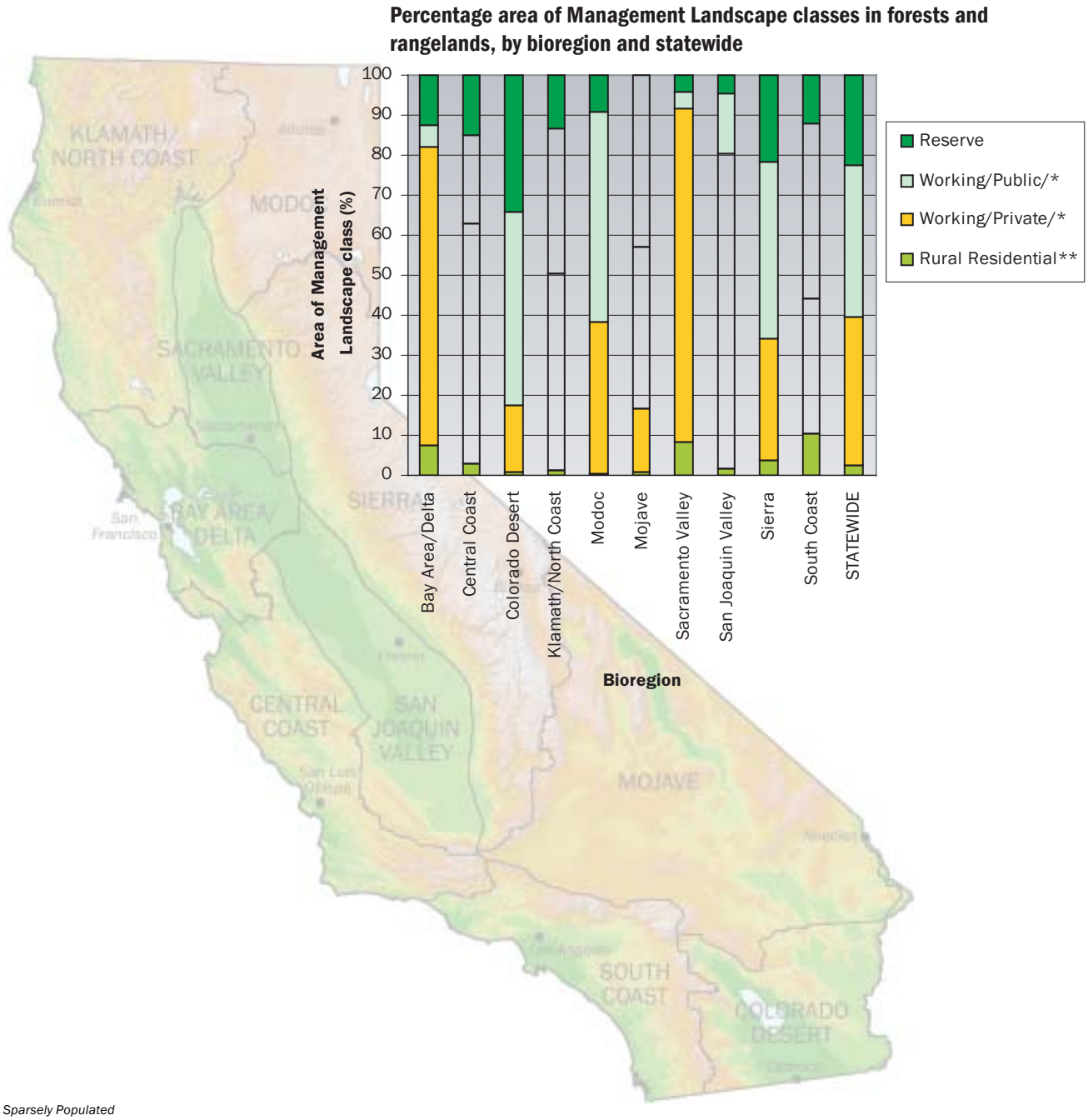
Working/Public/Sparsely Populated: These lands include the portions of U. S. Forest Service, Bureau of Land Management, state forests, and other public lands where commodity production is permitted but is rarely the primary mission. They cover about 38 percent of California's forests and rangelands. Overall, these lands are less productive than working landscapes that were initially privatized from the public domain. Since the early 1990s commodity production has dropped significantly on many public working forests and rangelands in order to avoid potential environmental impacts and to address endangered species concerns.

Reserve: This class includes parks and ecological preserves. Parks oriented more towards the traditional side of the traditional/ecosystem service mix play a strong role in providing recreational opportunities. These lands typically include National Park Service lands, state parks, and U. S. Forest Service wilderness areas which require infrastructure for visitors that can significantly alter the natural ecosystem. They cover approximately 23 percent of California's forests and rangelands. Ecological preserves differ from recreation-oriented parks and typically have less infrastructure, allow less access, and have a "larger is better" philosophy that typically gives scientists, rather than recreational managers, greater management control.

Rural Residential (includes Working/Public and Working/Private): These lands have numerous residences, but are not yet urban (housing density of one or more units per 20 acres and less than one unit per acre). Consequently, they still have many resource values. Land management is more oriented towards open space, viewsheds, places of rural lifestyle, or recreation. While these lands are less than three percent of the statewide forests and rangelands, they are the most visible to the public and have complex management issues and impacts driven by more intensive activities related to human use and infrastructure. Residents often seek to constrain land management on adjacent parcels for aesthetic, recreational, wildfire safety, and residential property value reasons. In numerous areas, this leads to further fragmentation and conversion of land that had been previously managed as working landscapes. Lastly, this class continues to expand in extent as ever greater numbers of people move from the cities to rural "ranchette" communities.

Figure 39. Regional Land Management Activities Indicator

Rural Residential lands are a growing percentage of forests and rangelands in all bioregions and a significant component in three of them—Bay Area/Delta, Sacramento Valley and South Coast. Working/Private landscapes generally have more intensive land management than Working/Public landscapes and Reserves but are less fragmented than Rural Residential.



* Sparsely Populated
** includes Working/Public/Rural Residential and Working/Private/Rural Residential classes
Source: FRAP, 2002b; FRAP, 2002d
Map: California Biodiversity Council bioregions

Metropolitan Forests and Rangelands

On-line Technical Report:
http://frap.cdf.ca.gov/assessment2003/Introductory_Materials/population.html
Data Quality: Partial data

California is world renowned for its extensive forests of coastal redwoods, sierran mixed conifers interspersed with giant sequoia groves, and extensive stretches of oak covered woodlands. However, the most-viewed forest and rangeland landscapes are actually the areas immediately adjacent to metropolitan areas.

FRAP terms the natural vegetation within the urban area and its six-mile wide buffer the *metropolitan forests and rangelands*. These lands include a wide variety of management statuses including wildlife and ecological preserves, regional parks, ranch lands, and private timber management operations. Although not forests and rangelands, agricultural lands contribute to open space amenities and are also included in this analysis. In addition to the relatively large parcels that are professionally managed for defined combinations of commodities, traditional services, and ecosystem services, a large and growing fraction of these metropolitan forests and rangelands are in management classes characterized by large parcel residential land use (Working/Private/Rural Residential and Agriculture/Rural Residential). In these areas, the individual management decisions of thousands of landowners determine the overall mix of outputs and the levels of risk from other threats such as invasive species, diseases, and catastrophic wildfire. From regulatory and public investment perspectives, difficulties in planning in metropolitan forests and rangelands abound due to the large numbers of owners and the shared authority between local, state, and federal agencies.

Metropolitan forests and rangelands include the full suite of management classes from Reserve to Working/Private/Rural Residential. FRAP identified 24 of the largest metropolitan areas for analysis of management classes within a six-mile buffer from the edge of each urbanized area. More than half of all Californians live in two large metropolitan areas. The Los Angeles metropolitan area stretches from Ventura County to western Riverside/San Bernardino counties and down to Orange County. The San Francisco Bay Area includes those counties touching the greater San Francisco and San Pablo Bays. The other 22 areas are scattered from Eureka in the northwest to Hemet in the southeast. Based on the 1990 census, these 24 metropolitan areas included approximately 80 percent of all residences in the State.

Table 23 shows the distribution of Management Landscape classes within the metropolitan forests and rangelands in order of percentage of land classified as Urban. The types of land that comprise the metropolitan forests and rangelands vary considerably in terms of ownership, recreational access, reserve status, and the existence of scattered dwellings. For many of the denser communities, the availability of an open coastline has an additionally positive role that cannot be captured in these statistics.

Figure 40 compares the percentage distribution of Management Landscape classes for the six largest metropolitan areas in the state. The most striking aspect is the large differences in composition of open space around each metropolitan area.

The Working/Private/Sparesely Populated landscape (primarily ranches and managed forests) represents the largest component of metropolitan forests and rangelands (30 percent). The long-term continuation of amenities partly depends on the relative balance between the economic feasibility of continued commodity-based land management versus the economic opportunity of new development.

The Agriculture/Sparsely Populated landscape is the main management class in the rapidly growing metropolitan areas of the San Joaquin Valley, and also possess the best attributes for expanding residential development (flat land with existing roads and utilities).

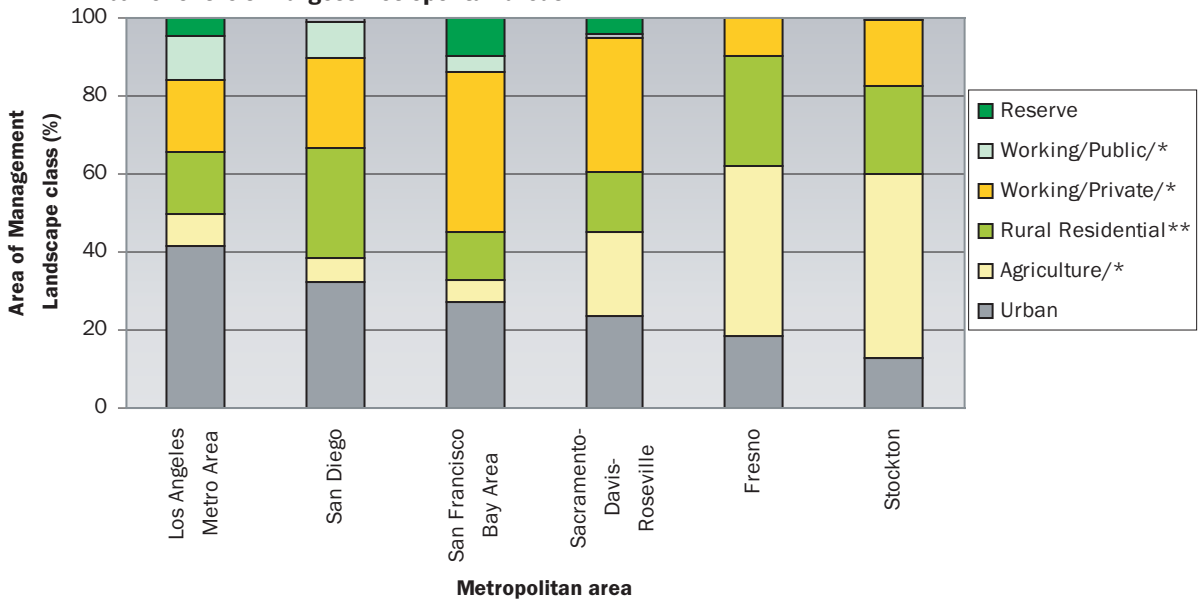
Overall, commodity-based land uses (Working and Agriculture) are a very small component of metropolitan economies but contribute a large share of total open space benefits at a very low public cost compared to the acquisition and management of public sector open space.

Table 23. Percentage area of Management Landscape classes within a six-mile buffer of 24 major metropolitan areas*

Metropolitan area	Urban	Agriculture/ Sparsely Pop.	Reserve	Working**	Rural Residential***
Los Angeles Metro Area	42	8	5	30	16
San Diego	32	6	1	32	28
San Francisco Bay Area	27	5	10	45	12
Sacramento-Davis-Roseville	23	22	4	35	16
Fresno	18	44	<1	10	28
Bakersfield	16	34	<1	38	12
Santa Barbara	16	6	1	60	17
Monterey-Salinas	14	24	1	34	26
Santa Cruz	14	6	13	16	52
Santa Rosa	14	4	4	31	47
Palm Springs	13	4	16	55	13
Stockton	13	47	<1	17	22
Eureka	12	10	1	50	26
Modesto-Turlock	12	38	1	20	30
Redding	11	6	4	38	40
Santa Maria	11	28	<1	57	4
Visalia	11	60	<1	11	18
Lancaster	10	20	<1	55	14
Merced	8	31	<1	46	14
Yuba City-Marysville	8	48	1	23	20
Hemet	8	18	<1	59	16
Chico-Paradise	7	17	2	61	14
Porterville	5	47	<1	32	15
Average of all metropolitan areas	25	16	4	37	18

** Total area from which percentages are calculated includes the metropolitan area and its six-mile buffer.*
*** includes Working/Public/Sparsely Populated and Working/Private/Sparsely Populated*
**** includes Working/Private/Rural Residential, Working/Public/Rural Residential, and Agriculture/Rural Residential*
Source: FRAP, 2002b

Figure 40. Percentage area of Management Landscape classes within a six-mile buffer of the six largest metropolitan areas



** Sparsely Populated*
*** includes Working/Private/Rural Residential, Working/Public/Rural Residential, and Agriculture/Rural Residential*
Source: FRAP, 2002b

Locations of Range Livestock Management Activities

On-line Technical Report:
http://frap.cdf.ca.gov/assessment2003/Chapter6_Socioeconomic/rangelivestock.html
Data Quality: Partial data ◐

Range livestock operations continue to be constrained due to low profitability and other factors. Three key measures from the National Agricultural Statistics Service (NASS, 2001) give substantial insight into the current and potential trends of livestock management activites in the State:

- decline in total number of farms, and concentration of livestock industry on large farms;
- shift in farm owner principle occupation towards non-farm principle occupations; and
- continued reliance on public grazing allotments for supplemental forage use.

These factors suggest that the bulk of production will likely occur on larger farms, and that some of these operations will be very sensitive to the availability of supplemental forage, requiring use of lands that provide forage under grazing permits or leases. There will still be numerous small farms and ranchettes, but their management goals typically differ from larger farms and their total production is small.

Number of Beef Cattle Farms Excluding Feedlots Over 500 Acres

The category *beef cattle farms excluding feedlots* most closely approximates the livestock industry reliant on forests and rangelands. Overall, the number of beef cattle farms excluding feedlots has declined 22 percent between 1982 and 1997. The majority of this decline has occurred in farms less than 500 acres in size, whereas farms greater than 500 acres have remained relatively stable (Table 24).

Concentration of Beef Cattle Industry on Farms Greater than 500 Acres

Cattle inventories on beef cattle farms excluding feedlots reached 1.9 million head in 1997. Over half of the cattle inventory on beef cattle farms is located on farms greater than 2,000 acres. While inventories have slightly increased on smaller farms and declined on larger farms, the vast majority of cattle on forest and rangeland farms are still found on larger sized farms. This is likely to remain true in the future as well (Figure 41).

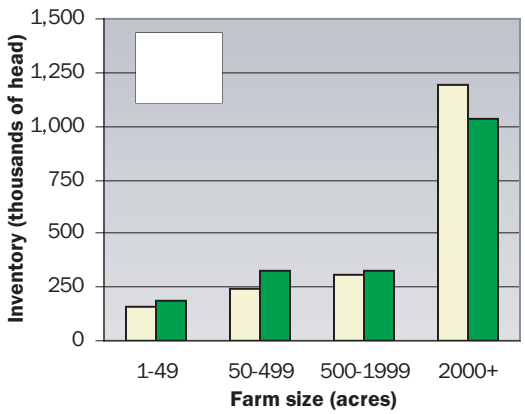
Farms of 500 acres or more in size, particularly those larger than 2,000 acres, comprise most of the area of beef cattle farms, though it varies by region. In the future, range management is likely to continue on these larger farms, especially those over 2,000 acres in size. This is due largely to the majority of owners having ranching as a principal occupation and being long-time owners. Many of these landowners have also prepared

Table 24. Number of beef cattle farms excluding feedlots in four farm size classes, 1982, 1987, 1992, and 1997

Year	All sizes	1–49 acres	50–499 acres	500–1,999 acres	2,000+ acres
1982	14,850	7,342	4,234	1,863	1,411
1987	14,092	6,112	4,406	2,053	1,521
1992	12,288	5,044	3,930	1,852	1,462
1997	11,510	4,452	3,794	1,827	1,437

Source: National Agricultural Statistics Service, 2001

Figure 41. Cattle and calf inventory on beef cattle farms excluding feedlots in four farm size classes, 1982 and 1997



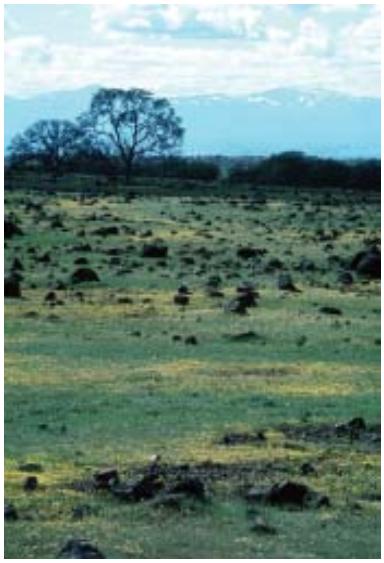
Source: National Agricultural Statistic Service, 2001

plans that provide for protection of water quality under Rangeland Water Quality Management Plans to ensure environmentally sustainable operations requirements.

Regionally, the central coast, northeastern California, San Joaquin Valley, and the deserts contain the most extensive areas of cattle farms (Figure 42). These areas are the regions most likely to have continuous rangeland operations in the future.

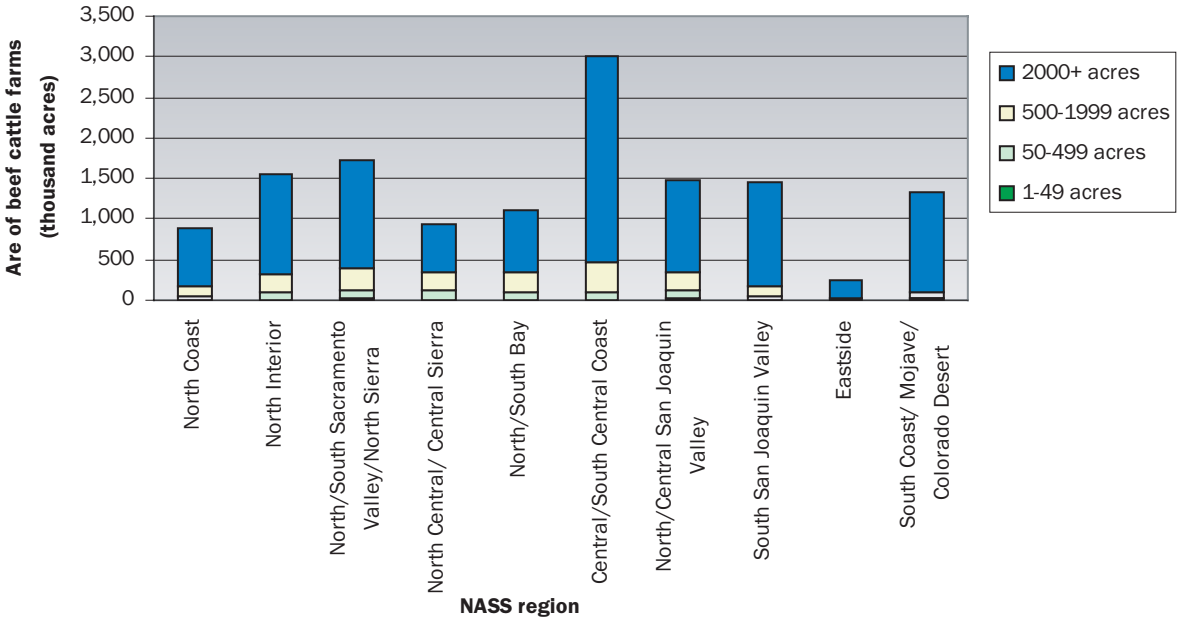
In light of the economic challenges to continued rangeland operations, a number of larger ranches have been acquired by nonprofit organizations or have entered into easements for conservation purposes over the past decade. In many cases, ranching activities continue, though they may be subject to different constraints or management goals. One example is the Dye Creek Ranch in Tehama County that came under the management of The Nature Conservancy in 1987 as a result of a 25-year lease with the State of California. The Conservancy has continued to operate the land as a working ranch, leasing grazing rights to a private rancher. The land functions as a nature preserve and a place for education as well as a source of commodity production.

In 1998, the Conservancy also purchased the Simon Newman and Romero Ranches (61,000 acres) east of San Jose with the purpose of creating a perimeter of protection around the core of the Mount Hamilton Wilderness. Cattle ranching continues to operate on these lands as well. Another example is a conservation easement developed through the Pacific Forest Trust for the Howe Creek Ranch (3,640 acres) near Rio Dell in Humboldt County. Conditions of the easement promote continued grazing and timber management while ensuring the land will not be subdivided.



Dye Creek Ranch. Photo courtesy of Dr. Oren D. Pollack.

Figure 42. Area of beef cattle farms excluding feedlots by NASS region*, 1997



** For a map of NASS regions, see Figure 80, p. 152.*
Source: National Agricultural Statistic Service, 2001

Owners of Beef and Cattle Farms excluding feedlots with Principal Occupation other than Farming

For beef cattle farms excluding feedlots of less than 500 acres, 60 percent of the operators had principal occupations other than farming; of farms 500 acres or larger, over 66 percent of the operators indicated that farming was their principal occupation. This suggests that commitment to continuing livestock operations may be more profitable with larger farms.

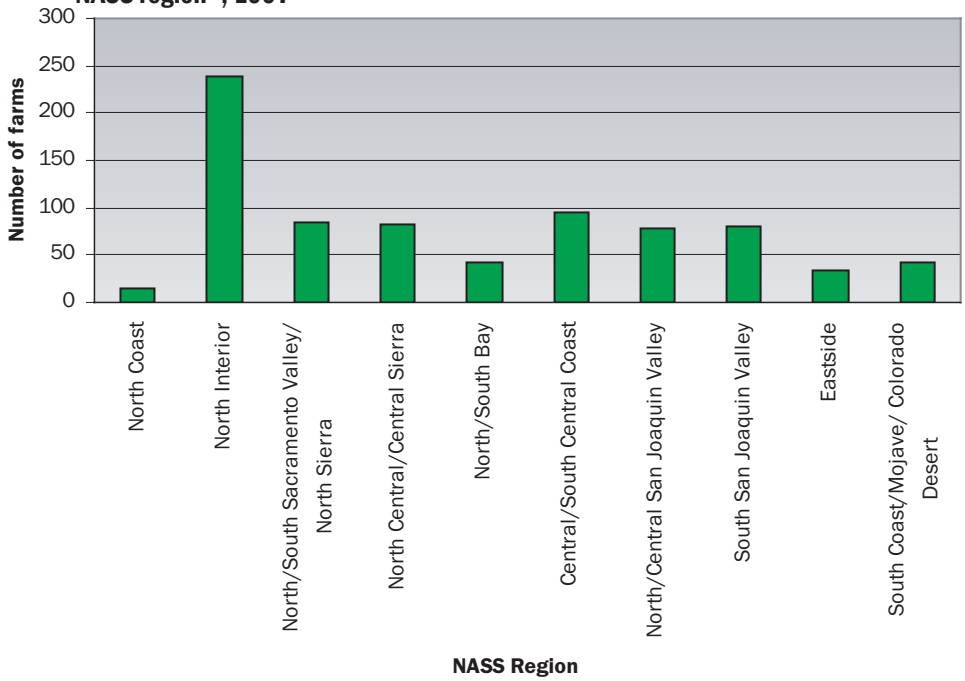
Within the range livestock industry, beef cattle farms of less than 50 acres have relatively more new owners. This is consistent with land development patterns in California where newer owners occupy smaller parcels near urban areas, and parcel size increases with distance from urban areas. These landowners usually have other sources of income. Livestock is secondary or highly specialized, such as raising calves or prize bulls. On larger parcels where there are a smaller percentage of owners indicating sources of income other than ranching, owners may be more sensitive to economic pressures from low profits.

Reliance on Outside Forage

Forests and rangelands both provide natural forage for livestock. However, forage varies in its nutritional value by species, time of year, and other factors. On rangelands, cattle consume a varied diet that may include grasses, legumes, forbs, and brush (browse). Frequently, this forage provides insufficient feed or variable feed quality. These conditions can lead to periods of undernutrition and slower growth. At such times, owners must supplement feed or move their cattle to another location where feed is available.

In addition to forage use on an owner's property, many operations lease additional land for supplemental grazing. Livestock grazing on these lands is subject to private contracts and public permits. In California, the number of farms using grazing permits between 1987 and 1997 increased among all permit types, suggesting increasing dependence on leased lands for supplemental forage use. Regionally, the North Interior region held nearly one-third of the beef cattle farms excluding feedlots using grazing permits in 1997 (Figure 43).

Figure 43. Number of beef cattle farms excluding feedlots using grazing permits by NASS region*, 1997



** For a map of NASS regions, see Figure 80, p. 152*
Source: National Agricultural Statistics Service, 2001

Impacts from Timber Production

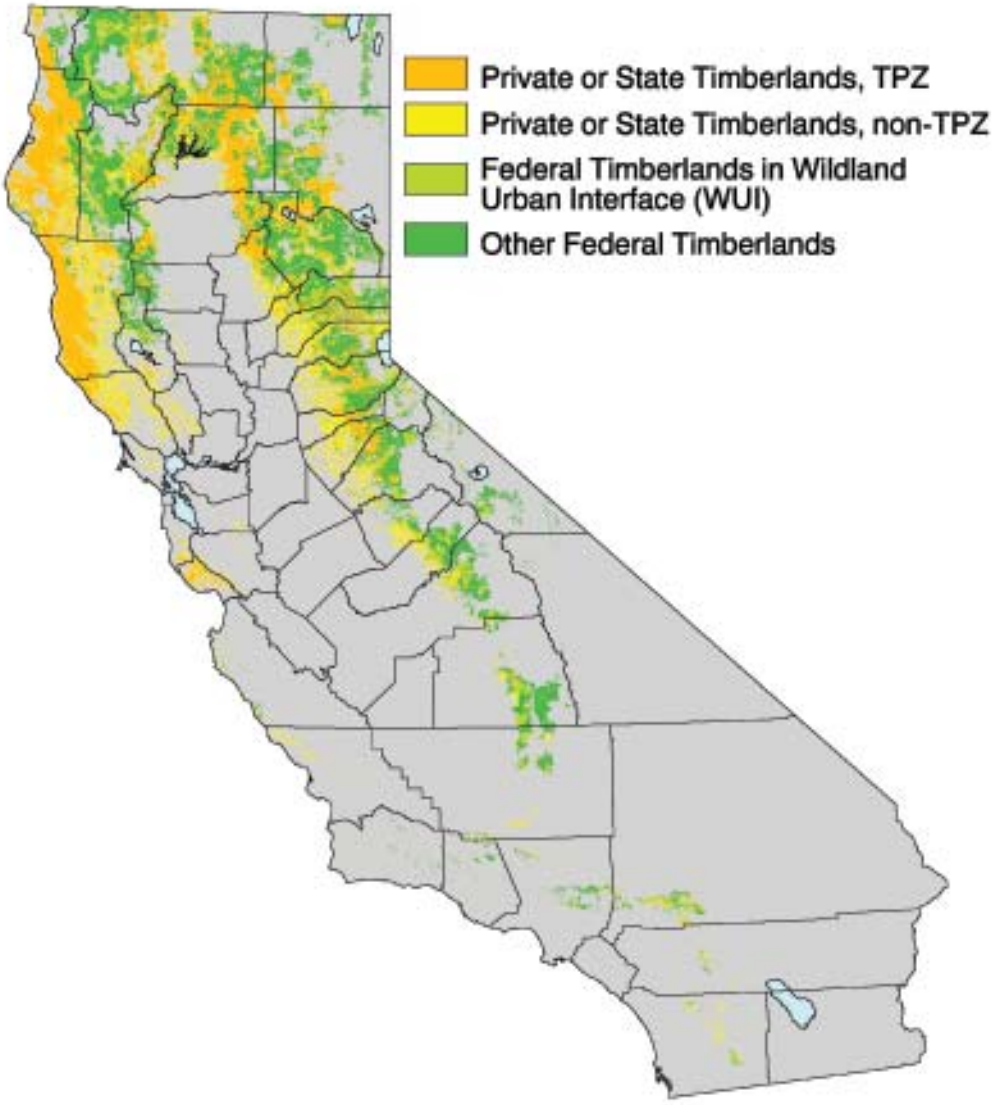
On-line Technical Report:
http://frap.cdf.ca.gov/assessment2003/Chapter6_Socioeconomic/forestindustry.html
Data Quality: Partial data ◐

Locations of Timber Management Activities

Historically, timber production has occurred on private timberlands and on public timberlands that were not reserves or otherwise withdrawn from harvest. In recent years, however, timber harvesting has declined greatly on all public lands. An area of possible future expansion is federal land adjacent to wildland urban interface (WUI) areas where harvesting will occur as part of fuel reduction activities (Figure 44). Wildland urban interface is a general term applied to areas of human development exposed to threats from wildfire (see Forest Health–Wildfire, p. 94).

Harvesting continues on most private lands. Where these lands are designated Timberland Production Zones (TPZ), a high percentage is likely to remain devoted to timber growing. Regionally, lands with the highest proportion of timberlands in TPZ include the Klamath/North Coast and Modoc bioregions (Figure 45). Private timberlands lacking this zoning may shift to a variety of other uses over time. Private non-TPZ lands are likely to

Figure 44. Timberlands by ownership, Timberland Production Zone (TPZ), and wildland urban interface (WUI) classifications



Source: FRAP, 1999; FRAP, 2003h; FRAP, 2003j

continue to experience impacts from timber management but dedication to timber production is uncertain. Finally, federal timber lands not adjacent to WUI and lands reserved from timber production are likely to have limited timber harvest activities in the near future.

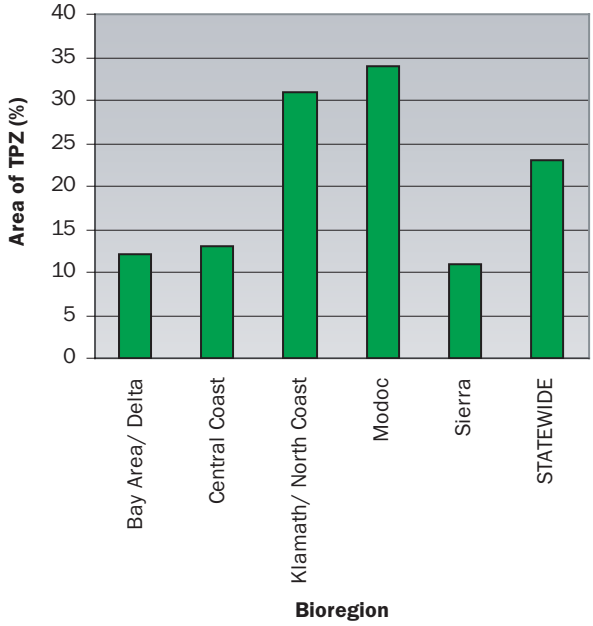
Trends in Timber Harvesting and Silvicultural Methods

Recent trends in timber harvest levels and types of silvicultural systems used for harvesting provide insight into potential future impacts from timber management. According to the State Board of Equalization (2003), timber harvesting on both public and private lands in California has decreased from 1970s levels of four to six billion board feet to two billion board feet in 2002 (Figure 46). This downward trend is related to both economic factors and the impact of forest policies regarding the protection of endangered and threatened wildlife species as well as other environmental concerns, particularly on public land.

Timber harvest volume on public lands decreased from two billion board feet in 1988 (40 percent of total timber harvest volume) to 170 million board feet in 2002 (10 percent). The decline in harvest on public lands has been especially significant in counties that have traditionally had high harvest volumes from national forest lands. For example, the percentage of total timber harvested in Plumas County from federal lands fell from 71 percent in 1991 to just 24 percent in 2002. In contrast, timber harvest volume on private lands has declined just slightly since 1991 and has remained steady at around two billion board feet annually in recent years. Additionally, harvesting has shifted towards younger and smaller trees while old growth and larger-sized timber harvested over this period has declined dramatically.

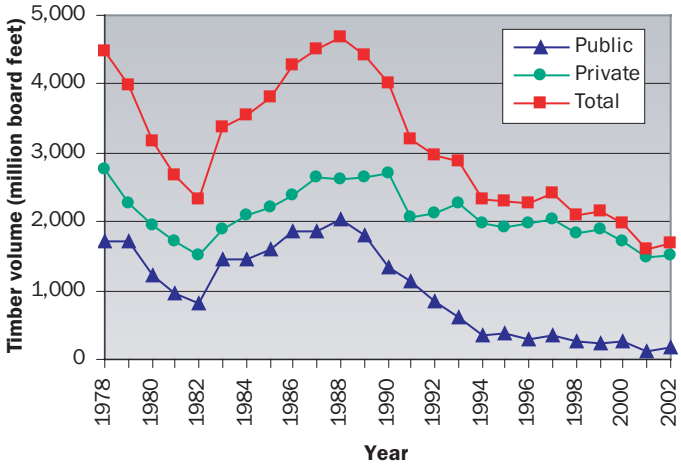
Both trends, overall reduced harvesting and less harvesting of old growth, suggest that land management impacts due to logging will continue to decrease in the future. The logging activities that remain will be focused on lands with younger forests. Even though overall harvesting has declined, California is still a major national provider of lumber, ranking fourth in total lumber production in the United States.

Figure 45. Pecentage area of timberland in TPZ by timber producing bioregion and statewide



Source: FRAP, 2003h

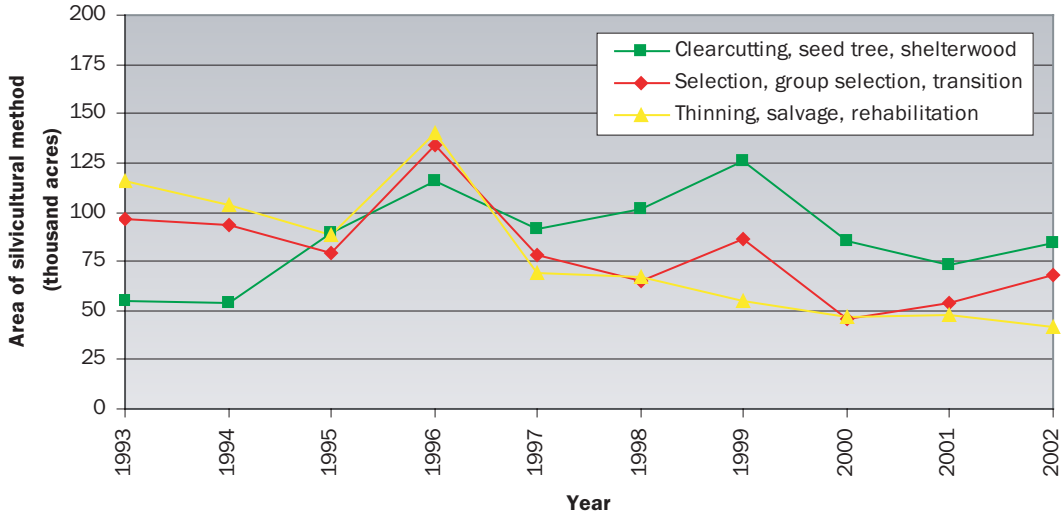
Figure 46. Volume of timber harvested on public and private ownership, and total, 1978–2002



Source: Compiled by FRAP from California State Board of Equalization, 2003

Management impacts of forests in the future depends on the owners' management objectives. These objectives are implemented in significant part by control of the establishment, composition, and growth of forest stands, known as the practice of silviculture. A silvicultural system is a program of forest stand treatments during the life of the stand. One common silvicultural system referred to as evenaged management addresses forests with tree stands of similar age class and size. Evenaged management systems include clear-cutting, seed tree, and shelterwood. Another common silvicultural system emphasizes the creation and maintenance of well stocked forest stands with trees of various age classes, termed unevenaged management. Harvesting involves removing individual trees or small groups of trees, and common methods include the selection and transition methods. The transition method is used when the manager wants to change an irregular or evenaged stand into a balanced, unevenaged structure. Over the last two decades, area harvested under evenaged and unevenaged silvicultural systems on private and state lands have varied by year and region. During the 1990s, total harvest area on private land varied between 200,000 and 300,000 acres (Figure 47).

Figure 47. Area of timber harvest by silvicultural method on private and state lands combined, 1992–2002



Source: CDF, 2002a

Lands in Reserve Status

On-line Technical Report:
http://frap.cdf.ca.gov/assessment2003/Chapter1_Biodiversity/habitatdiversity.html

Data Quality: Partial data ◐

Approximately 23 percent of California's forests and rangelands fall into the Reserve Management Landscape class, which are lands managed consistent with statutory designations such as wilderness, wild and scenic rivers, national parks, and national monuments (Table 25, Figure 48). Reserve lands are less extensive than are lands managed for commodities. They are also unevenly distributed across the state. For example, high altitude forests are very well represented in Reserve status while valley riparian forests are not.

On these lands, active management impacts are negligible. However, lack of management is a concern as unattended forests can accumulate hazardous fuel loads which may result in catastrophic, stand replacing fires that drastically modify habitats and ecological processes.

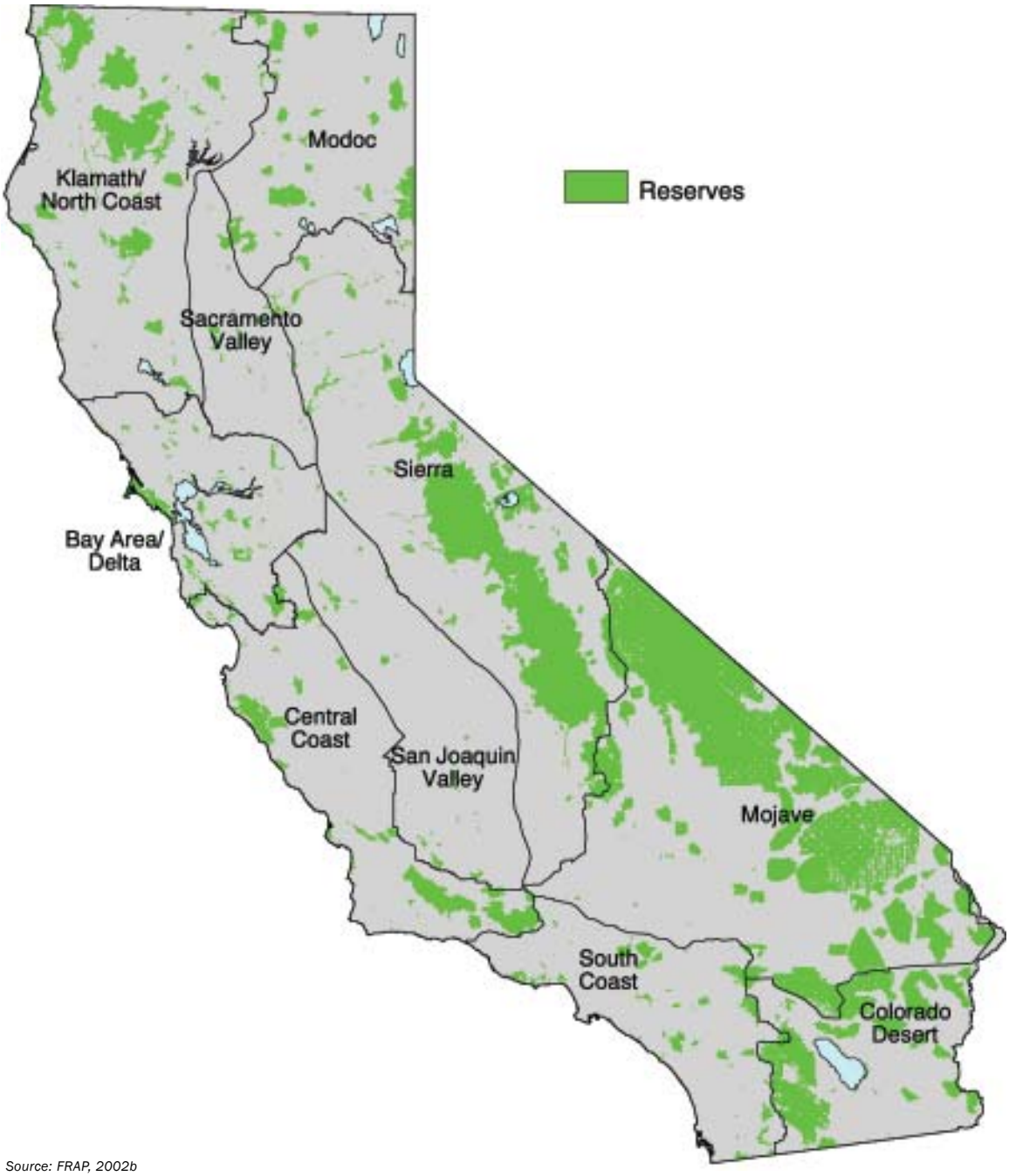
Table 25. Percentage area of forests and rangelands in Reserve Management Landscape class by bioregion and statewide

Bioregion	Percentage area in Reserve
Bay Area/Delta	12
Central Coast	15
Colorado Desert	34
Modoc	9
Mojave	43
Klamath/North Coast	13
Sacramento Valley	4
San Joaquin Valley	5
Sierra	22
South Coast	12
Statewide	23

Source: FRAP, 2002b

Sequoia National Park. Photo by G. Donald Bain, Geo-Images Project, UC Berkeley.

Figure 48. Lands in the Reserve management class



Source: FRAP, 2002b

Development Impacts on Forest and Rangeland Resource Sustainability

Loss or significant alteration of natural vegetation at the landscape scale due to housing development is a major factor affecting biological diversity, soil and water quality, commodity production, and other ecological processes. The Assessment considers *development* to be housing density of one or more units per acre. This includes both urbanization (high density housing) and parcelization (low density housing typical of rural residential development), as the main change agent operating on landscapes and processes. Development impacts occur from outright loss of natural landscapes, degradation of forest continuity and structures (i.e., habitat fragmentation), reduced water quality, and loss of open space that contributes to quality of life.

Development Indicators

- **Projected Loss and Alteration of Land Cover Due to Housing Development**
- **Projected Loss and Alteration of Hardwood Land Cover Due to Development**

Serrano. Photo courtesy of Serrano, El Dorado Hills.

Development

Representative Goal

Maintain optimum amount of timberland, discourage urban expansion into timberland, support … long-term private … conservation of oak woodlands, and protect California's land resource, to insure its preservation and use in ways which are economically and socially desirable *(paraphrased from California Timberland Productivity Act of 1982; Government Code section 65030, Declaration of State Policy and Legislative Intent for the Environmental Goals and Policy Report, Government Code section 65030, California Fish And Game Code Section 1362, Oak Woodlands Conservation Act).*

Findings

- Development refers to the encumbering of forests and rangelands with high density housing typical of towns and cities (urbanization) as well as low density housing typical of rural residential areas (parcelization). Impacts occur from conversion of natural landscapes (habitat loss) and disruption of forest continuity and structures (habitat fragmentation) leading to problems such as degradation of water quality and loss of open space.
- Between 1982 and 1997, over 933,000 acres of non-federal forests and rangelands were converted to urban uses, as reported by the National Conservation Resource Service's National Resource Inventory (NRI, 2000).
- Over the next 40 years, FRAP projects that approximately 10 percent of the current forest and rangeland base (2.7 million acres) will be impacted by development (high density urbanization and low density rural residential). This estimate is not directly comparable to past NRI calculations as NRI measures high density urbanization only.
- Detailed, site specific projections of rural residential development in El Dorado County found that whereas only four percent of natural habitat area was lost to development, nearly 40 percent was greatly reduced in quality.
- Certain forest and rangeland habitats are more likely to be affected by future development. Hardwood woodlands, shrublands, and desert rangelands are likely to be most impacted.
- The South Coast, Sierra, Mojave and San Joaquin bioregions are projected to have the greatest extents and percentages of private forests and rangelands affected, although a considerable amount of working landscape remains in these regions.

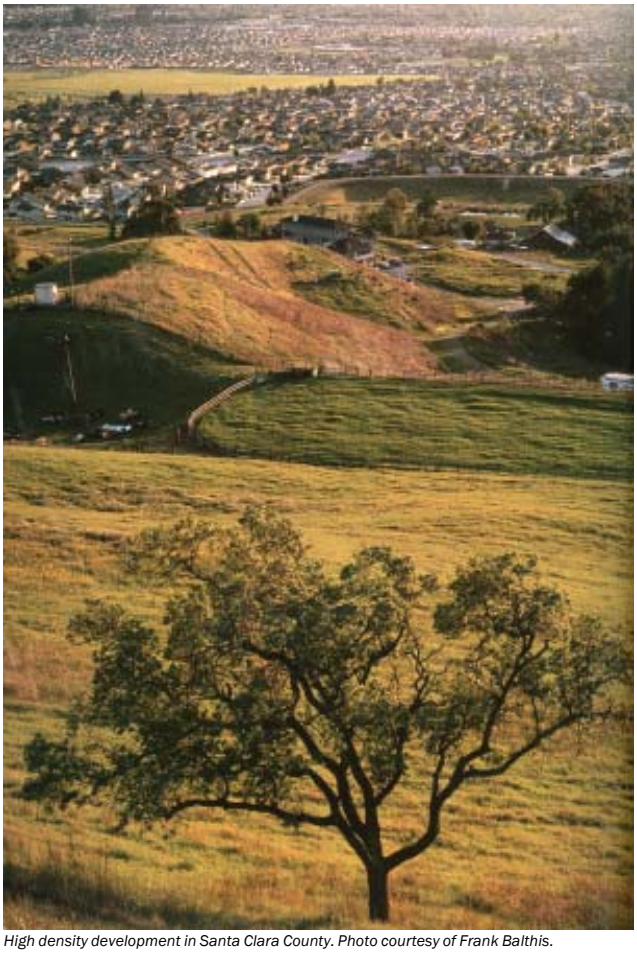
Projected Loss and Alteration of Land Cover Due to Housing Development

On-line Technical Report:
http://frap.cdf.ca.gov/assessment2003/Chapter3_Quality/habitat.html
Data Quality: Partial data ◐

To project impacts of future housing development, FRAP estimated the projected locations of new housing development and intersected them with FRAP's land cover data. This overlay produces information on the privately-owned land covers and locations that will likely be impacted by housing development between 2000 and 2040.

Bioregional trends in projected development of housing density greater than 1 unit per 20 acres (including urban) show double digit projected percentage losses in private forests and rangelands in the Mojave, South Coast, Sierra, and San Joaquin Valley bioregions (Figure 49). It is within these regions that the greatest probability of significant landscape fragmentation within private lands exists if policy tools, such as easements, acquisitions, and Natural Community Conservation Programs (NCCPs) are not used to maintain habitat and landscape connectivity.

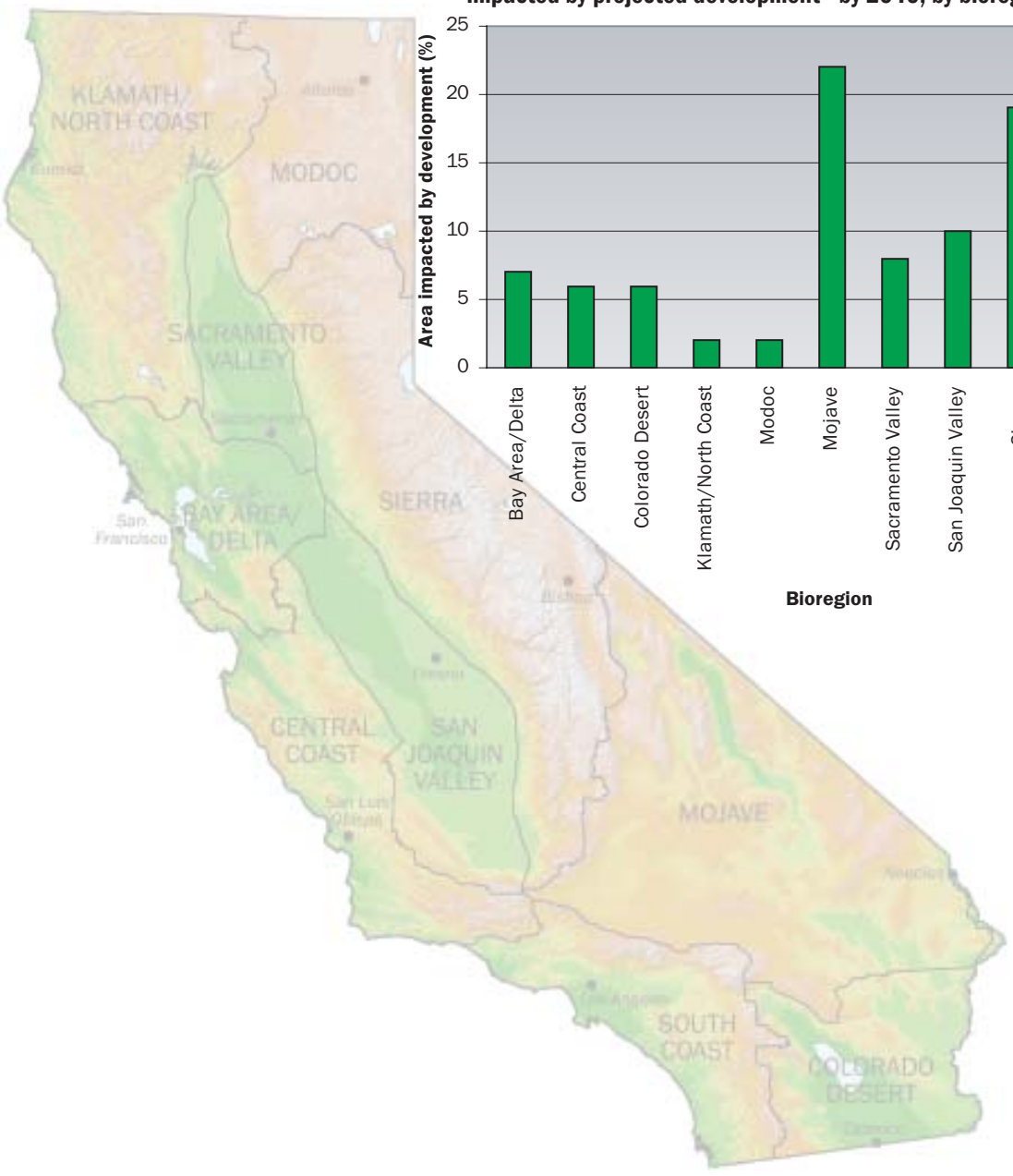
A detailed study conducted by FRAP in El Dorado County reveals that habitat fragmentation and degradation of habitat quality from rural residential development are of greater magnitude than actual habitat loss (Saving and Greenwood, 2002). Whereas projections revealed that only four percent of natural land cover area would be converted to development, nearly 40 percent would experience a marked decline in habitat quality due to fragmentation and the reduction of habitat area to patch sizes incapable of supporting basic ecological functions.



High density development in Santa Clara County. Photo courtesy of Frank Balthis.

Figure 49. Regional Development Indicator

Projected loss and alteration of land cover due to housing development (housing density of one or more units per 20 acres) is expected to be a significant source of loss and degradation of natural vegetation on private lands. This impact will range from outright loss of forests and rangelands from high density development to habitat degradation from increases in low density housing. Specific land covers are at greater risks than others. For example, Hardwood Woodlands, while expansive in extent, are projected to have large decreases in area due to development.



Percentage area of current private forests and rangelands potentially impacted by projected development* by 2040, by bioregion and statewide

** housing density of one more more units per 20 acres*
Source: FRAP, 2003b
Map: California Biodiversity Council bioregions

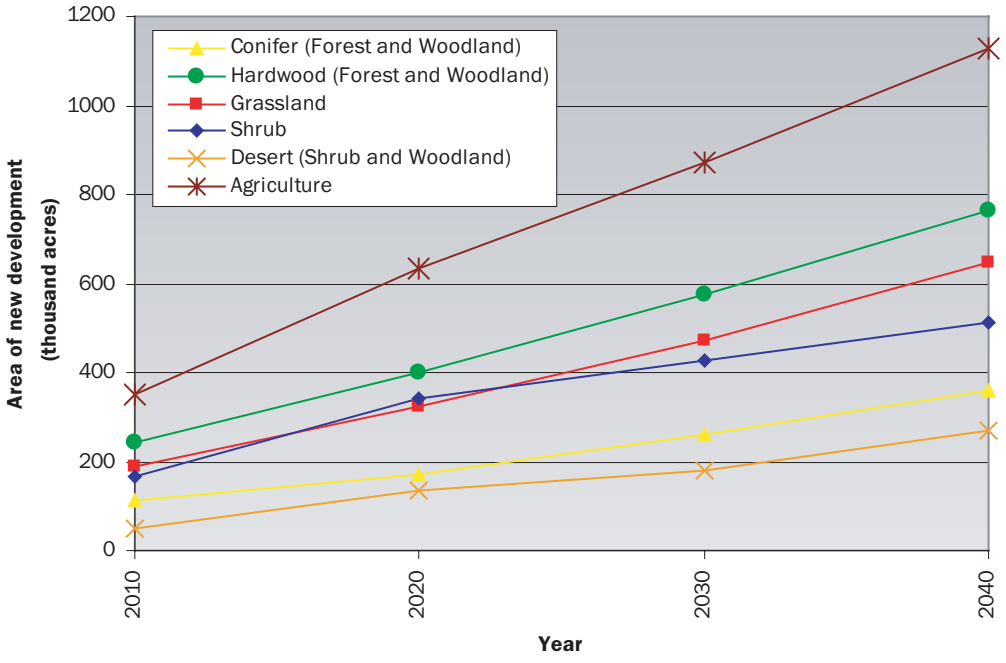
Over the next 40 years, development is expected to impact approximately 2.6 million acres of private forests and rangelands (Table 26). Rangeland cover types (Conifer Woodland, Hardwood Woodland, Hardwood Forest, Shrub, Grassland, Desert Shrub, Desert Woodland and Wetland) will experience the most development, reaching 2.2 million acres by 2040. This exceeds the projected development of agricultural lands (1.1 million acres) (Figures 50 and 51, Appendix map Historical and Projected Development).

Table 26. Projected area and percentage of current private, undeveloped land cover classes potentially impacted by new development* by decade to 2040 (thousand acres)

Land cover class	2000 undeveloped land base	Area of new development*				Total	Percentage loss
		2000–2010	2010–2020	2020–2030	2030–2040	2000–2040	2000–2040
Conifer Forest	5,649	105	58	85	95	343	6
Conifer Woodland	417	6	2	4	5	17	4
Hardwood Woodland	3,724	147	103	101	113	463	12
Hardwood Forest	2,416	95	54	74	78	300	12
Grassland	8,345	190	134	145	177	646	8
Shrub	4,324	165	175	88	85	514	12
Desert Shrub and Woodland	3,705	51	82	45	91	269	7
Wetland**	134	1	0	1	0	3	2
Forest and Rangeland Total	28,713	760	608	543	644	2,554	9
Agriculture	8,744	351	281	240	254	1,126	13
Total	37,457	1,111	889	783	898	3,681	10

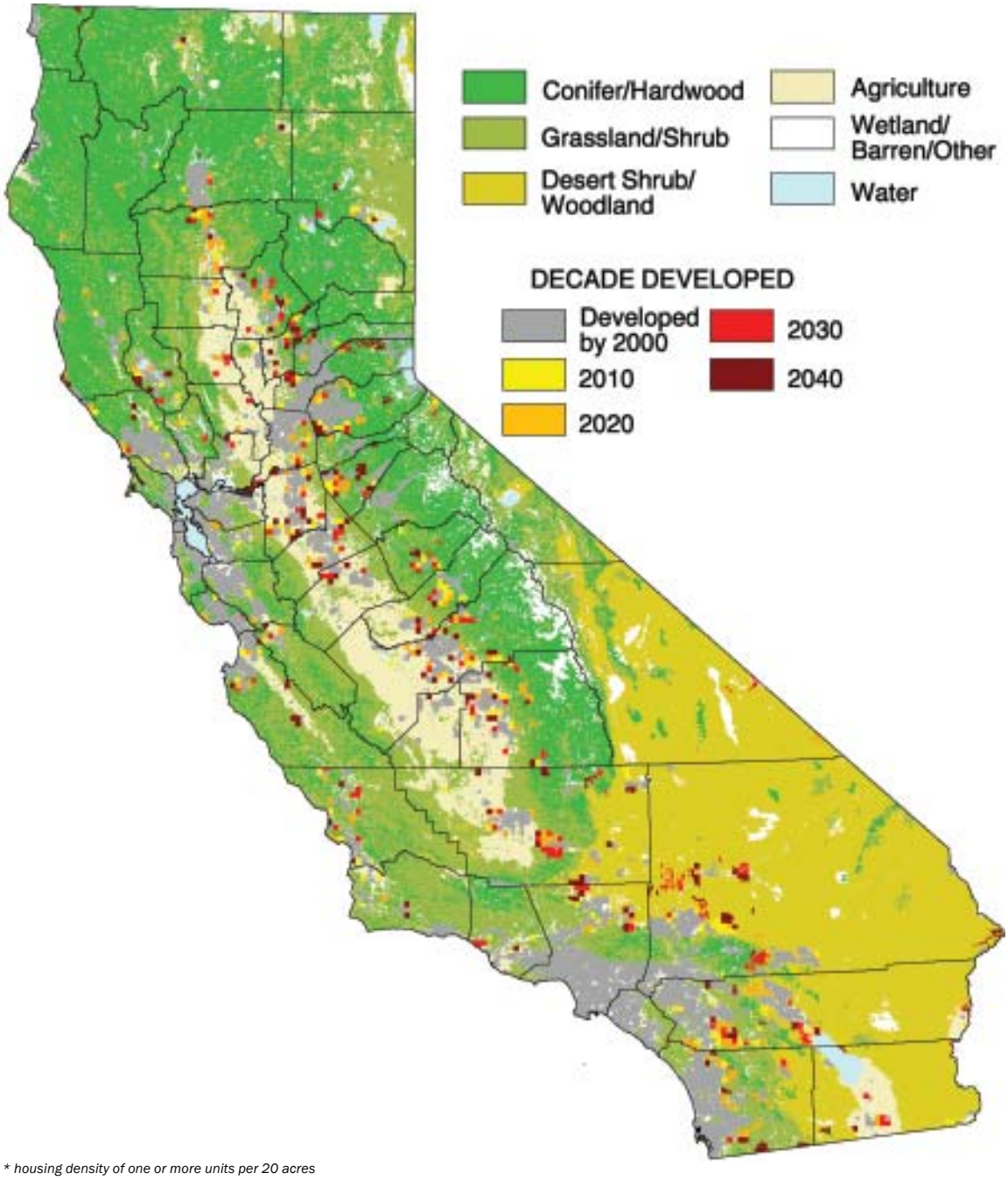
** housing density of one or more units per 20 acres*
*** Only the CWHR type Wet Meadow is considered forests and rangelands. See Appendix, Table A–2.*
Source: FRAP, 2002d; FRAP, 2003b

Figure 50. Projected area of new development* on private land cover classes by decade to 2040



** housing density of one or more units per 20 acres*
Source: FRAP, 2002d; FRAP, 2003b

Figure 51. Projected development* by decade to 2040 and current land cover



** housing density of one or more units per 20 acres*
Source: FRAP, 2002d; FRAP, 2003b

Projected Loss and Alteration of Hardwood Land Cover Due to Development

On-line Technical Report:
http://frap.cdf.ca.gov/assessment2003/Chapter1_Biodiversity/hardwoods.html

Data Quality: Partial data ◐

Because of its proximity to existing urban concentrations, some loss of hardwood land cover to residential development is expected. The extent and pattern of new residential development could have significant impacts on the ecological function of hardwoods by reducing habitat extent and continuity, creating air quality impacts, increasing wildfire risk, and creating conditions favorable for the spread of invasive exotic species.

If projections based on past land use and management hold true, these pressures will intensify. FRAP estimates that seven out of nine Hardwood habitat types will have at least 10 percent of their 2000 base area impacted by development at a density of at least one housing unit per 20 acres by 2040 (Figure 52). Certain Hardwood habitats are more susceptible than others to development. Valley Oak Woodland and Valley Foothill Riparian are particularly vulnerable because of their low abundance, limited reserve status, and adjacency to intensively developed land uses. Blue Oak Woodland, Blue Oak-Foothill Pine, and Coastal Oak Woodland also face development pressures, but have far larger distributions.

Through zoning classifications and tax policies, government has attempted to help forest and rangeland owners maintain land in production or keep it from being broken into smaller parcels for development. However, these special tax zonings do not appear to have been used on a large portion of the forests and rangelands covered by oak woodlands. The State also has encouraged local governments to develop policies regarding the protection of hardwoods. To varying degrees, counties have been active in developing conservation policies. These include formal voluntary county guidelines, county ordinances, and land use planning processes. As of May 2000, all but a few counties had some process for governing privately owned hardwood range resources within their boundaries. However, many of the policies focus on protecting hardwood trees rather than habitat values, which are harder to measure. Still, some counties such as Los Angeles and Contra Costa focus on broader aspects of hardwood protection.

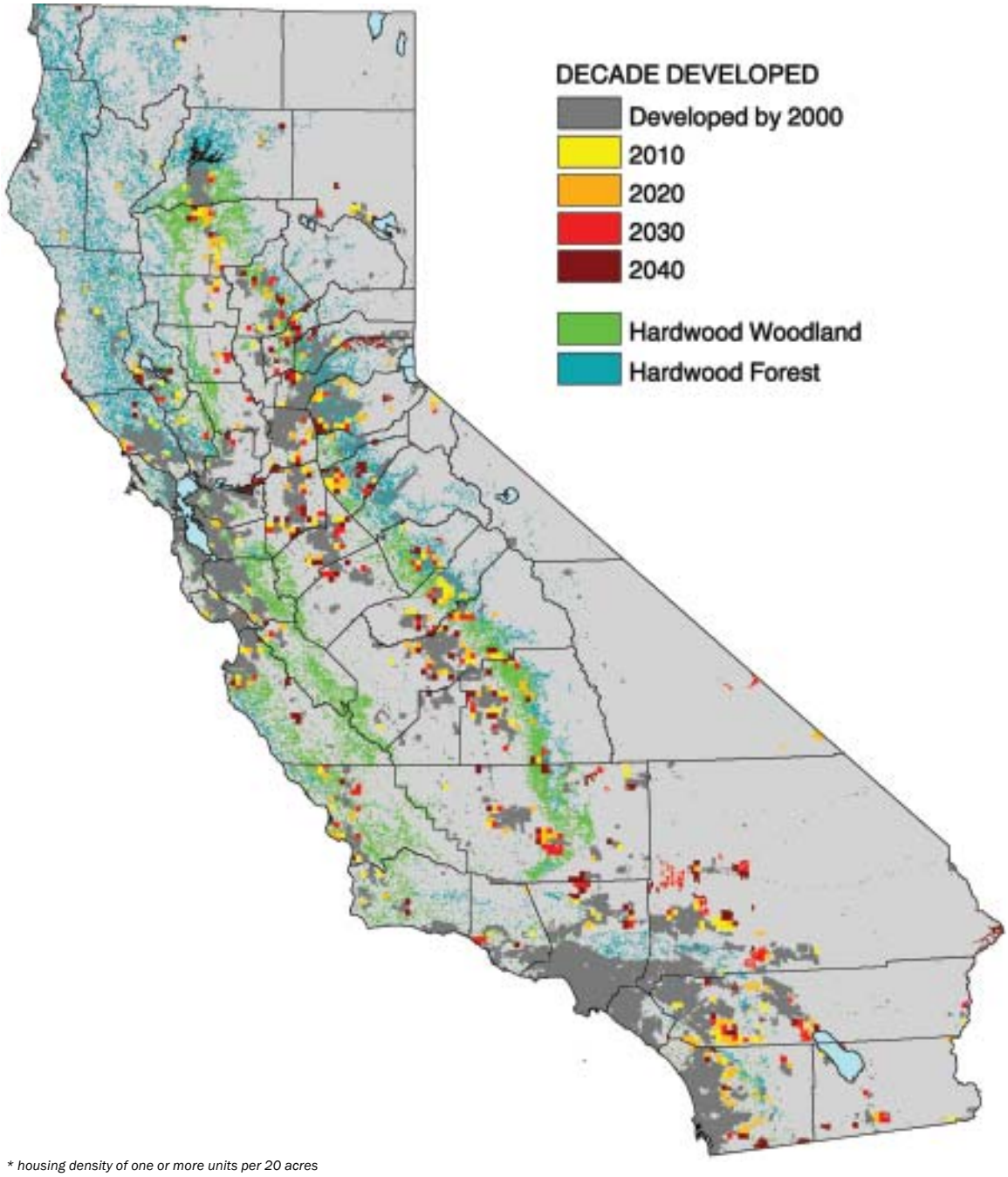
Oak resources can also be protected at the local level through implementation of California Environmental Quality Act (CEQA) guidelines and county general plans. However, local planning processes often do not discuss cumulative impacts across watersheds or larger areas, especially regarding oak woodlands. This occurs despite the fact that development has been the major cause of the loss of oak woodlands.

Conservation plans, joint projects, conservation easements, and even acquisition of lands in fee (purchase and title changes) can also protect hardwoods and hardwood habitats as well as involve landowners, nonprofit organizations, and governments at all levels. The Wildlife Conservation Board and various conservancies have coordinated much of the effort. To a large degree, the focus has been on hardwood lands that hold special value, such as riparian forests or threatened or endangered species habitats.

In 1990, the passage of Proposition 117 provided additional protection of hardwood and riparian habitats. This ballot initiative protected mountain lions in California and established the Habitat Conservation Fund that requires the state to spend $30 million per year for 30 years protecting habitat. Expenditures have focused on habitat acquisition, especially riparian habitat, and some restoration and improvement. The Natural Heritage Preservation Tax Credit Act of 2000 provided over $50 million in tax credits for donations of qualified lands and water placed in permanent preservation. In addition, the California legislature passed the Oak Woodlands Conservation Act in 2001. Under this legislation, funds can be utilized to buy oak woodland conservation easements or fee interests, improve lands, or grant private landowners with cost-sharing incentive payments. They can also be used for public education and outreach or to assist with the development of local general plans relative to oak woodland habitat.

Even with these tools, the sheer magnitude of development on hardwood lands makes the issue one of the major challenges for the next decade. Strategies will have to be flexible and adaptive, and will need to account for the fact that most of the Hardwood habitat types are in the Working/Private landscape, complete with the wide range of owners and management goals that this category brings.

Figure 52. Hardwood land cover classes and projected development* by decade to 2040



** housing density of one or more units per 20 acres*
Source: FRAP, 2002d; FRAP, 2003b

Wildfire Impacts on Forest and Rangeland Resource Sustainability

Over the millennia, fire has played an integral role in regulating the spatial pattern, composition, and structure of California's natural resources. In fire-adapted ecosystems, natural (pre-1600s) fire regimes strongly influenced how ecosystems looked and functioned. These fire regimes annually involved millions of acres of wildfire across California.

Many California ecosystems depend on a particular fire regime for long-term health. Disruption of these natural cycles often has significant ecological ramifications for ecosystem structures, functions, and capabilities to provide for human needs (ecosystem health). While fire often is described as a destructive agent, the ecological role that fire plays on vegetation is often better characterized as fire-maintained or fire-recycled, rather than fire-destroyed.

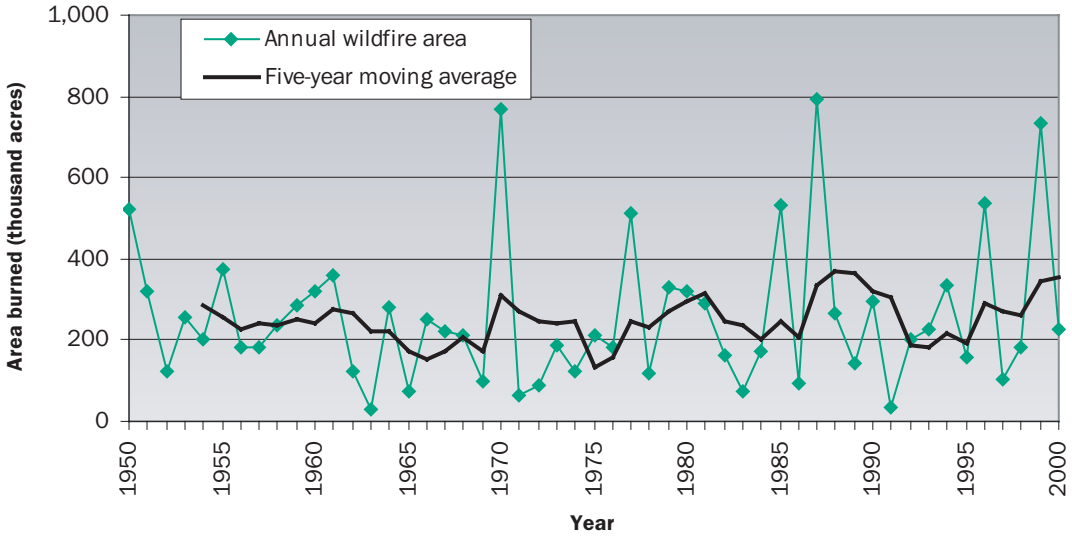
Modern-era acreage of fire covers only a fraction of that during the presettlement era. Over the last two decades, California has averaged 250,000 acres burned annually (Figure 53). This represents only a fraction of the several millions of acres that burned under presettlement regimes. Data from 1950–2000 indicate that rates of burning in the modern era are strongly influenced by vegetation type. Shrubland burning rates are considerably higher than other vegetation types, with almost one percent of area burned per year, compared to woodlands (0.4 percent), grasslands (0.3 percent), and conifer forests (0.2 percent).

Much of California's forests and rangelands support conditions where wildfire can be devastating to habitats, communities, and watershed values if fires are not aggressively suppressed. Fires that burn in areas under hot, dry, and windy conditions are difficult to control even with the world's most advanced wildland fire protection system. Potential impacts to ecosystem health are a concern in the Modoc, Klamath/North Coast, Sierra, and South Coast bioregions. Potential impacts on people are highest in the South Coast, Bay Area/Delta, and, to a lesser extent, the Sierra bioregions (see Figure 54).

Wildfire Indicators

- **Wildland Fire Threat**
- **Proportion of Forests and Rangelands Susceptible to Ecosystem Health Risks from Wildfire**
- **Proportion of Housing Units in the Wildland Urban Interface at Significant Risk from Fire**

Figure 53. Annual area burned*, statewide, 1950–2000



** fires over 300 acres in area*
Source: FRAP, 2002a

Wildfire

Representative Goal

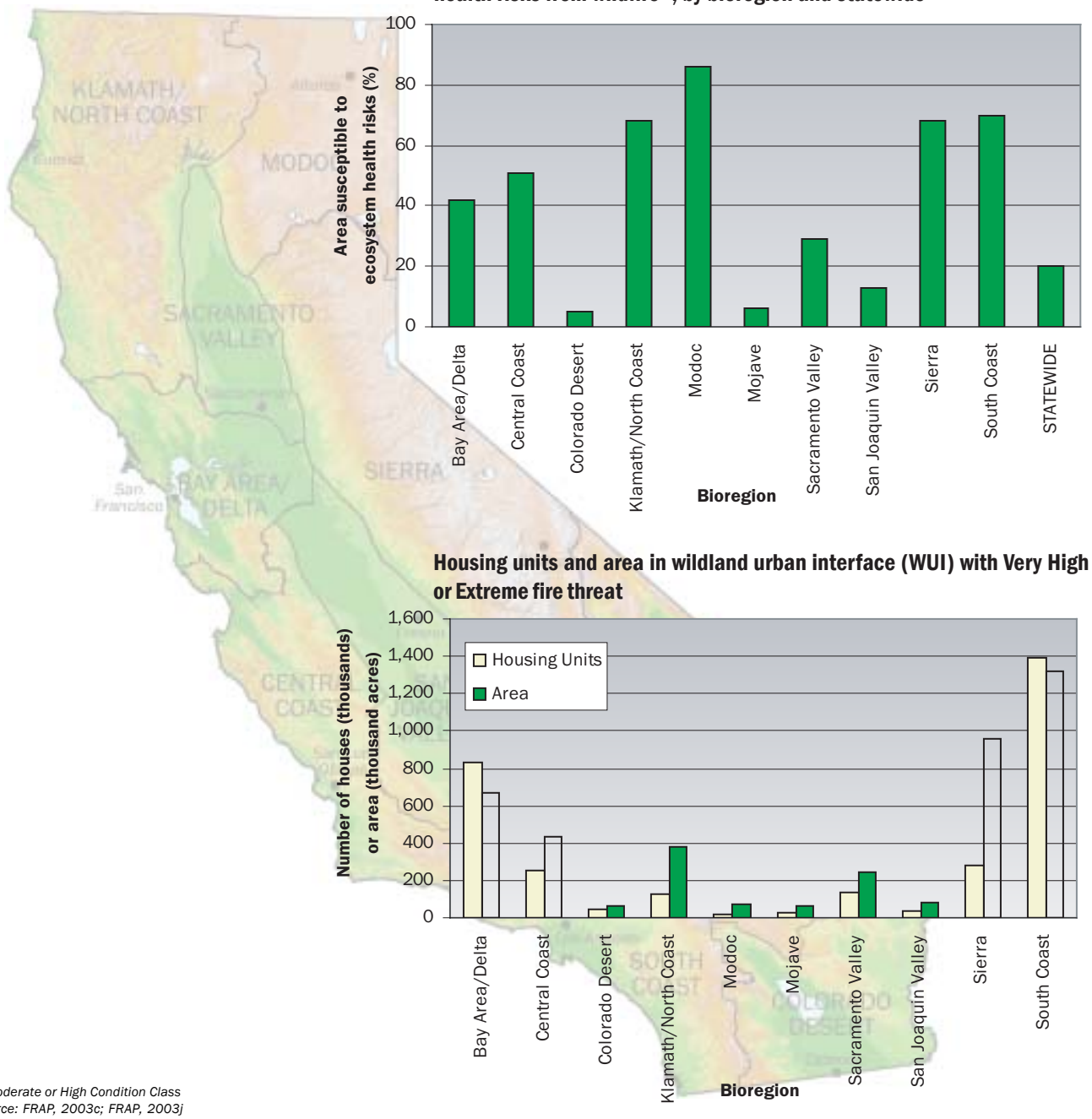
Classify lands … [for] severity of fire hazard [to] reduce the potential intensity of uncontrolled fires that threaten to destroy resources, life, or property; apply fuels reduction in fire defense improvements; make direct immediate and aggressive continuing attacks on all unwanted fires *(paraphrased from California State Board of Forestry policy memos and CDF Handbook, Chapter 0340, California Public Resources Code Section 4201, Article 9. Fire Hazard Severity Zones).*

Findings

- Wildfire and prescribed fire (purposely set fire) have a dual role in California. Wildfire can destroy valuable resources and degrades quality of life. However, fire can also provide an essential ecological function by cycling nutrients, modifying habitat for wildlife, and increasing forest health by decreasing woody material, thus making forests less susceptible to unnatural fire severity, pest, disease, drought, and pollutant stresses.
- Levels of wildfire vary annually depending on weather, frequency of events, and levels of wildfire protection services. Over the last 50 years, approximately 250,000 acres have burned each year, with several years having over 750,000 acres burned.
- Modern-era extent of fire is only a fraction of the area burned during the presettlement era. The combination of successful suppression efforts, lack of re-introduction of prescribed fire, and some management legacies have led to elevated levels of fire threat to many natural and human assets. FRAP currently estimates that 48 percent of California has conditions promoting High to Extreme fire threats.
- Several ecosystems are at substantial risk to adverse impacts from fire, resulting in destabilization and loss of biodiversity and ecological functions such as water cycling and soil productivity. Most forest and rangeland dominated bioregions have 60 to 80 percent of their natural land cover at High risk to ecological damage from wildfire.
- Human health, quality of life, and human assets (houses and property) are also at risk from wildfire. Nearly 5.5 million acres are in the wildland urban interface, including nearly 3.2 million homes at significant risk from wildfire. The Sierra bioregion has the most area of wildland urban interface at Very High or Extreme fire threat and the South Coast bioregion has the most homes threatened.

Figure 54. Regional Wildfire Indicators

Wildfire is expected to have significant impacts on biological diversity, productive capacity, and quality of life. These are realized by threats of extreme fire behavior that destabilize certain ecosystem structures, destroy timber stands, and threaten human assets.



** Moderate or High Condition Class*
Source: FRAP, 2003c; FRAP, 2003j
Map: California Biodiversity Council bioregions

Wildland Fire Threat

On-line Technical Report:
http://frap.cdf.ca.gov/assessment2003/Chapter3_Quality/wildfire.html

Data Quality: All required data

Fire threat is an index of both the expected frequency of fire occurring and the fire's physical ability to cause impacts. Elevated fire threat is widespread, with approximately 48 percent of the state having High, Very High, or Extreme fire threat (Table 27). Roughly one-third of California presents a Moderate fire threat; these areas may still suffer considerable impacts from wildfires should they burn under extreme fire weather conditions.

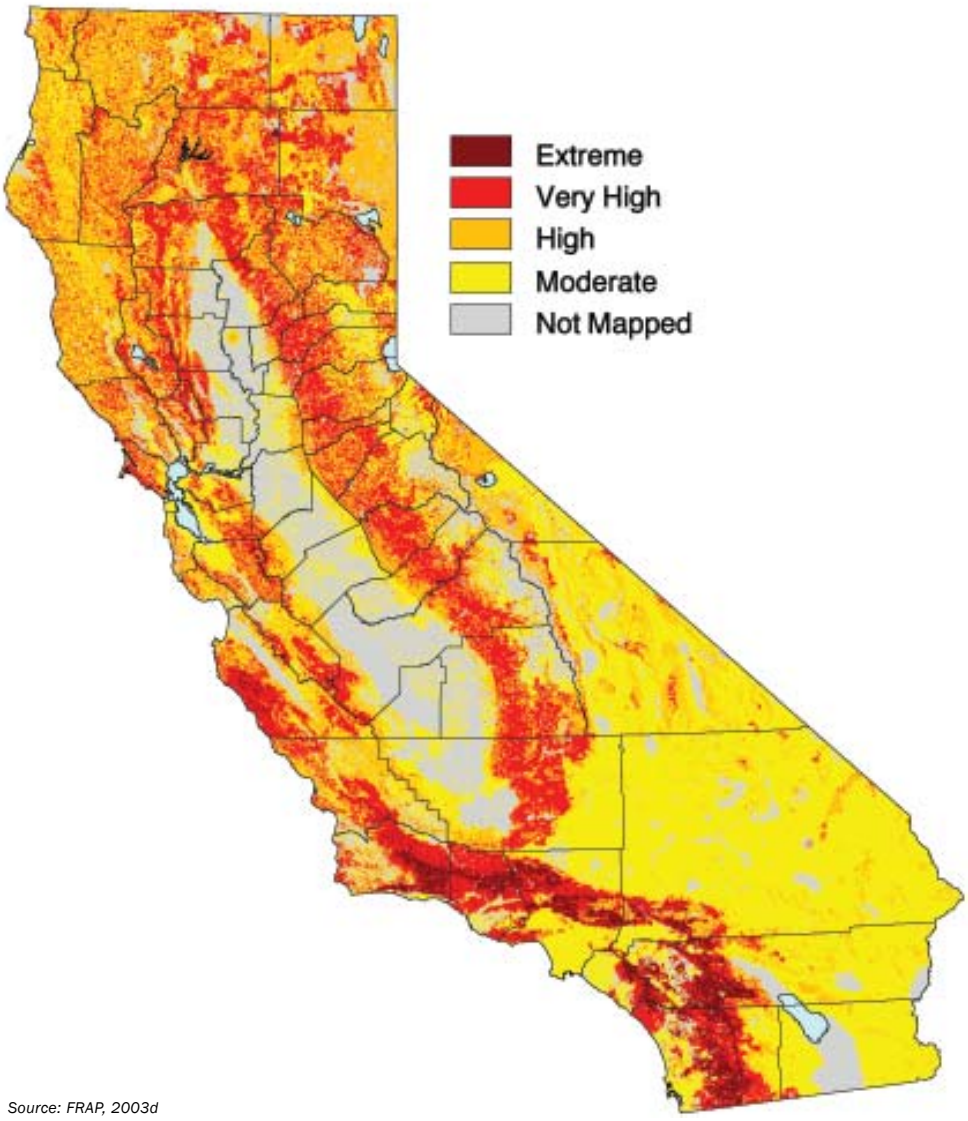
The distribution of fire threat suggests that areas of highest threat are scattered statewide, with large contiguous zones in southern California, the central coast, lower elevations of the Sierra Nevada, and much of the interior of northern California (Figure 55, Appendix map Fire Threat). Fire threat is both widespread and adjacent to many areas of dense population.

Table 27. Area and percentage area of fire threat ranks, statewide

Fire threat rank	Area (thousand acres)	Percentage
Extreme	2,249	2
Very High	15,769	16
High	30,371	30
Moderate	36,943	37
Not mapped	15,582	15

Source: FRAP, 2003d

Figure 55. Threat of wildfire



Source: FRAP, 2003d

Proportion of Forests and Rangelands Susceptible to Ecosystem Health Risks from Wildfire

On-line Technical Report:
http://frap.cdf.ca.gov/assessment2003/Chapter3_Quality/wildfirerisk.html
Data Quality: All required data

Wildfire can cause serious and long-lasting change to ecosystems. To describe fire-related risk to ecosystems the term *condition class* has been developed to relate current expected wildfires to their historic frequency and effects. Condition class ranks are defined as the relative risk of losing key components that define an ecosystem. Higher ranked areas present greater risk to ecosystem health (Table 28). Condition class is a measure of the expected response of ecosystems to fire given current vegetation type and structure that often is far different from that historically present. Today's wildfire impacts to ecosystems are a result of major disruption of the historical fire regime, increasing fuel accumulation, and the reduction of expected fire frequency. This ecological disequilibrium often results in changes in plant composition and structure, uncharacteristic fire behavior and other disturbance agents, altered hydrologic processes, and increased smoke production

Several bioregions have over 60 percent of their forests and rangelands in Moderate and High condition classes (Table 29, Figure 56). These areas have vegetation structures and fire histories that have deviated from historical levels and pose moderate or high risk to ecosystem health. Each bioregion has unique habitats with substantial risk to ecosystem health disturbance. The Modoc region, dominated by sagebrush steppe and the pervasive influence of exotic grasses, has largely lost its basic ecological integrity, and future fires only exacerbate the problem. Similarly, the forested areas of the Klamath/North Coast and Sierra bioregions are at risk due to unnaturally severe fires, where, without active restoration efforts, post-fire succession may result in loss of forested cover for decades.

Table 28. Condition class definitions used in assessment of risks to ecosystem health

Class	Departure from natural regimes	Vegetation composition, structure, fuels	Fire behavior, severity, pattern	Disturbance agents, native species, hydrologic functions	Increased smoke production
Low Condition Class 1	None, minimal	Similar	Similar	Within natural range of variation	Low
Moderate Condition Class 2	Moderate	Moderately altered	Uncharacteristic	Outside historical range of variation	Moderate
High Condition Class 3	High	Significantly different	Highly uncharacteristic	Substantially outside historical range of variation	High

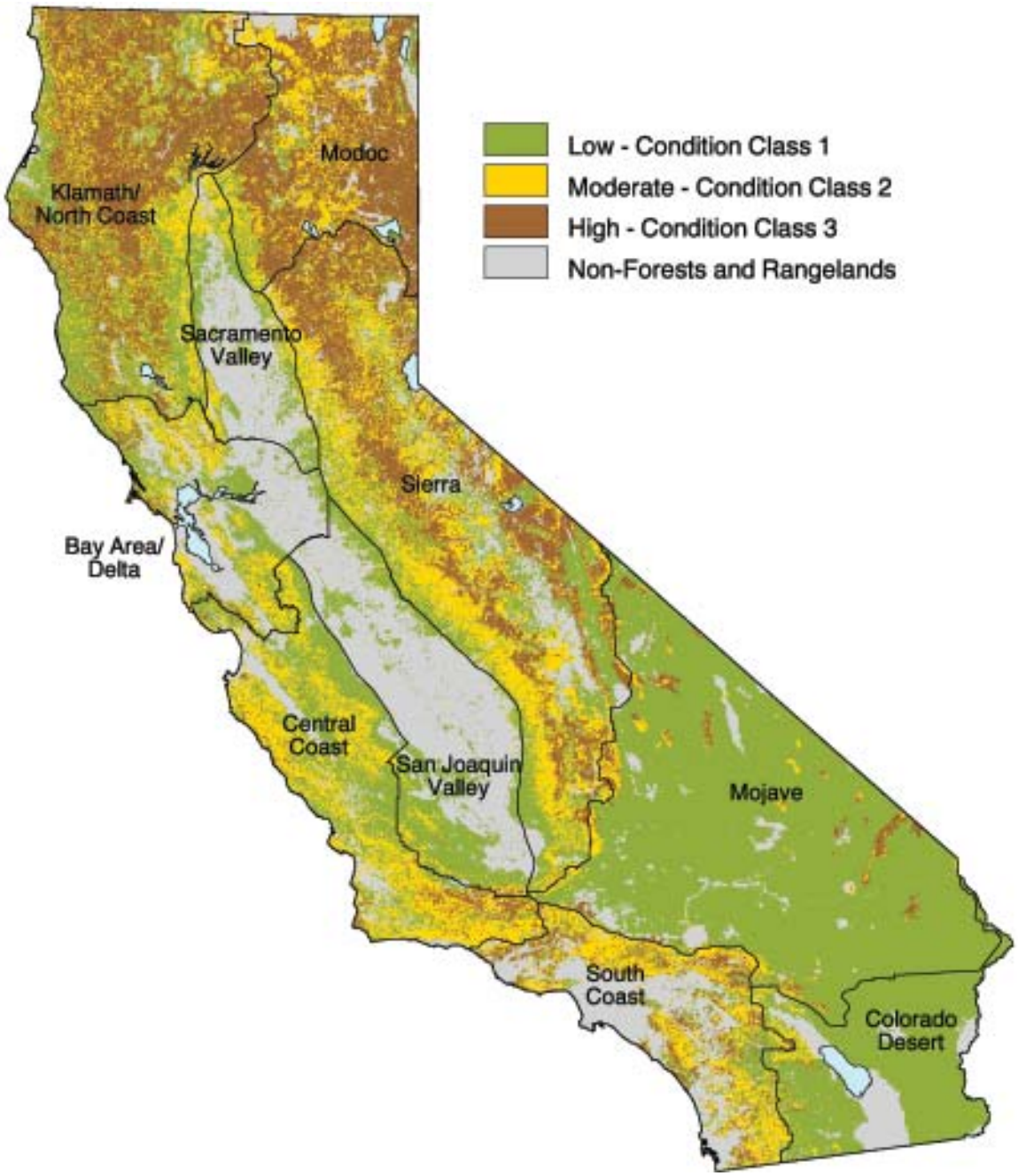
Source: FRAP, 2003c

Table 29. Percentage area of forests and rangelands in Condition Classes 2 and 3 (Moderate and High) and habitats with large proportions of area in Condition Classes 2 and 3

Bioregion	Percentage	Habitats with large proportions of Condition Classes 2 and 3
Bay Area/Delta	41	Mixed Conifer
Central Coast	51	Sagebrush; Grassland
Colorado Desert	5	Sagebrush; Grassland
Klamath/North Coast	68	Klamath Mixed Conifer
Modoc	86	Sagebrush; Grassland
Mojave	6	Sagebrush; Grassland
Sacramento Valley	30	Ponderosa Pine
San Joaquin Valley	11	Sierran Mixed Conifer
Sierra	68	Ponderosa Pine
South Coast	72	Coastal Sage Scrub

Source: FRAP, 2003c

Figure 56. Fire-related risks to ecosystem health as measured by condition class



Source: FRAP, 2003c

Proportion of Housing Units in the Wildland Urban Interface at Significant Risk from Fire

On-line Technical Report:
http://frap.cdf.ca.gov/assessment2003/Chapter3_Quality/wildfirerisk.html

Data Quality: All required data ●

The wildland urban interface (WUI) is a general term applied to areas of human development exposed to threats from wildfire. These include both forests and rangelands and some urbanized areas. FRAP defines those lands exposed to Very High or Extreme fire threat to be at *significant risk from wildfire.*

Nearly 5.5 million acres of developed areas comprise the total extent of the WUI (Table 30). Of this total, 919,000 acres are exposed to an Extreme fire threat, and an additional 3.4 million acres are exposed to Very High threat, resulting in a total of some 4.3 million acres in the wildland urban interface at significant risk to damage from wildfire. There are over 12 million housing units in California, of which approximately 3.2 million are at significant risk to damage from fire (Table 31, Figure 57).

Table 30. Area of wildland urban interface by housing density* and fire threat, 2000 (thousand acres)

Housing density class	Fire threat class			Total area in WUI
	Extreme	Very High	High	
Rural (one or more units per 20 acres and less than one unit per five acres)	459	1,734	393	2,586
Interface (one or more units per five acres and less than one unit per acre)	250	723	176	1,149
Urban (one or more units per acre)	210	910	609	1,729
Total	919	3,367	1,178	5,464

** WUI does not include sparsely populated areas with housing densities less than one unit per 20 acres.*
Source: FRAP, 2003j

Table 31. Housing units in the wildland urban interface by housing density* and fire threat, 2000 (thousands)

Housing density class	Fire threat class			Total housing units in WUI
	Extreme	Very High	High	
Rural (one or more units per 20 acres and less than one unit per five acres)	49	178	42	269
Interface (one or more units per five acres and less than one unit per acre)	110	316	83	509
Urban (one or more units per acre)	380	2,132	1,624	4,136
Total	539	2,626	1,749	4,914

** WUI does not include sparsely populated areas with housing densities less than one unit per 20 acres.*
Source: FRAP, 2003j

Figure 57. Wildland urban interface (WUI) susceptible to High, Very High, and Extreme fire threat by housing density, 2000

Source: FRAP, 2003j

A bioregional breakdown illustrates differences in WUI configuration, where rural and urban areas show different patterns of risk (Table 32). The Bay Area/Delta and South Coast bioregions contain the majority of housing units at significant risk (2.2 million of 3.2 million statewide). This result is largely due to extensive urbanized regions that are bounded at their periphery by areas that pose Very High or Extreme wildfire threat. In contrast, rural regions such as the Sierra and Klamath/North Coast, have substantially fewer housing units at significant risk, despite extensive area of elevated fire threat. This result is largely due to the small area of high density housing in these regions. Despite their relatively lower numbers of total units at risk, the Sierra, Klamath/North Coast, Modoc, and Central Coast bioregions have a majority of their housing units at significant risk from wildfire (79, 65, 55 and 52 percent, respectively) (Table 32).

The wildland urban interface in the Klamath/North Coast and Sierra bioregions is dominated by low density rural housing completely embedded within an elevated

Table 32. Total housing units and housing units in WUI exposed to significant risk* from wildfire, by bioregion (thousands)

Bioregion	Total housing units	Housing units in WUI at significant risk*	Percentage of housing units in WUI at significant risk*
Bay Area/Delta	2,805	835	30
Central Coast	494	257	52
Colorado Desert	222	48	22
Klamath/North Coast	196	128	65
Modoc	39	21	55
Mojave	270	25	9
Sacramento Valley	687	139	20
San Joaquin Valley	808	33	4
Sierra	357	283	79
South Coast	6,256	1,395	22
Total**	12,135	3,165	26

** Very High or Extreme fire threat*
*** Totals do not sum due to rounding.*
Source: FRAP, 2003j

fire threat environment. While the total asset concentration is low, the area distribution is extensive (Table 33). This has major implications for future fire protection in the high-growth Sierra bioregion.

Taken collectively, California has both a diverse and widespread wildland urban interface, where cities adjacent to forests and rangelands constitute the greatest number of housing units at risk from wildfire, but extensive areas of low density housing with a more dispersed configuration dominate some regions. Development pressure appears to be causing the expansion of both of these pattern profiles, indicating an overall increase in risk over time in the absence of major mitigation strategies.

Table 33. Total and percentage area of WUI at significant risk* from wildfire, by bioregion (thousand acres)

Bioregion	Total area in WUI	Area in WUI at significant risk*	Percentage area in WUI at significant risk*
Bay Area/Delta	929	667	72
Central Coast	500	432	86
Colorado Desert	82	68	83
Klamath/North Coast	409	382	93
Modoc	89	73	82
Mojave	173	65	38
Sacramento Valley	431	240	56
San Joaquin Valley	289	79	27
Sierra	972	961	99
South Coast	1,591	1,319	83
Total	5,465	4,286	78

** Very High or Extreme fire threat*
Source: FRAP, 2003j

Pests and Disease Impacts on Forest and Rangeland Resource Sustainability

Impacts from pests and disease (generally those from insects, animals, and pathogens) are constantly shaping California's forests. At low levels, they perform necessary roles in forest ecosystems through pollination, nutrient cycling, and thinning over-mature and unhealthy trees. When these forces act in conjunction with natural influences such as fire, drought, and wind, they can have a considerable effect on forests.

Elevated levels of insect or disease outbreaks can cause substantial loss of forest resource values. They can cause economic losses by lowering the ability of sites to grow merchantable timber as well as reduce the value of aesthetic and recreational amenities. Large shifts in structure and composition of forests caused by pests and disease can affect wildlife habitat, in particular, those species that rely on dense forest canopy.

Insects, such as the eucalyptus borer, have been introduced from outside California as have diseases such as white pine blister rust. Exotic insects and diseases may face few natural predators or resistance in California's ecosystems and may become established and spread.

Management activities can also create forest conditions that favor the outbreak of forest pests. Altered fire regimes, resulting from successful fire control, and past management practices along with past high levels of mortality, have resulted in increased fuels accumulation, increased tree stress, and additional host material for breeding of pest and disease organisms.

Pests and Disease Indicators

- **Proportion of Conifer Forest Areas at High Risk to Pest Damage through 2015**
- **Identification of Emerging Pests and Diseases**
- **Presence or Absence of Range Livestock Diseases**

Insect-caused tree mortality in mixed conifer forest.

Pests and Disease

Representative Goal

Maintain forest resources from damage from … natural enemies, promote health and vigorous conditions to minimize losses from pests, and expand efforts to slow emerging pests *(paraphrased from California State Board of Forestry policy memos and CDF Handbook, Chapter 0352; Public Resources Code, Section 4750.1).*

Findings

- Pests and diseases are parts of natural processes that when operating in normal historical ranges or low levels perform necessary roles in ecosystem process such as pollination, nutrient cycling, and thinning overstocked forests. Elevated levels of pests create economic losses to timber, reduce aesthetic qualities, and can affect biodiversity by shifting structures and composition to favor one species over another.
- Levels of mortality from insects to conifer forests on federal lands have declined since peaking in 1994 when over 800,000 acres had identifiable mortality of trees. Recent combinations of drought stresses, high vegetation stocking and decadence have resulted in substantially increased levels of mortality in the San Bernardino and Peninsular Ranges of southern California.
- More than 15 percent of the conifer forests in California are at high risk to mortality from pest damage due to overstocking through 2015. Approximately 25 percent of the conifer forests in some bioregions, including the Modoc and South Coast, are at high risk.
- Emerging pest concerns involve introduction of new, often exotic pests that have potential for impacting biodiversity by destroying unique host habitats. These pests and diseases include sudden oak death, which affects coastal oak woodland habitat in the Bay Area/Delta bioregion; eucalyptus borer, which is prevalent in the urban South Coast bioregion; and pitch canker, which affects closed cone pine habitats of the BayArea/Delta and Central Coast bioregion.

Proportion of Conifer Forest Areas at High Risk to Pest Damage through 2015

On-line Technical Report:
http://frap.cdf.ca.gov/_assessment/Chapter3_Quality/forestpests.html

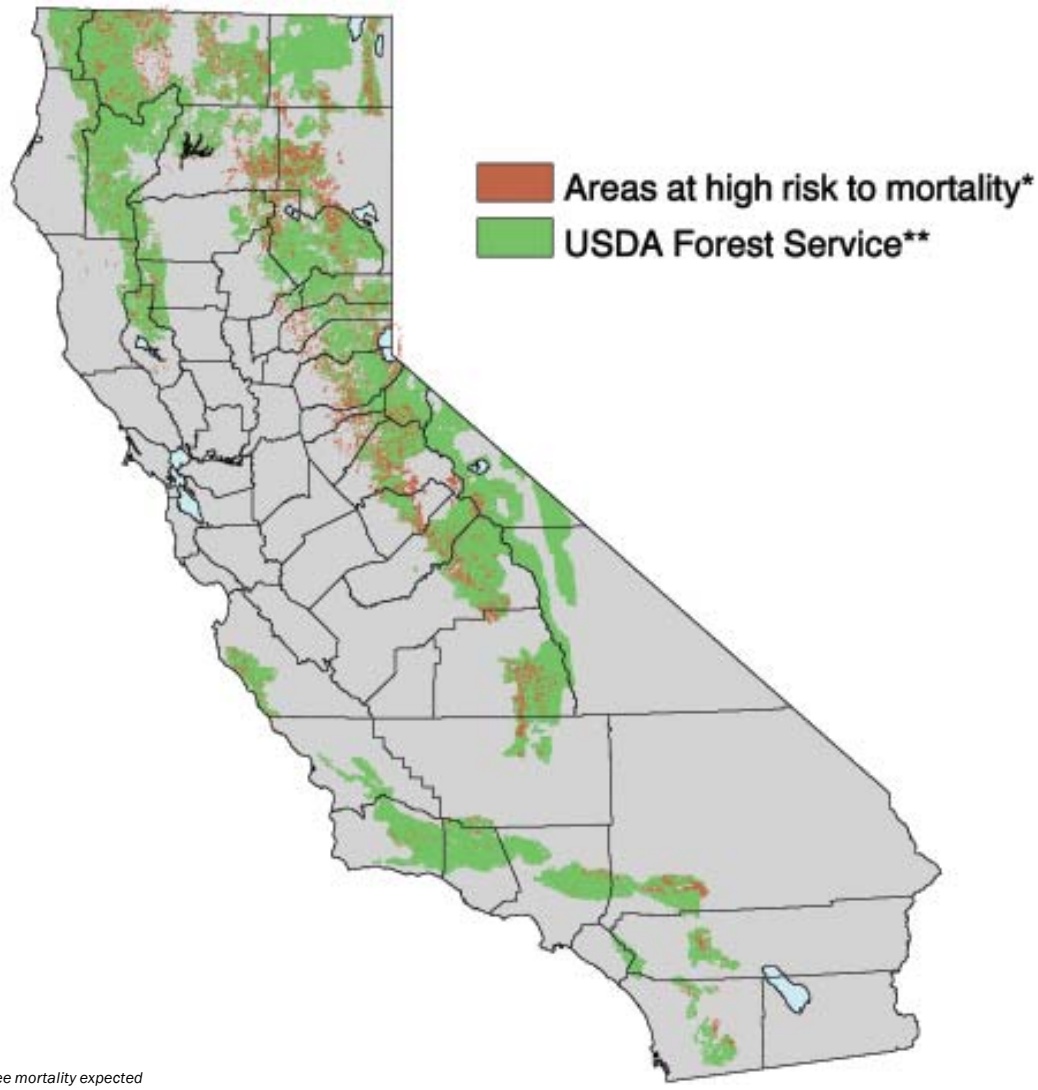
Data Quality: Partial data ◐

Much of California's forests are at *high risk to mortality* from pest damage (greater than 25 percent tree mortality expected). Given current management regimes and fire suppression tactics, stocking levels on many forests are very high. With increased stocking levels, host materials accumulate making some areas susceptible to insect and disease attacks.

Mortality from pests in conifer forests is a concern in several bioregions. The Modoc and South Coast bioregions have over 20 percent of their Conifer Forest area at high risk (Figure 58).

A survey conducted by the U. S. Forest Service on national forests and other adjacent lands estimated that 3.5 million acres of forests are at high risk to tree mortality through 2015—a total of 2.3 million acres on national forest lands and 1.2 million acres on other lands (Figure 59).

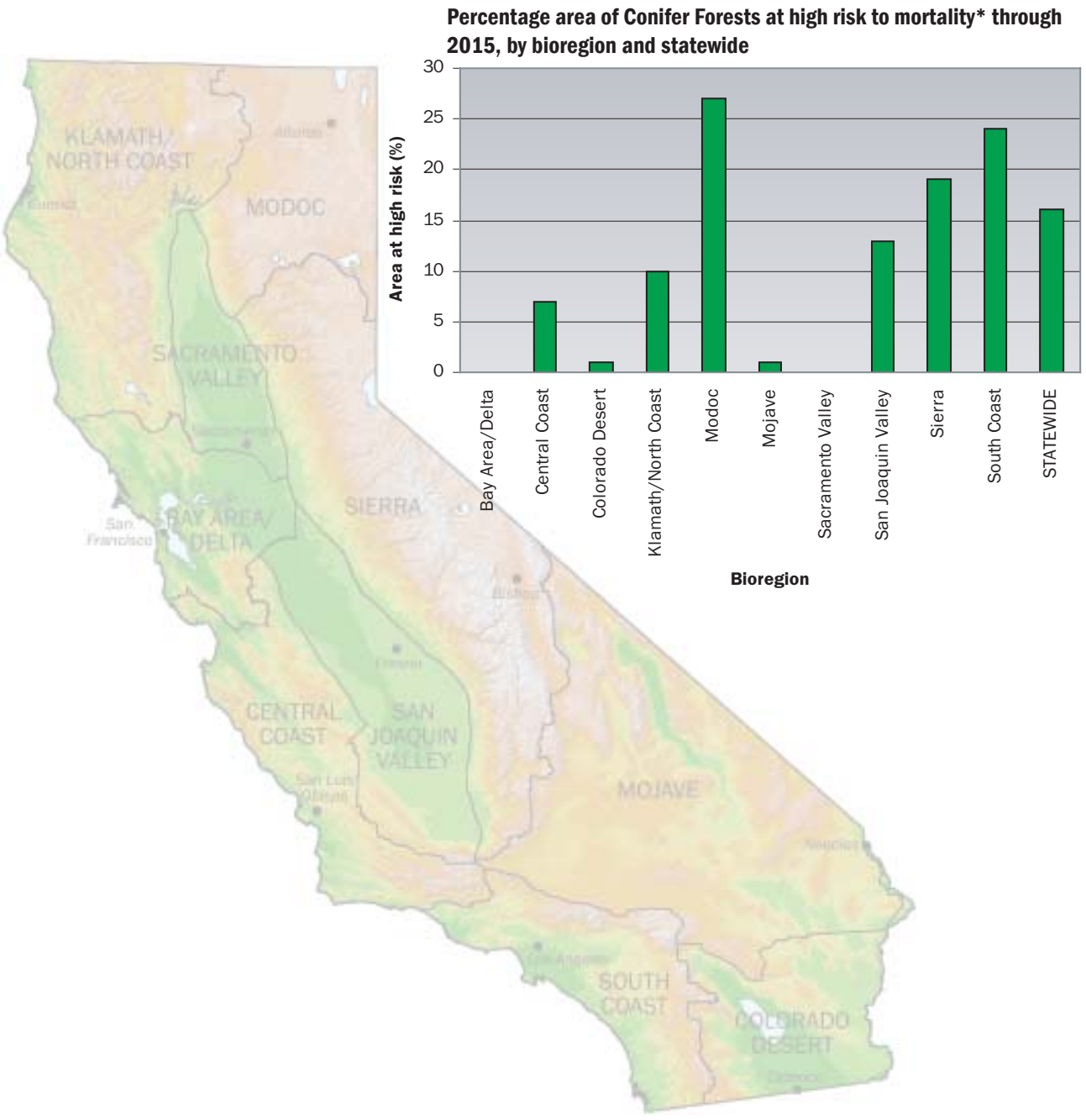
Figure 58. Areas at high risk to mortality* from insects through 2015



** greater than 25% tree mortality expected*
*** includes national forest land, adjacent private land, Yosemite National Park and Lassen National Park.*
Source: Compiled by FRAP from USFS, State, and Private Forestry, Forest Health Project, 2002; FRAP, 1999

Figure 59. Regional Pests and Disease Indicator

Though they sometimes have a beneficial role, pests and disease generally have a negative impact on biological diversity and productive capacity. Areas at high risk to pest damage can realize substantial mortality of valuable Conifer Forest tree species with less recovered wood and product values. Also, the emergence of new diseases, particularly in the coastal regions of California, can affect widespread habitats such as coastal oak woodlands by destroying specific tree species.



** greater than 25 percent tree mortality expected*
Source: Compiled by FRAP from USFS, State, and Private Forestry, Forest Health Project, 2002; FRAP, 1999
Map: California Biodiversity Council bioregions

Overstocked conditions (too many trees in a given site) and potential pest damage in conifer forests are of particular concern in several habitats. Within the area surveyed, Ponderosa Pine and Lodgepole Pine habitats had the greatest percentage of their area at risk. Approximately 55 percent of the Ponderosa Pine habitats surveyed were at high risk to mortality over the next 15 years (Figure 60).

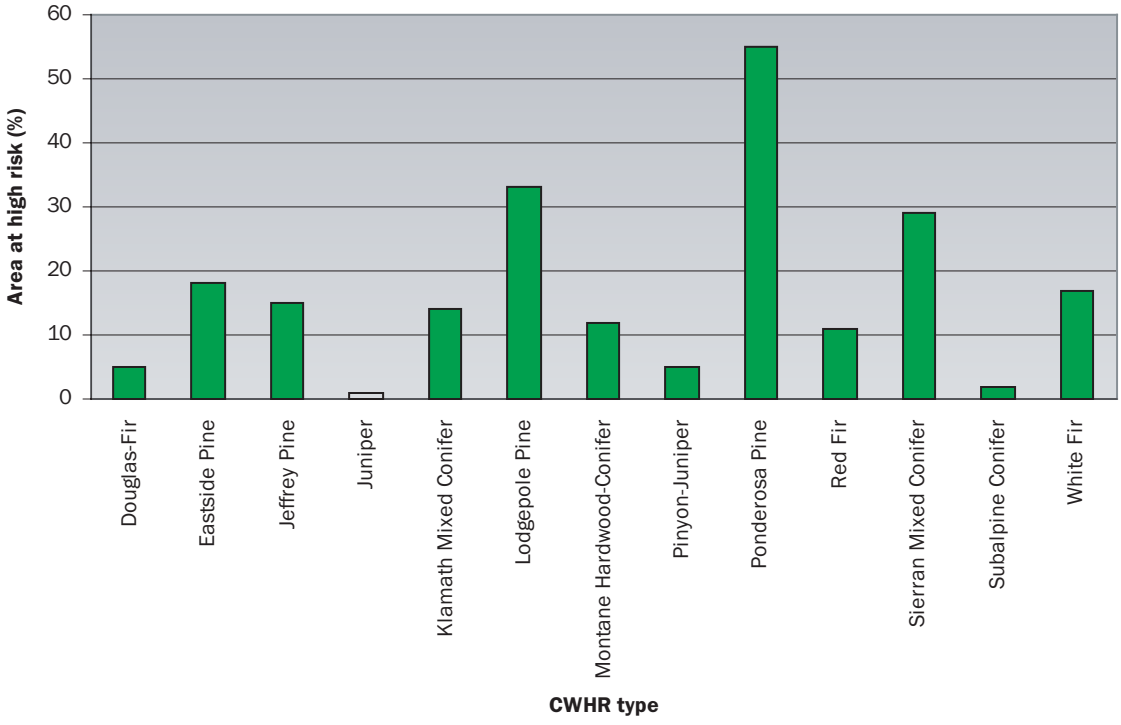
While causes of this level of potential pest damage in these regions are generally related to overstocking of stands, different ecological and anthropogenic influences are also important. For the Modoc region, fire exclusion related to the displacement of native shrub species that frequently burn have resulted in less frequent fires that would typically reduce tree stocking levels. In the South Coast bioregion, the combination of overstocked stands from lack of timber management, periodic drought stress, and air pollution entrapment interact to stress forests and make them more susceptible to pests. The most recent example is the substantial mortality in the pine and mixed conifer forests of the San Bernardino National Forest. There, some forested areas are exhibiting up to 80 percent mortality due to the combined influence of drought and bark beetle infestations.

Identification of Emerging Pests and Diseases

On-line Technical Report:
http://frap.cdf.ca.gov/_assessment/Chapter3_Quality/forestpests.html
Data Quality: Partial data

The historically high levels of mortality seen in the early 1990s in the Sierra and Modoc bioregions have declined in recent years, although new pests are beginning to become established that threaten forest and rangeland resources. Several pests and diseases are of particular interest including sudden oak death (*Phytophthora ramorum*), eucalyptus borer (*Phoracantha* sp.), white pine blister rust (*Cronartium ribicola*), and pitch canker (*Fusarium subglutinans*)

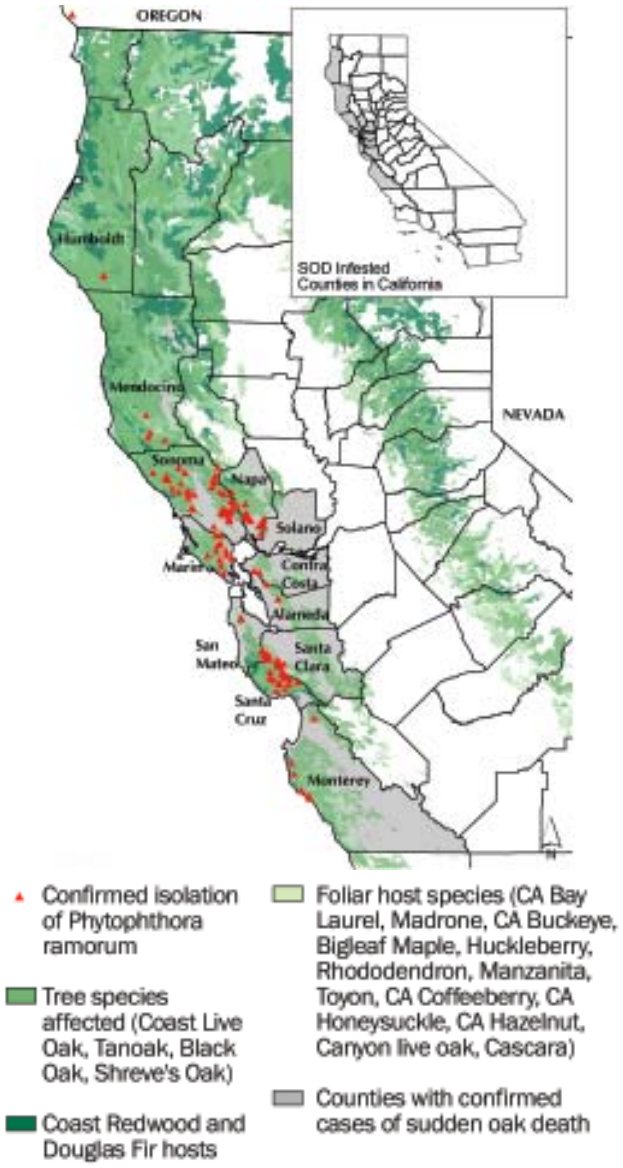
Figure 60. Percentage area of California Wildlife Habitat Relationship (CWHR) types on national forests and adjacent ownerships at high risk to mortality* through 2015



** greater than 25 percent tree mortality expected*
Source: Compiled by FRAP from USFS, State, and Private Forestry, Forest Health Project, 2002; FRAP, 1999, FRAP, 2002d

Sudden oak death is spreading through a variety of tree and shrub species in 12 coastal counties of California and is continuing to be found in new hosts (Figure 61). Eucalyptus borer and related exotic Australian defoliators cause significant damage to urban southern California eucalyptus trees. White pine blister rust, a disease with a long history in California, continues to threaten sugar and other pine species by affecting regeneration and size class distributions. Pitch canker, which affects coastal pine species, is in decline although no remedy for eradication of the disease has been identified.

Figure 61. Distribution of sudden oak death*



** Updated February 2003*
Source: California Oak Mortality Task Force, 2002

Presence or Absence of Range Livestock Diseases

On-line Technical Report:
http://frap.cdf.ca.gov/_assessment/Chapter6_Socioeconomic/rangelivestock.html
Data Quality: Partial data

American agricultural policy has long recognized the threat to domestic farming and ranching from diseases introduced from other countries. Concerns over homeland security have heightened efforts to monitor the food supply chain. California's livestock industry has undergone a variety of changes making it more susceptible to the spread of diseases such as foot-and-mouth disease and anthrax. These changes include factors such as greater concentrations of cattle in feedlots and nearby areas, and use of dairy related by-products as cattle feed.

Losses to livestock owners occur from a number of sources including disease, predators, digestive problems, respiratory problems, calving or lambing problems, weather, poison, theft, and other factors. Two prominent concerns of the livestock industry are losses due to health and disease, and predators.

U. S. sheep producers are concerned with a number of health conditions including stomach/intestinal worms, scurvy, mastitis (inflammation of the udder), footrot, vitamin E/selenium deficiency, and pregnancy disease. Concerns over two diseases have dominated the U. S. and international arena—foot-and-mouth disease and mad cow disease. Outbreaks of either disease would shut down beef, dairy, sheep, and swine operations and prevent movement of animals to pasture or shipping animals to other states. California currently has no industry-threatening outbreaks and has expanded quarantine capacity to control any potential events.

Exotic and Invasive Species Impacts on Forest and Rangeland Resource Sustainability

One of the oldest and potentially most serious forms of environmental disruption is the introduction of a non-native (exotic) species. The magnitude of possible environmental change has not been recognized until recently. This is particularly true when considered against the more publicized effects of habitat alteration, toxics, and other environmental perturbations.

The introduction of exotic species is a serious threat to natural communities. Non-native invasive species alter ecosystem structures, compositions, and processes. Those non-native species that have successfully established themselves in California have had far reaching effects including direct competition and exclusion or hybridization with native species. Indirect effects from exotic plant species include altering hydrologic cycles, soil erosion rates and disturbance regimes, such as frequency and intensity of fire.

*Spotted knapweed (*Centaurea maculosa*). Photo courtesy of California Department of Food and Agriculture.*

Invasive plant species generally exhibit certain characteristics that make them effective competitors and that facilitate their establishment and dispersal. These characteristics include large numbers of easily dispersed seed, ability to reproduce by both seed and vegetative growth, and ability to persist under variable environmental conditions such as dry or wet soil conditions. Invading non-native species that are successful at establishing viable populations are generally symptomatic of landscapes and ecosystems that have been altered and have suffered a reduction in some of their original ecological function. Exotic species can not only negatively impact natural systems and processes but the production of natural resource commodities as well. The result of these species invasions and introductions is that geographically separate biological regions now share an increasing number of species in common.

Exotic and Invasive Species Indicators

- **Presence of High Impact Non-native Invasive Plants**
- **Proportion of Non-native Animal Species Relative to Total Species**
- **Presence of Weed Control Programs**

Exotic and Invasive Species

Representative Goal

Ensure that the potential effects of introductions (of exotic species) will not have unacceptable negative impacts on native species, agriculture interests, and public health and safety … by controlling the introduction and spread of exotic plant and animal species *(paraphrased from California Fish and Game Code, Section 2116 to 2160; California Fish and Game Commission policy on Endangered and Threatened Species).*

Findings

- Non-native invasive species alter ecosystem structure, composition, and processes and out-compete and exclude native plants and animals. Effects also include changing ecosystem function by altering hydrologic cycles, soil erosion rates, and disturbance regimes, such as frequency and intensity of fire.
- Forty-two non-native invasive plant species are of great concern to biological diversity because of their ability to aggressively spread and negatively affect native species and habitats.
- A high number of the most detrimental non-native invasive plant species are found in the Bay/Delta, South Coast, Central Coast, and Klamath/North Coast and Sacramento bioregions.
- Overall, approximately 14 percent of California's animal species (terrestrial and aquatic vertebrate) are established non-natives.
- The introduction of non-native fish species, in conjunction with severely altered hydrologic regimes, is considered one of the main reasons for the endangerment or extinction of what once were some of the most abundant native fish species in aboriginal California (habitat change and over-fishing being the other two). Introduced fish species comprise 53 of the 120 freshwater species found in California.
- Efficient and effective control programs and strategies are characterized by efforts that prevent invasions and quickly detect new occurrences so that the species may be removed or contained before spreading.

Presence of High Impact Non-native Invasive Plants

On-line Technical Report:
http://frap.cdf.ca.gov/_assessment/Chapter3_Quality/nonnative.html
Data Quality: Additional development (?)

A number of agencies and groups, including the California Exotic Pest Plant Council and the California Department of Food and Agriculture Noxious Weed Information Project maintain lists of noxious weeds to help identify infestations and necessary management actions. These sources provided input into determining a set of high impact non-native invasive plant species (NIPS). High impact NIPS species are capable of having significant impacts on biological diversity, productive capacity, soil and water, and social well being. These impacts include out-competing native species, slowing timber regeneration and forage production, altering riparian shading and streambank morphology, and altering fire regimes affecting public heath and safety.

FRAP evaluated NIPS associated with forests and rangelands for their potential impacts on biological diversity values. The evaluation considered potential rate of spread, disruption to native species of concern, influences on ecological processes such as fire, and monotypical spread. Over all forests and rangelands statewide, 76 NIPS were identified as likely having some affect on biological diversity, with 42 classified as High Impact NIPS. Examples of High Impact species to biological diversity values include cheat grass (*Bromus tectorum*), yellow star thistle (*Centaurea solstotoalis*), Scotch broom (*Cytisus scoparius*), and medusa-head (*Taeniatherum caput-medusae*).

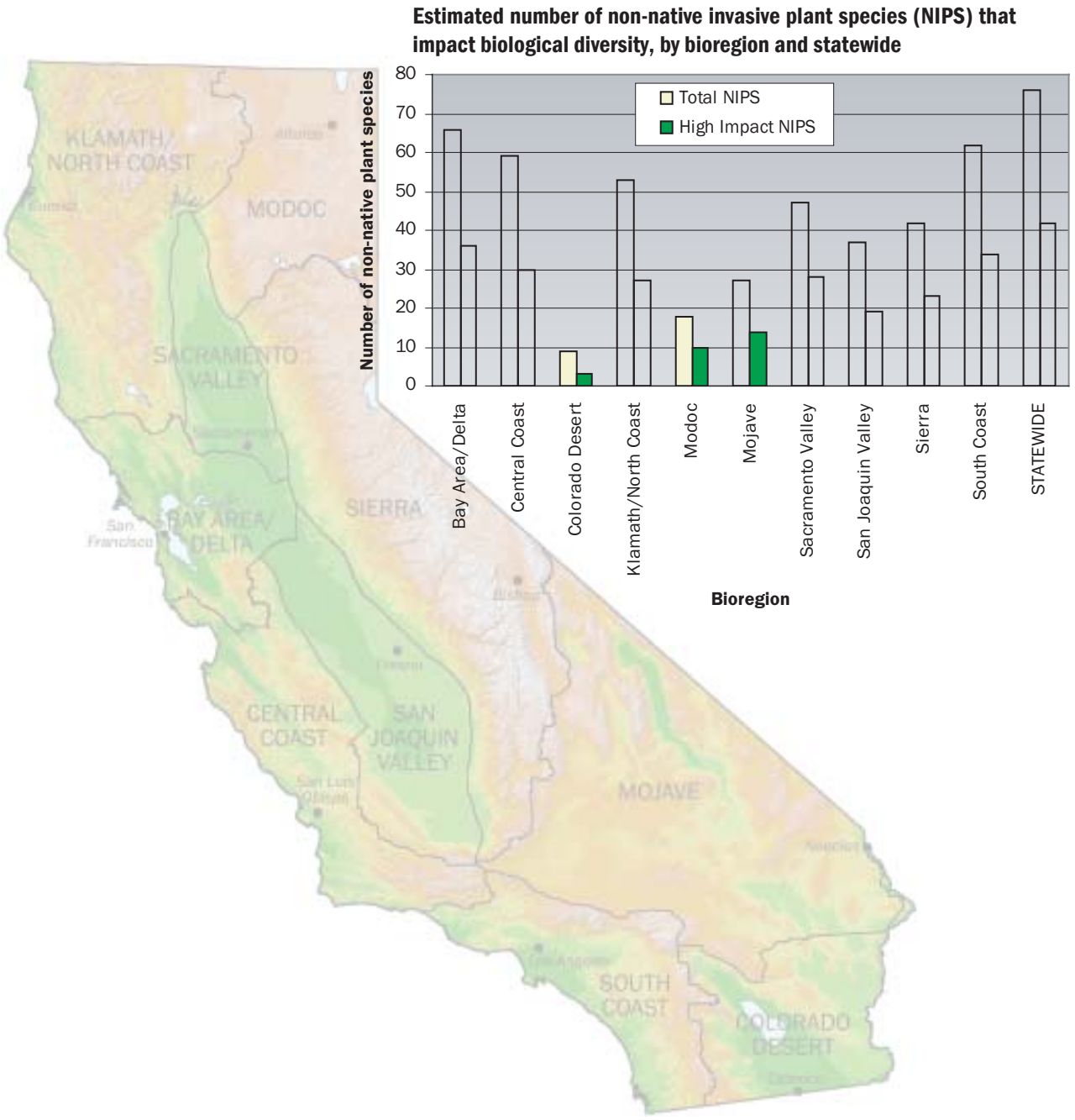
An evaluation of the ocurrence and frequency of non-native invasive plants suggests they are prevalent throughout California, with the highest numbers of species occurring in the coastal bioregions. The South Coast and Bay Area/Delta bioregions (which already have high development pressures) also face a continued and severe threat to remaining biological diversity values from non-native plants (Figure 62).

Medusa-head (Taeniatherum caput-medusae). *Photo courtesy of Craig Thornsen, California Department of Food and Agriculture, Botany Laboratory.*

Yellow starthistle (Centaurea solstitialis). *Photo courtesy of Jo-Ann Ordano, California Academy of Sciences.*

Figure 62. Regional Exotic and Invasive Species Indicator

Non-native invasive plant species (NIPS) alter ecosystem structure, composition, and processes and out-compete and exclude native plants. High Impact species are defined as those having potential for widespread damages to specific resources, high rates of spread, and difficulty of containment.



Source: Compiled by FRAP from Bossard et al., 2000; FRAP, 2003f
Map: California Biodiversity Council bioregions

Proportion of Non-native Animal Species Relative to Total Species

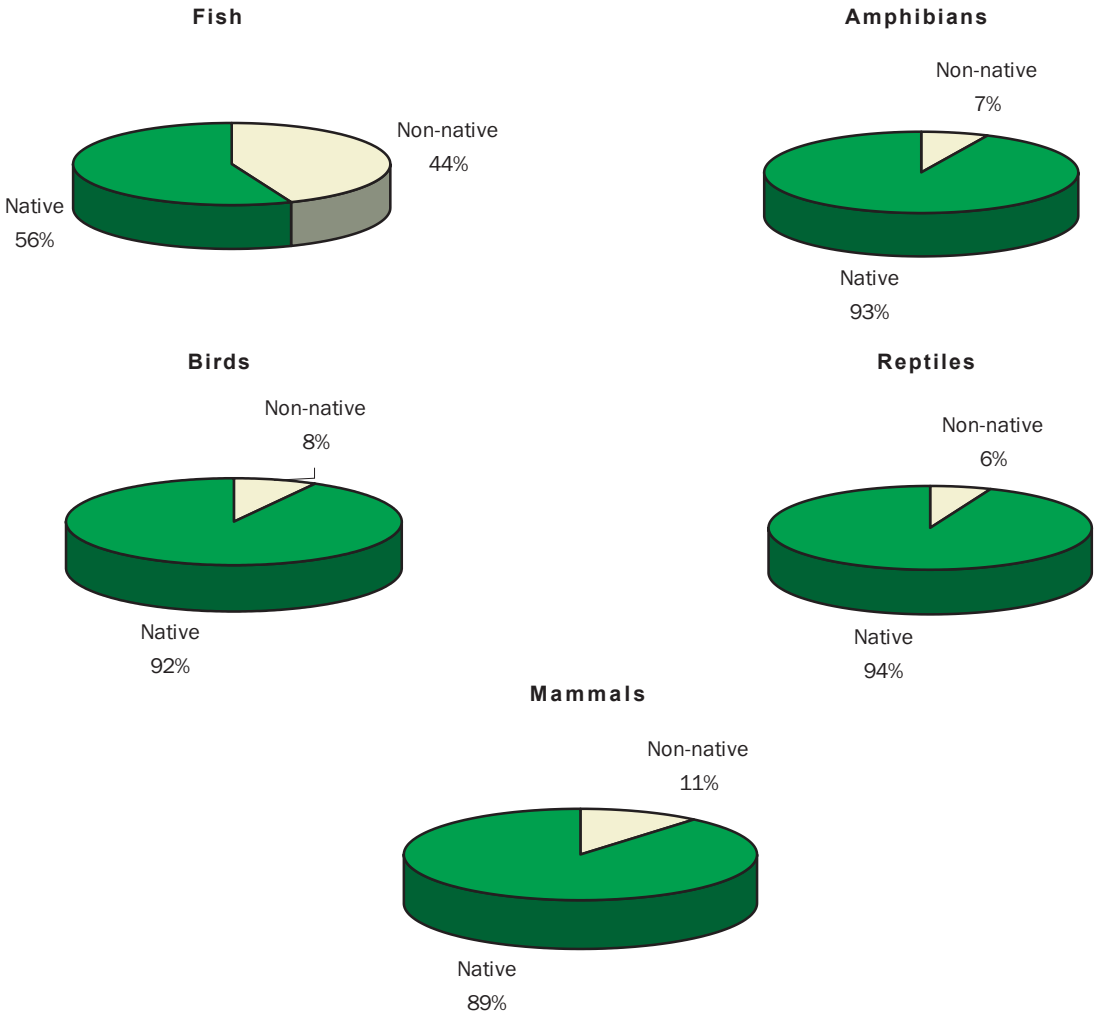
On-line Technical Report:
http://frap.cdf.ca.gov/_assessment/Chapter3_Quality/nonnative.html

Data Quality: Partial data

Non-native animal species are also increasingly recognized as one of the principal threats to the maintenance of biological diversity (Figure 63). Overall, approximately 14 percent of California's animal species (terrestrial and aquatic vertebrates) are established non-natives.

Introduction of non-native fish species is considered one of the three main reasons (habitat change and overfishing being the other two) for the endangerment or extinction of what once were some of the most abundant native fish species in aboriginal California. Introduced fish species make up 53 of the 120 freshwater species found in California (Moyle and Davis, 2000). These species, now the most abundant fish in many of California's waterways, were introduced primarily to improve sport and commercial fishing, as an agent of pest control, for agriculture, or by accident.

Figure 63. Proportion of established non-native animal species by taxa



Source: Grenfell et al., 2000; Moyle and Davis, 2000; Moyle, 2001; California Bird Records Committee, 2000

Presence of Weed Control Programs

On-line Technical Report:
http://frap.cdf.ca.gov/_assessment/Chapter3_Quality/nonnative.html

Data Quality: Partial data

Efficient and effective weed control programs and strategies are characterized by efforts that prevent invasions and quickly detect new occurrences so the species may be removed or contained before spreading. The California Department of Food and Agriculture's (CDFA) Noxious Weed Prevention and Control Program works under the assumption that it is more cost effective to keep pests out of California than to address potentially widespread and ongoing infestations. The strategy for pest prevention is similar for all kinds of pests. There are four major parts: 1) keep a foreign pest from getting into California in the first place (exclusion); 2) if a pest does get in, find it while the population is still small (detection); 3) when such a population is found, remove it so California is once again free of the pest (eradication); and 4) inform the public of the importance of keeping California free of new pests. The CDFA also has pest control functions that help to reduce the impact of a pest if it escapes the pest prevention program and can no longer be removed from California.

Northern pike illustration courtesy of Robert Hines, U. S. Fish and Wildlife Service.

The CDFA prioritizes species and program efforts based on criteria of potential for spread and effectiveness of available control mechanisms. The highest priority is given to species whose populations have not spread extensively and/or can be readily controlled. Some species such as yellow starthistle, with the possible exception of developing biological control techniques, are beyond conventional means of large-scale control or eradication. Native species will be better protected if new non-native species that pose a threat are recognized quickly and action taken to prevent or slow their spread.

At the national level, Federal Executive Order 13112, issued in February 1999, requires coordination and strengthening of federal activities to control and minimize the economic, ecological, and human health impacts caused by invasive species. This Executive Order is based on efforts of existing federal, state, and non-governmental organizations related to invasive species. The Order established the National Invasive Species Council which has developed a National Invasive Species Management Plan. Published in 2001, the plan delineates 57 specific action items that federal agencies should address to improve coordination, prevention, control, and management of invasive species. It also provides support for the work done by U. S. Department of Agriculture's Animal and Plant Health Inspection Service (APHIS) to prevent and control potentially damaging exotic pests and diseases. APHIS has a variety of duties that include protecting the welfare of animals, safeguarding human health and safety, minimizing damage to wildlife, and managing ecosystems vulnerable to invasive pests and pathogens. In the case of exotics, APHIS protects agriculture, forest, rangeland, and wetland ecosystems.

Air Pollution Impacts on Forest and Rangeland Resource Sustainability

A number of air pollutants can be readily transported to forests and rangelands throughout many air basins. Recent trends suggest high levels of air pollutants are likely to continue in several air basins in the southern and eastern portions of California. Here, urban activity, transportation, and agriculture generate waste that is transported via westerly wind flows. In foothill and mountain areas this may raise air quality issues related to visibility and human health as well as land management options.

Air pollutants of focus in this assessment are ozone and particulate matter (PM). Ozone has begun to disrupt the natural growth process and diminish other natural values of forest and rangelands. While these effects are generally not severe, damage to forest vegetation has been detected. Particulate matter is of concern because it impairs visibility, can lodge in the lungs causing health problems, and deposits compounds containing toxins that affect natural resources. Sources of PM include prescribed burns, wildfires, agricultural burning, road dust and wood stove burning. PM originates from air basins both within and outside of forests and rangelands.

Forest and rangeland ecosystem health and vitality can be highly affected by air pollution. The primary impacts have been related to decline in tree growth, increased susceptibility to pests due to lost vigor, and increased nutrient inputs, such as nitrogen from NO_x, beyond the capability of the ecosystem to process them.

Air Pollution Indicators

- **Trends of Air Pollution Levels Expressed in Non-attainment Days**

Photo courtesy of Bureau of Land Management.

Air Pollution

Representative Goal

Promote and protect public health, welfare and ecological resources through the effective and efficient reduction of air pollutants while recognizing and considering the effects on the economy of the state *(paraphrased from Mission of the California Air Resources Board).*

Findings

- Air pollutants are readily generated and transported to forests and rangelands throughout many air basins. Recent trends suggest high levels of air pollutants are likely to continue in several air basins in the southern and eastern portions of California where urban activity, transportation, and agricultural pollution sources generate wastes that are transported via westerly wind flows.
- Most air basins show decreasing numbers of non-attainment days for ozone and particulate matter. Air basins of most concern are those with high numbers of non-attainment days and those that most recently show increasing levels of air pollution (San Joaquin, Sacramento, and southern portions of the Mountain Counties).
- Ozone, combined with other stressors such as drought, makes timber resources more vulnerable to disease, fire, and pests. The southern Sierra Nevada mountain forests are the most infected and most susceptible areas to damage.

Trends of Air Pollution Levels Expressed in Non-attainment Days

On-line Technical Report:
http://frap.cdf.ca.gov/assessment2003/Chapter3_Quality/air.html

Data Quality: All required data

Trends in air pollution have shown improvements due to new laws and regulations as well as improved technologies. These results show decreasing numbers of non-attainment days (days in which state air pollution maximums are exceeded) in several air basins for ozone and particulate matter greater than ten microns in size (PM10) (Figure 64).

Ozone levels remain a concern to forest and rangeland resources within the Sierra Nevada mountains and east of the San Joaquin Valley and South Coast air basins. Wide variations in air quality are found throughout these air basins. Most air basins in northeast and northwest California have few to zero days in which state air quality standards are exceeded. The San Joaquin Valley, South Coast, Salton Sea, and San Diego air basins experience highest amounts of non-attainment days.

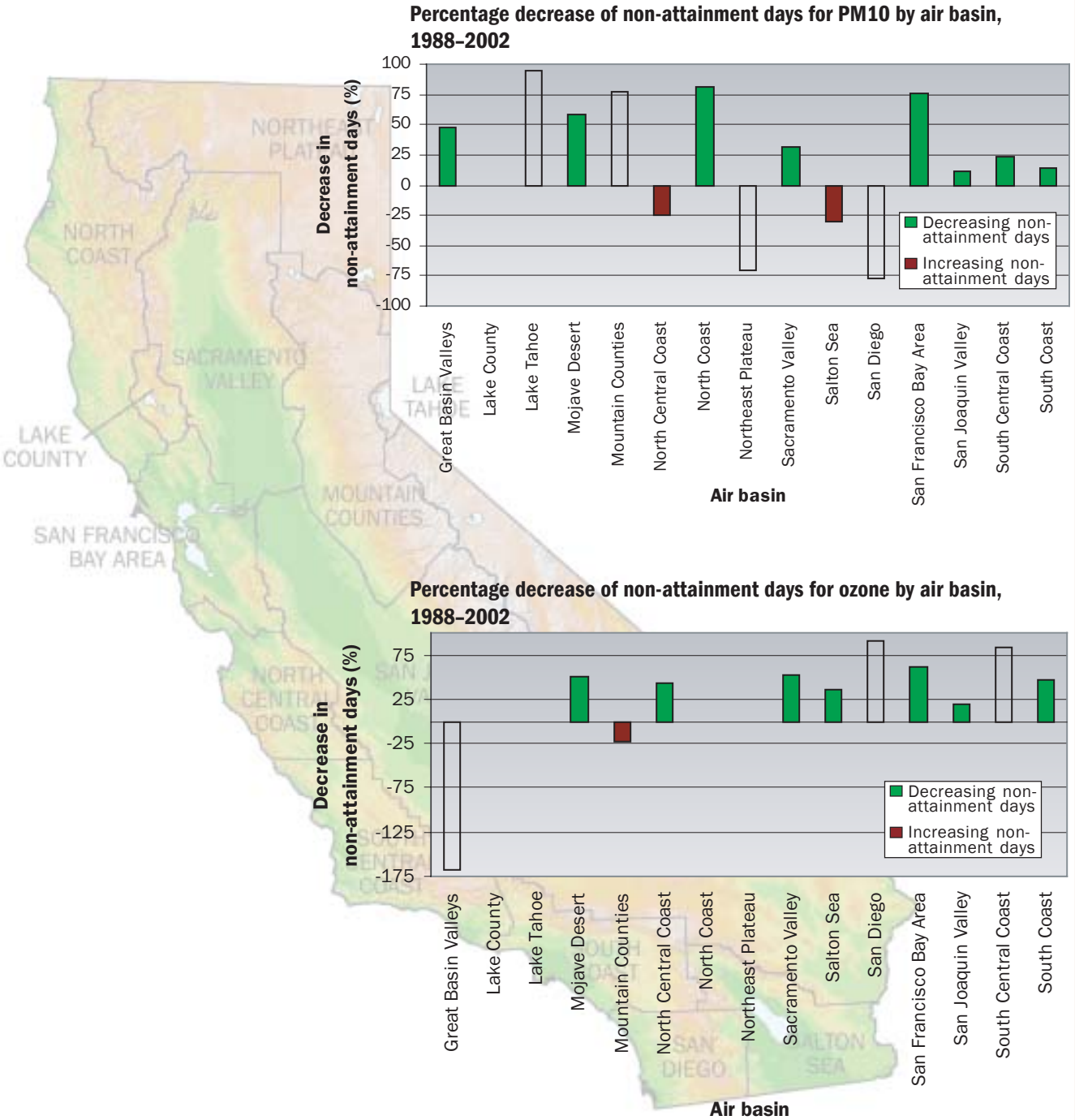
The primary source of ozone that drifts east into the Sierra Nevada mountains has been linked to the agricultural activity in the Sacramento and San Joaquin valleys via westerly air flows. In these valleys, agricultural industries introduce sources of hydrocarbons and ozone gases such as nitrous oxide (NO_x). Vehicle emissions have generally been less of a concern as ozone emission standards have effectively reduced ozone levels. However, in the Sacramento Valley air basin, on-road motor vehicles are the primary source of emissions. As a result, ozone levels have slowly increased over the last several years east of the Sacramento Valley in the Mountain Counties air basin (Alexis et al., 2001) (Figure 65).

Plant species have varying degrees of sensitivity to ozone exposure. Ponderosa and Jeffrey pines are the most sensitive species and are among the most valuable timber resources in California. Ozone, combined with other stressors such as drought, makes timber resources more vulnerable to disease, fire, and pests. The southern Sierra Nevada forests are the most susceptible and affected areas. In 1997, roughly 35 percent of trees monitored in the Sierra National Forest had symptoms of ozone injury. Within the Sequoia National Forest, located further south, 45 percent of trees monitored had ozone injury symptoms. Damage also occurs to the north; for example in the Lake Tahoe area, trees in a sample area show 21 to 29 percent with ozone damage symptoms (Campbell et al., 2000).

Photo courtesy of Riverside Fire Laboratory, U. S. Forest Service.

Figure 64. Regional Air Pollution Indicators

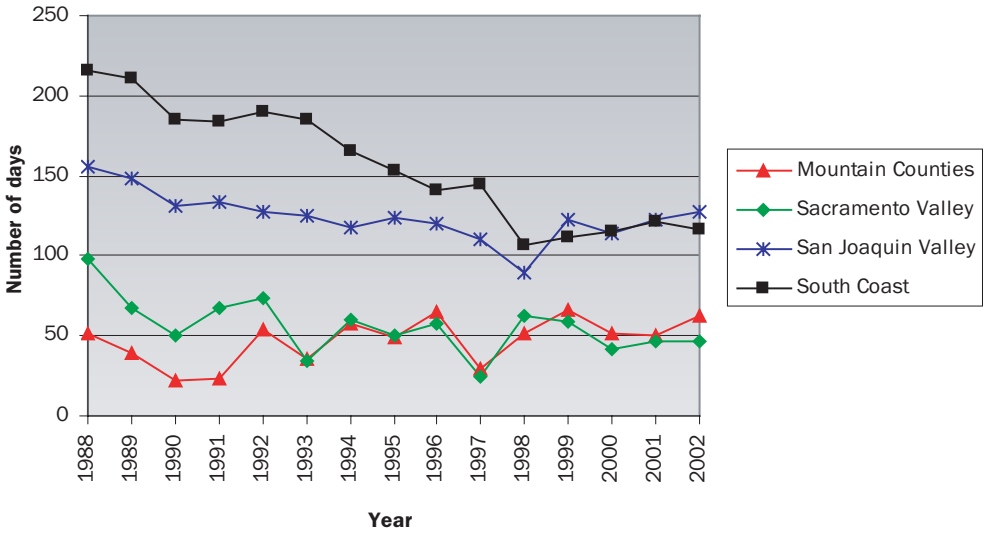
Air pollution trends show many forest and rangeland related air basins with substantial numbers of non-attainment days for ozone and particulate matter (PM10). Of particular concern are those air basins with increasing non-attainment days.



Source: Compiled by FRAP from Alexis et al., 2001
Map: California Air Resources Board air basins

Smoke generated by fire is a common form of particulate matter. Increasing concentrations can cause adverse health effects and decreased visibility. Sources of smoke include wildfires, prescribed fires, prescribed natural fires (fires caused by a lightning source and allowed to burn), biomass waste burning, and urban enclave burning such as wood stoves and fireplaces. The effects of smoke on air quality are highly evident in the Sierra Nevada mountains. Large wildfires occur there frequently, prescribed burning is increasing, transport of smoke from the burning of agricultural waste in the San Joaquin and Sacramento valleys occurs in late summer, and urban wood stoves operate in the late fall and winter. Figure 66 shows the number of days per year PM10 levels exceeded the state standard from 1988 through 2002. PM10 emission levels in the South Coast, San Joaquin Valley, and Sacramento Valley remain high and have been increasing since the late 1990s.

Figure 65. Number of days state ozone standard exceeded for selected air basins, 1988–2002

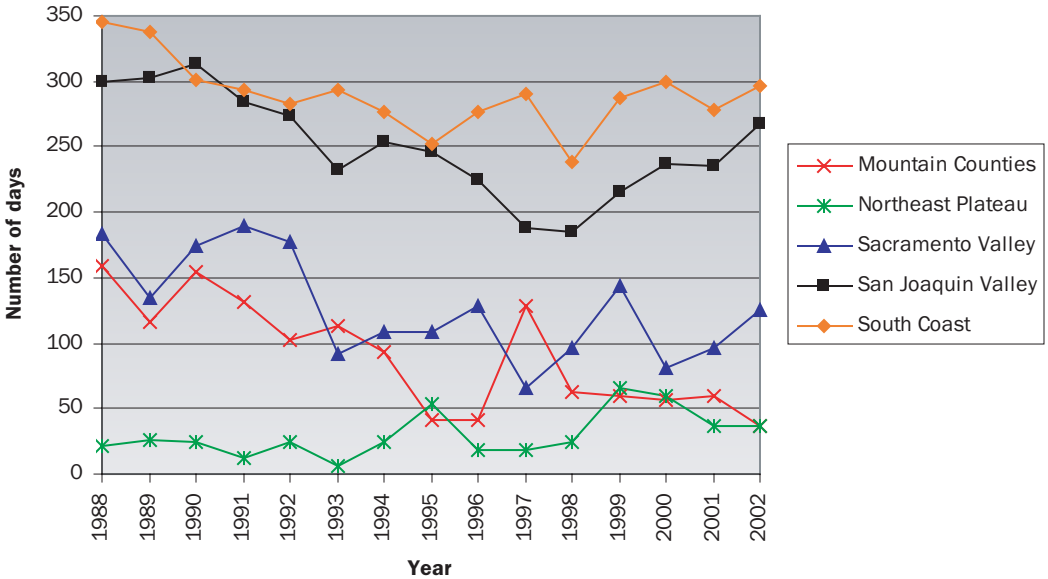


Source: Alexis et al., 2001

Health concerns and regulatory constraints related to particulate matter from smoke will likely affect the use of prescribed fire as a tool for hazardous fuel reduction. This constraint may lead to the need for other fuel management methods, such as mechanized harvesting, to reduce the risk of wildfire.

Los Angeles skyline visible south from Angeles Crest Highway, Angeles National Forest : G. Donald Bain, Geo-Images Project, UC Berkeley

Figure 66. Number of days PM10 exceeded state standard for selected air basins, 1988–2002



Source: Alexis et al., 2001

Soil Conservation and Water Quality Status and Trends

Soil and water, as basic elements of productivity, are key to natural resource sustainability and social well being. Soil condition affects tree growth and forage production and plays an important role in ecological processes such as nutrient storage and water or carbon cycling. In addition, forest and rangeland soil conditions play an important role in maintaining high quality water for drinking, agriculture, industry, and in-stream environmental uses.

Over the last decade, there has been increased recognition of the influence of forest and rangeland soil and water conditions on ecological processes operating at the watershed level. Federal and state agencies in California have spent millions of dollars for watershed assessment and project review while forest and range landowners have devoted time and money at the project and watershed level. These efforts have provided useful information to agencies and landowners, yet they have shown the difficulty of assessing the status and trends of soil and water conditions. Part of this difficulty lies in coping with the inherent variation in physical and biological processes, the complexity of linkages between human actions and impacts on natural processes, and the overriding impact of natural events such as wildfire, severe storms, and weather patterns.

Key to an evaluation of soil and water status and trends is an assessment of watershed conditions. Watersheds are the geographic area drained by a particular stream or network of streams. The quality and quantity of water depends upon a complex variety of linkages between land use, natural events, vegetation condition, climate, and geological formation. In some places where comprehensive watershed analysis has been done, there is abundant information but lack of consensus on how to evaluate it. In general, however, there is a lack of information with which to systematically examine watershed conditions across California.

With quantitative information on water and soil quality generally lacking, basic information is provided regarding the linkage between conditions and land use along with findings on regulatory status of water quality. The specific indicators are shown below.

Soil Conservation and Water Quality Indicators

- Land Use in Watersheds
- Regulatory Status of Water Quality Impairments
- Trends in Salmon Populations
- Monitoring Results of Private Timber Management Practices
- Monitoring, Watershed Assessment, and Cumulative Watershed Effects

Soil Conservation and Water Quality

Representative Goal

Ensure that protection of beneficial uses of streams and soil erosion associated with timber operations is adequately controlled to protect soil resources, forest productivity, and water quality *(paraphrased from Z'Berg-Nejedly Forest Practice Act, Article 5, 4562.5,4562.7).*

Controllable water quality factors … shall not cause further degradation of water quality *(paraphrased from State Anti-degradation Policy, Basin Plan, Chapter 3, Water Quality Objectives).*

Findings

- Watershed quality is directly related to the mix of land uses and management goals that are found in the watershed. Watersheds with forests and rangelands typically provide the highest water quality in California.
- Regulatory profiles of water quality in California as of 2002 indicate that 14 percent of California rivers and streams have some impairment of beneficial uses.
- Land management on forests and rangelands (timber and grazing activities) are listed as at least one of the many causes of water quality impairment, particularly in the North Coast and Lahontan Regional Water Quality Control Board regions.
- Trends in salmon populations are largely a function of habitat quality including water quality and quantity and general environmental conditions. The combination of habitat conditions and other environmental influences has resulted in a long-term, downward trend in populations of specific salmon stocks.
- Monitoring of hill slope erosion conditions found that individual timber harvesting practices required by the California Forest Practice Rules are very effective in preventing soil erosion.
- While there is broad agreement on the linkages between management practices, and cumulative watershed effects, a consensus is lacking on how to measure, monitor or evaluate effects. Continuing efforts to improve the information and understanding of watershed process will be necessary to facilitate improvements in watershed conditions and protection of soil and water resource values. Limited recent studies in the central Sierra Nevada continue to indicate that native surface roads are the primary human-caused source of sediment.

Land Use in Watersheds

On-line Technical Report:
http://frap.cdf.ca.gov/assessment2003/Chapter4_Soil_and_Water/watershedquality.html
Data Quality: Partial data

Fundamental to understanding watershed condition is knowing how land use within a watershed affects the water quality. While other natural environmental conditions such as wildfire and climatic changes can affect water quality, the mix of land uses in any one watershed largely determines the levels of protection from human disturbances (Figure 67). Using the concept of the Management Landscape (land use, ownership, and housing density), forests and rangelands can be grouped into classes that broadly describe how land is used and managed, thus producing a basis for understanding the interactions of land use and watershed conditions.

Each type of Management Landscape class is indicative of a different land use mix and potential impact on watershed conditions. The general classes of interest to watersheds are Reserve, Working, Rural Residential, Agriculture, and Urban.

Reserve lands, such as national parks and wilderness areas, are permanently managed consistent with statutory designations, which often have strict limits on mangement activities. Typically, these lands' ecological structures and processes remain intact and function within their natural range of variation. Generally, Reserve lands contribute positively towards water quality and aquatic habitat.

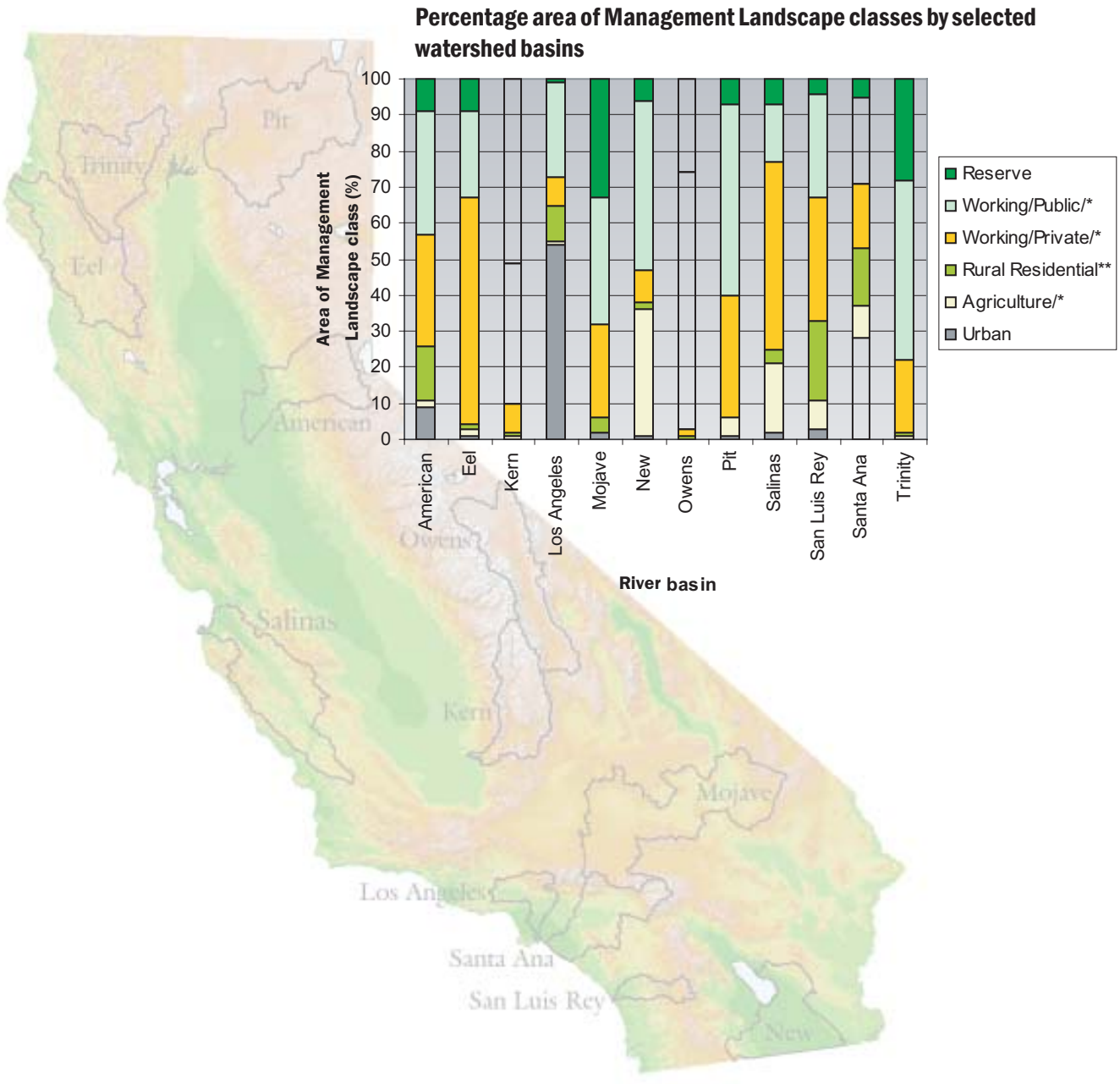
Working landscapes, both Public/Sparsely Populated and Private/Sparsely Populated, have a wide range of historical and current watershed conditions. Lands may have conditions caused by past practices, such as sediment from roads or damaged hillsides, that continue to cause problems. Other lands may have minimal disturbance with little or no impacts on water or soil quality. However, managed forests often provide beneficial protection to water quality by mitigating conditions that contribute to episodic wildfire and other natural catastrophes that degrade water quality.

Some more intensively managed private lands have a greater potential for water quality impacts, but also have heightened efforts to protect water quality. These efforts on both public and private working landscapes have been guided by standards implemented under state and federal clean water laws.

Frog Lake, Mokelumne Wilderness, Sierra Nevada Mountains

Figure 67. Regional Soil Conservation and Water Quality Indicator

Different watersheds have different mixes of land uses and management goals. The different management emphases influence watershed conditions, potential nonpoint source pollutants, and in-stream water quality, as well as levels of financing for protection and restoration investments.



* Sparsely Populated
** includes Working/Public/Rural Residential, Working/Private/Rural Residential, and Agriculture/Rural Residential
Source: California Interagency Watershed Mapping Committee, 1999; FRAP, 2002b
Map: Selected CALWATER (v2.2) watershed basins

Rural Residential lands can be either Working/Public or Working/Private landscapes but they have a low density of housing structures (density of one or more units per 20 acres and less than one unit per acre). These lands, however, still retain wildland characteristics and have resource values, although management is more oriented towards open space, viewsheds, places of rural lifestyle, or recreation, than commodity production or ecological integrity. Rural Residential lands introduce complex urban impacts to a watershed including permanent road systems that alter overland flow of stormwater runoff, fertilizer, herbicide, and pesticide residues, wastes from human activities, fragmentation/parcelization of continguous habitats, and the introduction of non-native plant and animal species.

Agricultural lands refer to areas where natural vegetation has been replaced by irrigated crops and orchards. Housing densities may be either Sparsely Populated (less than one housing unit per 20 acers) or Rural Residential. Urban lands are those lands having housing densities of one or more units per one acre or intensive commercial or industrial uses. Water quality impacts from these land uses are beyond the scope of this assessment. However, common degradations associated with these land uses include exposure of soil to erosion, introduction of contaminants into waterways, modification of water courses, and removal of natural vegetation resulting in increased rates and volume of stormwater runoff. These can have substantial impacts on watershed conditions, particularity in comparison to lands with limited human disturbance.

Regulatory Status of Water Quality Impairments

On-line Technical Report: http://frap.cdf.ca.gov/assessment2003/Chapter4_Soil_and_Water/watershedquality.html

Data Quality: Partial data

The State Water Resources Control Board (SWRCB) and its nine Regional Water Quality Control Boards (RWQCB) establish water quality standards and compliance for California's waterways. Every two years, the RWQCBs identify waterbodies tdeemed to not be attaining their beneficial uses and places them on the list of imparied waters. This EPA approved list identifies the portion of the waterbody impaired as well as the types and suspected sources of pollutants for each waterbody. Currently, the RWQCBs are required to develop a Total Maximum Daily Load (TMDL) for each listed waterbody. The TMDL is the amount of pollutant over time that can enter the waterbody without limiting its beneficial uses. The RWQCBs then develops and adopts implementation plans for achieving the necessary reductions in pollutant loading specified by the TMDL. A review of the 2002 list of impaired waterbodies re-

Riparian forest, Putah Creek. Photo courtesy of Marc Hoshovsky, California Department of Fish and Game.

veals that California has over 26,000 miles of impaired streams, about 14 percent of the total miles of streams and rivers in California. Although not all water bodies have been monitored to assess water quality status, the list of impaired waters represents those waterbodies where the RWQCBs have scheduled committments to addressing water quality problems on a watershed basis.

Impairment information for RWQCB watersheds provides a description of the cause of pollution that results in impairment. Most watercourses have many different potential causes. Silviculture, rangeland grazing, and agriculture were sometimes listed as at least one of the causes of pollution impairment (Table 34). The high proportion of impairments identified as unknown indicates the lack of certainty in identifying nonpoint source pollution sources.

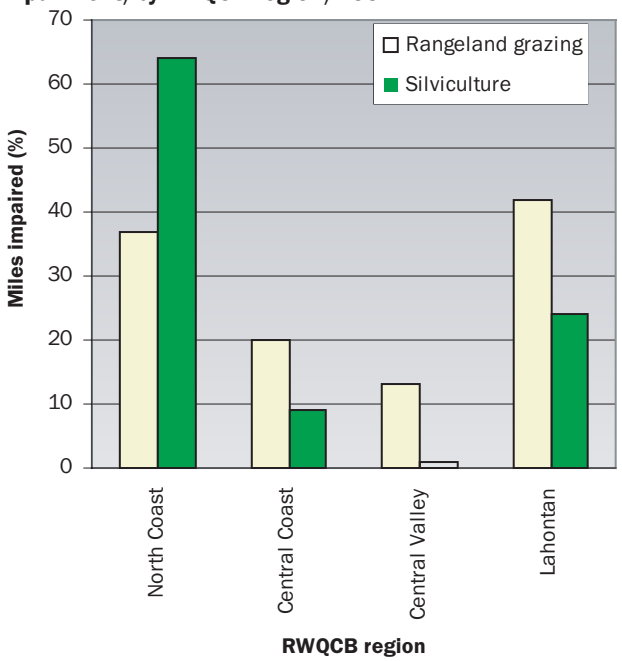
Figure 68 shows a regional review of the percentage of impaired water bodies where silvicultural or rangeland grazing activities are one of the many causes of pollution. Over 60 percent of the impaired water bodies in the North Coast list silviculture as one of the causes of pollution. Rangeland grazing activities are one listed cause of impairment on approximately 42 percent of the impaired waterbodies in the Lahontan Regional Water Quality Control Board region (Sierra Nevada mountain range).

Table 34. Sources of nonpoint pollution in California's impaired lakes, wetlands, and rivers, 2002

General pollution source	Lakes and reservoirs	Freshwater wetlands	Rivers and streams
	Surface Area		Miles
Agriculture (non-rangeland)	25,616	73,598	10,638
Rangeland grazing	113,569		8,278
Construction	88,285	62,590	6,702
Silviculture	106,068		13,374
Habitat modification	93,932		19,723
Hydromodification	89,467		15,598
Industrial/municipal point sources			2,938
Land disposal	23,600		1,596
Marinas	108,682		
Unknown sources	192,533	62,590	19,042
Other	155,925	65,636	9,562
Resource extraction	101,202		6,675
Urban runoff	112,970		1,939

** Most water body have more than one pollution source. Therefore miles impaired by each pollution source does not add up to total miles impaired.*
Source: Compiled by FRAP from California State Water Resources Control Board, 2000

Figure 68. Percentage of impaired river and stream miles with silviculture or rangeland activities as a cause of impairment, by RWQCB region, 2002



Source: Compiled by FRAP from California State Water Resources Control Board, 2000

Trends in Salmon Populations

On-line Technical Report:
http://frap.cdf.ca.gov/_assessment/Chapter4_Soil_and_Water/watershedquality.html

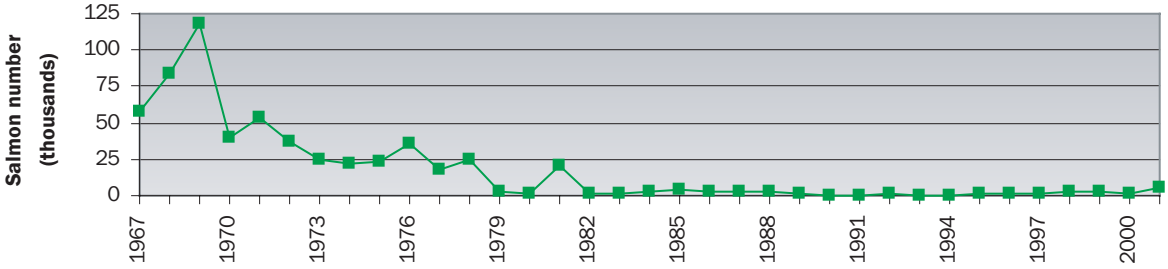
Data Quality: Partial data

The ability of a watershed to produce juvenile salmon is largely a function of the quality and quantity of stream habitat conditions, including water quality and quantity. Important elements of water quality include water temperature within a suitable range that corresponds with migration, egg development, growth of young, and the production of invertebrates as food sources. The extent to which water quality and availability issues influence estimated annual escapement of adults and numbers of juveniles (smolts) produced is not readily separated from other environmental conditions. However, water quality and quantity are clearly some of the most fundamental measures of habitat suitability and ultimately salmonid production.

The RWQCB designates several water bodies with salmon populations as impaired based on water quality concerns that arise from unacceptable levels of sediment load, elevated water temperature, pollutant occurrence and other factors. Eight water bodies within the range of the Southern Oregon/Northern California Coast population of coho salmon have been designated as impaired by the SWRCB and Environmental Protection Agency under section 303(d) of the federal Clean Water Act. The primary basis for listing the Mattole, Eel, Van Duzen, Mad, Shasta, Scott, Klamath, and Trinity River basins as impaired is excessive sediment load and elevated water temperatures.

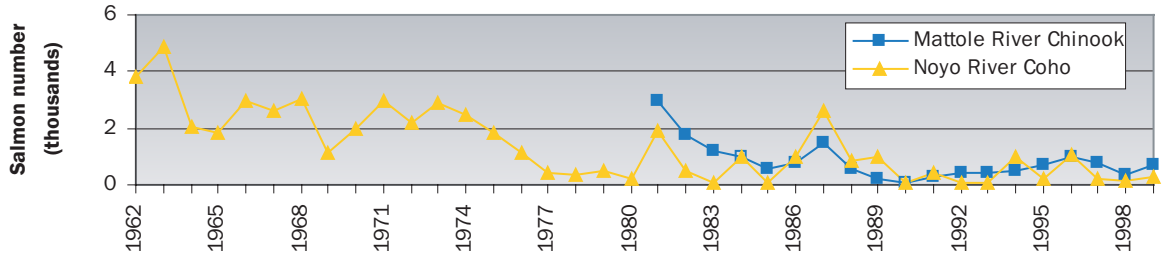
Annual estimates of salmon population levels exhibit marked variation due to a large number of interacting environmental conditions. These include specific stream habitat availability to accommodate freshwater life history requirements, water quality and availability, rainfall pattern as an influence on stream flow and out migration rate of juveniles, oceanic conditions during early residence, wildfire, level of commercial and recreational harvest, and historic and current land use activities (e.g., agriculture, timber management, and urbanization). These environmental and other conditions have resulted in long-term downward trends in populations for specific salmon stocks (Figure 69, Figure 70) and for some, formal listing under the California and/or federal Endangered Species Act.

Figure 69. Annual adult winter chinook salmon returns, Sacramento River, Red Bluff Diversion Dam, 1967–2001



Source: California Department of Fish and Game, Native Anadromous Fish and Watershed Branch, 2002.

Figure 70. Annual adult salmon returns, Noyo River coho and Mattole River chinook, 1962–1999



Source: Southwest Fisheries Science Center, 2001; Downie et al., 2002.

Monitoring Results of Private Timber Management Practices

On-line Technical Report:
http://frap.cdf.ca.gov/assessment2003/Chapter4_Soil_and_Water/watershedquality.html

Data Quality: Partial data

On non-federal lands, Forest Practice Rules (FPR) govern timber operations. These rules are adopted by the Board of Forestry and Fire Protection (BOF) and implemented by CDF. During the 1990s, the BOF through its Monitoring Study Group (MSG), developed a program to monitor the implementation and effectiveness of the FPR in protecting water quality. The early efforts of the program have been directed at monitoring impacts on the hillslope as opposed to in-stream. Hillslope impacts are usually easier to identify and quantify than those instream, thus providing more immediate feedback about the impact of timber operations on sediment. Connections between hillslope activities and instream channel conditions are much harder to define.

The BOF adopted a strategic plan to guide this program in 2000. The plan calls for four key parts: 1) continuation of the Hillslope Monitoring Program; 2) use of CDF Forest Practice Inspectors to assemble hillslope monitoring data on a random sample of completed Timber Harvest Plans (THPs); 3) development of scientifically credible monitoring plans for cooperative watershed monitoring projects in selected basins to provide in-stream data; and 4) design and/or fund monitoring projects that can answer focused questions about FPRs implementation and effectiveness.

The most extensive information comes from the Hillslope Monitoring Program. Results to date indicate that implementation rates of the FPRs related to water quality are high. They also show that individual practices required by the Rules prevent hillslope erosion when properly implemented. Implementation ratings were greater than 90 percent for the landings, roads, skid trails, and watercourse protection zones sampled (Table 35). Watercourse crossings had the lowest implementation ratings at 86 percent.

CDF's Forest Practice Rules enforcement statistics suggest similar findings. Typically, water quality violations of the Forest Practice Rules are identified and corrected, where possible, as part of CDF's Forest Practice Inspection process. Information from CDF's Forest Practice Program database indicates that 975 violations were issued on the 4,749 Timber Harvesting Plans open from 1998 through 2000. These violations fell into three basic groups: harvesting practices and erosion control (347); watercourse and lake protection (308); and logging roads and landings (320). The highest numbers of violations involved waterbreaks, drainage, and operations near streams.

Since 1992 the U.S. Forest Service has also conducted a hillslope monitoring program on federal lands focused on implementation and effectiveness of its management practices. Preliminary results show that USFS silvicultural Best Management Practices (BMPs) are generally implemented and effective. Statewide, average implementation and effectiveness rates from 1992–2001 were both approximately 87 percent. Yearly rates and those for specific practices have varied. Streamside management zones and elements of road construction were areas of concern.

In addition to evaluation of hillslope conditions, work is on-going for monitoring in-stream conditions. Pilot work on cooperative in-stream monitoring has been done on the Garcia River where an in-stream monitoring plan, watershed assessment, and documentation of baseline conditions have been completed. In 2002/2003, smaller scale cooperative in-stream monitoring projects have been planned in Mendocino County with Campbell Timberland Management/Hawthorne Timber Company and in the Sierra Nevada/Cascade province (northern California) with Sierra Pacific Industries.

Table 35. Forest Practice Rule implementation ratings for 300 Timber Harvest Plans and Non-industrial Timber Harvest Plans, 1996–2001

Hillslope Monitoring Program sample area	Percentage of acceptable* implementation
Road transects	93
Skid trail transects	95
Landings	94
Watercourse crossings	86
Watercourse protection zones	98
All areas	95

** meets or exceeds requirements*
Source: Ice et al., 2002; Cafferetta and Munn, 2002

Monitoring, Watershed Assessment, and Cumulative Watershed Effects

On-line Technical Report: http://frap.cdf.ca.gov/assessment2003/Chapter4_Soil_and_Water/watershedquality.html

Data Quality: Additional development ?

The current Hillslope Monitoring Program traces timber harvest disturbances downhill to the receiving watercourses, but does not determine downstream channel and habitat impacts. Hence, the MSG results do not allow conclusions to be drawn about whether the existing rules provide properly functioning habitat for aquatic species. This requires analysis of linkages between channel conditions and hillslope disturbances. Such analysis is complex because channels receive and reflect the results of all watershed processes, including current and past, natural and forest practice-related impacts alike. Channels vary greatly in their dynamics between the North Coast and the Sierra, and even within each of these areas. Channels also change naturally over time and poor condition may just be part of this dynamic process.

Different factors may be relevant to measuring the health of the channel. For example, on the North Coast key parameters may include channel morphology, large woody debris (LWD) and potential LWD recruitment, canopy and shading, stream temperature, spawning gravel composition and permeability, spawning levels, sediment transport corridors, and turbidity.

The National Marine Fisheries Service and others have identified various channel form-related indices that identify healthy stream habitat for salmonid fisheries. However, desired target conditions or indices are not always known. One example is the acceptable length and frequency of fish exposures to high water temperature and turbidity.

Cumulative watershed effects are another case where the desired condition is uncertain. Although there is broad agreement that management activities can produce cumulative watershed effects (CWE), a consensus is lacking on how to measure, evaluate, or monitor effects and conduct watershed assessments. Central to any evaluation of CWE is a broadly agreed upon conceptual model of how land use can alter the risk of damaging natural resources within a watershed (Dunne et al., 2001).

A great deal of research has been conducted in order to better understand forest management impacts and CWE. However, detailed quantitative data is often limited to a few watersheds with few examples of accurate methods to extrapolate site-specific relationships across watersheds and larger regions.

One recent example is a study of hillslope erosion on private and public lands in the central Sierra Nevada during 1999 and 2000. Based on 150 measurement points the initial results indicate that native surface roads (i.e., unpaved, dirt or gravel roads) are the primary human-caused source of sediment. The study also recorded high rates of sediment production from high severity wildfires and areas used for off-highway vehicles (MacDonald and Coe, 2001).

Much work has been conducted in the western states to improve assessments of watersheds and provide information for cumulative watershed effects analysis in both rural and urban landscapes. Watershed assessment on forests and rangelands typically focuses on establishing the linkages among past and present land management activities, geomorphic and hydrologic processes,

One of 147 sediment fences installed to measure sediment production rates in the central Sierra Nevada Mountains. Photo courtesy of Drew Coe (Cafferetta and Munn, 2002).

aquatic and terrestrial habitat, and salmonid population responses (Ligon et al., 1999). Examples of formal watershed assessment approaches include the State of Washington Watershed Analysis, the Oregon Watershed Assessment Manual, and the Federal Interagency Watershed Assessment methodology used on public lands in western states.

Within California the Resources Agency began the creation of an infrastructure for a coordinated state watershed program in forested watersheds in 1998. In 2000 the Resources Agency, in coordination with the California Environmental Protection Agency, initiated the North Coast Watershed Assessment Program (NCWAP) in part as a response to specific requests from landowners and watershed groups that California take a leadership role in conducting scientifically credible, interdisciplinary assessments that could be used for multiple purposes. To date, NCWAP has completed assessments for the Mattole and Gualala Rivers. Assessments for Redwood Creek, Big River, and Albion River are nearing completion.

The information from the NCWAP assessment was used to identify the underlying causes of stream habitat deficiencies and establish linkages to watershed processes and land use activities. Results of assessments conducted by various agency personnel were brought together in an integrated synthesis process. This process attempts to describe spatial and temporal relationships between watershed and stream conditions with respect to their suitability to support salmonids. The findings identified deficiencies in stream habitat, but also documented on-going recovery in channel conditions.

Clearcut harvesting near perennial streams.

Specific watershed assessments by local-level groups multi-county level include Fishery Network of Central California Coastal Counties (FishNet4C) and the Five Counties Salmon Conservation Program. The CALFED Bay-Delta Program has created a broader regional context for local watershed assessment for the watersheds of the Sacramento and San Joaquin Rivers, as well as Southern California and coastal watersheds that receive water supply from these river systems.

Landowners and private companies are also involved in watershed assessments. For example, the Fish, Forests, Farms Community, a landowner and industry-based group working with Humboldt State University developed standardized protocols for assessment and monitoring. They have worked closely with the Department of Fish and Game and will help to identify the best ways to implement and monitor factors critical for fish protection. A number of private companies also have conducted detailed watershed assessments over some or all of their lands.

The Watershed Project Inventory at the U. C. Davis Information Center for the Environment (ICE) has identified and surveyed over 700 groups in California that indicated involvement in watershed projects. It is difficult to establish by name those watershed groups that are collaborative and inclusive of stakeholders and those that are special interest and exclusive of those who can be involved. ICE estimates that there are between 100 and 140 local watershed partnerships in California representing varying levels of activity (Sommarstrom, 2002).

Building on the growth of interest and understanding of watersheds will be valuable to improving and protecting resource conditions in the future. While watershed assessments, including CWE, should not be expected to eliminate risk to natural resources from forest management activities, they have the potential to both quantify and reduce that risk, thus improving the decision making process (Dunne et al., 2001).

Forests and Climate Change Impacts on Forest and Rangeland Resource Sustainability

Scientists have generally agreed that the earth's climate is changing, in part due to human activities that alter the chemical composition of the atmosphere through the buildup of greenhouse gases. These gases—primarily carbon dioxide (CO_2), methane, and nitrous oxide (NO_X)—trap heat. Uncertainty exists about exactly how earth's climate responds to these gases and how much global temperatures will rise.

Forests play an important role in the earth's carbon cycle. On one hand, the loss of forests on a global scale to other uses (deforestation) is responsible for up to one-third of carbon emissions to the atmosphere and ranks second only to the burning of fossil fuels as a source of CO_2 emissions. On the other hand, forests serve as a large carbon sink. They capture CO_2 from the atmosphere through photosynthesis and store it as carbon in wood and other carbon-based compounds in soil, understory plants, and in litter on the forest floor. Large amounts of additional carbon are stored in U. S. forests, including those in California (Birdsey et al., 2000).

While older forests store the greatest total amount of carbon, by maintaining vigorous growth in all forests, additional carbon can be removed from the atmosphere and stored in standing trees. Conversely, loss of forest lands, due to changing land use, and the soil and biomass that stores carbon can adversely affect and even contribute to greenhouse gas emissions.

Maintaining vigorous health of forests and conserving forest areas are vital to protecting resources from air borne pollutant impacts and provides opportunities for contribution towards pollution reduction through carbon sequestration. Objectives such as maintaining vigorous growth, increasing the volume of standing trees, retaining lands in a forested condition, and reducing wildfire all contribute towards carbon sequestration. Policies that promote conservation of forest lands and vigorous stands can significantly contribute to air pollution reduction. These same policies may also provide financial opportunities to landowners who are willing to manage their lands in ways that positively influence carbon storage.

Forests and Climate Change Indicators

- **Impacts of Climate Change on Forest and Rangeland Resources**
- **Effects of Forests on Carbon Levels**
- **Trends in Greenhouse Gas Emission Reduction**
- **Programs to Reduce Emissions of Greenhouse Gases**

Forests and Climate Change

Representative Goal

Acquire and develop data and information on global climate change for use in reducing or mitigating the production of greenhouse gases including net reductions through the management of natural forest reservoirs *(paraphrased from Cal. Public Resources Code Section 25730, Climate Change Inventory and Information).*

Findings

- Environmental and climate change impacts on forest ecosystems are likely to include the following: alteration in the growth and geographic range of different forest types; increases in the frequency of fire and insect outbreaks; and changes in the carbon storage function of forests (e.g., from sinks to sources).
- Multiple stresses (ozone, nitrogen deposition, land use change) and changes in human interactions with forests (e.g., settlement, recreational use) work in concert with climate change.
- California's forests and rangelands can provide a role in affecting global impacts from greenhouse gas emissions (primarily CO_2). Forests provide a large "sink" to sequester (capture) atmospheric CO_2 emitted from point and nonpoint pollution sources.
- Maintaining healthy forests will be vital to protecting resources from air borne waste impacts and provides opportunities to contribute to pollution reduction through carbon sequestration.
- Greenhouse gas (GHG) emission levels have risen by 3.5 percent in California between 1990 and 1999, compared to a U.S. rate of 11.5 percent. Carbon dioxide is the most common of these gases.
- California has a variety of programs in place to deal with climate change that involve forest and range resources. Examples include such programs as the California Energy Commission's Public Interest Energy Research Program; the State's Renewables Portfolio Standard; the Global Climate Action Registry, and a Joint Agency Climate Team to provide for agency coordination and program development. Taken together, these and other programs show an aggressive response by California policy makers to global climate change concerns.
- Additional State coordinated efforts are likely in such areas as GHG reduction; carbon sequestration and trading; research and development in renewable technologies; development of biofuels; increasing afforestation; land use policies that limit development on productive forestlands; and enhancing the State's capacity to project future climatic changes, assess impacts and evaluate solutions.

Impacts of Climate Change on Forest and Rangeland Resources

On-line Technical Report:
http://frap.cdf.ca.gov/assessment2003/Chapter5_Forests_and_Climate/climate.html
Data Quality: Additional Development ?

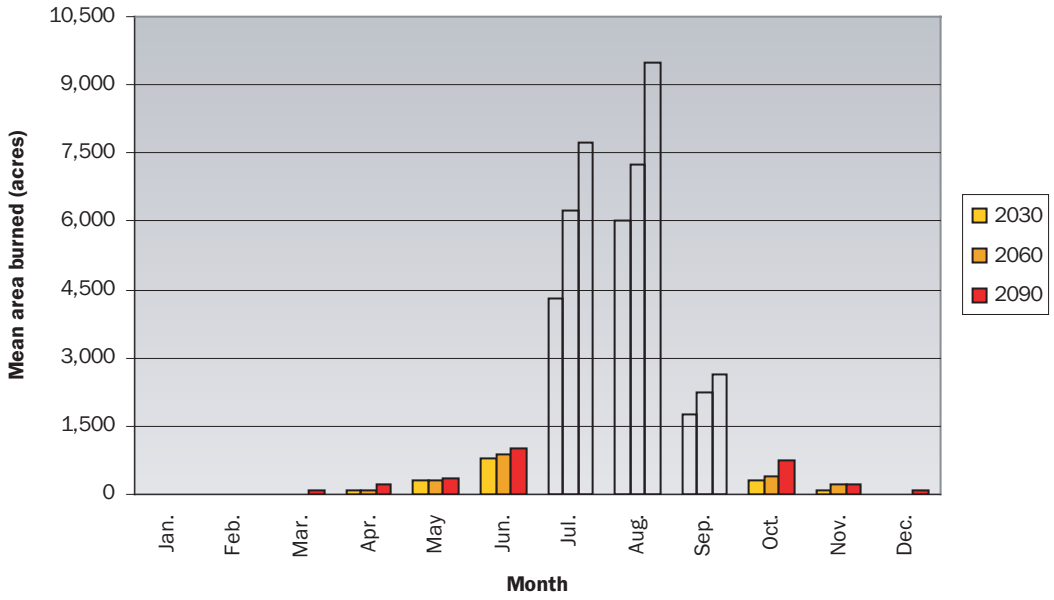
For California and other western states, scientists have been investigating the impact of environmental changes on forest ecosystems through field observation, controlled experiments, historical records, and computer-based modeling. They have identified the following areas of possible change:

- alteration in the growth and geographic range of different forest types;
- increases in the frequency of fire and insect outbreaks;
- changes in the carbon storage function of forests (e.g., from sinks to sources); and
- interactions of multiple stresses (ozone, nitrogen deposition, land use impacts, etc.) that work in concert with climate change.

Evaluations of these potential impacts of climate change are based on modeled scenarios and therefore contain significant uncertainties in quantification and relationship of variables. However, the basic premise is that climate change can alter both the function of forests and other natural processes.

One specific impact of climate change relative to forests and rangelands is the effect on wildfire. Fire behavior models predict a sharp increase in both ignitions and fire spread under warmer temperatures combined with lower humidity and drier fuels (Figure 71). The most severe effects will occur where modelled forecasts of vegetation change project an expansion of mixed conifer and a corresponding reduction in the red fir forest that occupies the next higher elevation zone. Mixed conifer types typically support more ignition prone fuels systems that also support faster spreading fires; the net result being an expected increase in both fire frequecny and size.

Figure 71. Projected mean area burned in the Sierra Nevada bioregion, 2030, 2060 and 2090



Source: Wilkinson, 2002

Effects of Forests on Carbon Levels

On-line Technical Report:
http://frap.cdf.ca.gov/assessment2003/Chapter5_Forests_and_Climate/climate.html
Data Quality: Partial

Over the last decade, California's forests have been a net sink of carbon. On an average annual basis from 1987–1997, over 5.2 million tons of carbon were added to the carbon stock on forest land (Table 36). The largest increases in carbon stocks were in live biomass and wood products. The amount of carbon on the forest floor and in the soils decreased slightly, although this is likely the result of reclassification of forest types and lack of consistent age class information rather than a true loss of carbon.

Table 36. Annual change in carbon stocks on forest lands by accounting component, 1987–1997 (million metric tons of carbon)

Accounting component	Average annual change		
	1987-1992	1992-1997	1987-1997
Biomass	5.04	5.09	5.06
Forest floor and coarse woody debris	-1.42	-1.58	-1.5
Soils	-0.85	-0.83	-0.84
Wood products and landfills	3	2.03	2.51
Total	5.77	4.71	5.24

Source: California Energy Commission, 2002b

Trends in Greenhouse Gas Emission Reduction

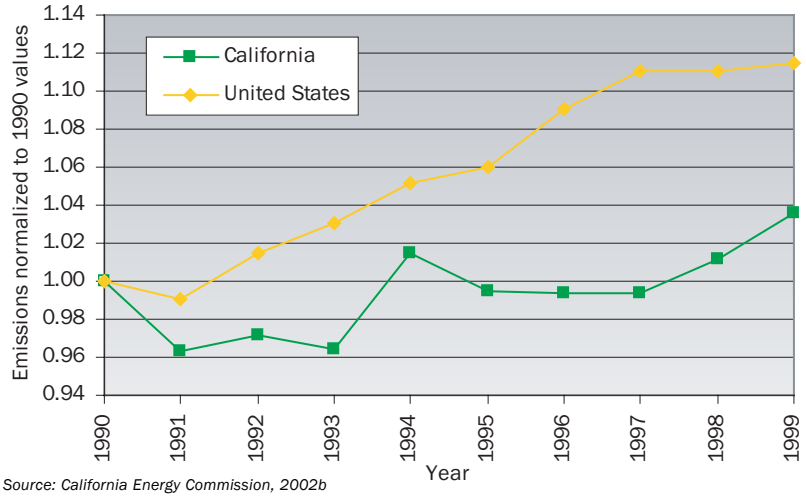
On-line Technical Report:
http://frap.cdf.ca.gov/assessment2003/Chapter5_Forests_and_Climate/climate.html
Data Quality: Partial

California has seen a modest increase in greenhouse gas emissions over the last decade. Carbon dioxide (CO_2), is the most common emission representing 84 percent of all GHG emissions in 1999. This increase is the consequence of several divergent forces within California; some lead to increases in greenhouse gas emissions, while others negate those increases.

Forces that increase CO_2 levels include a growing population, high emissions from the transportation sector as a result of the State's position as the national leader in vehicle miles traveled, and low water years reducing levels of hydroelectric power as an alternative source to fossil fuel burning. Forces that decrease CO_2 levels include a relatively temperate climate, resulting in marginally less heating and cooling energy use than other states, and aggressive efficiency and environmental programs whose purpose is to reduce carbon dioxide emission rates (California Energy Commission, 2002b).

Figure 72 depicts overall trends in gross emissions in California and the United States as a whole. Gross emissions include emissions from all the in-state and United States sources normalized to 1990 levels to allow a comparison between emissions in California and the United States (i.e., gross emissions in each year are presented as a ratio of gross emissions in 1990).

Figure 72. Relative Gross Greenhouse Gas Emissions, California and United States, 1990–1999



Source: California Energy Commission, 2002b

Programs to Reduce Emissions of Greenhouse Gases

On-line Technical Report:
http://frap.cdf.ca.gov/assessment2003/Chapter5_Forests_and_Climate/climate.html
Data Quality: Partial

Aside from physical indicators of global climate change, another way of measuring how society is addressing an issue is the presence or absence of programs that focus on the issue. Ideally, such programs might follow a sequence, such as identification of possible impacts and risks of climate change; review of the ability of existing State programs to respond to extreme climatic events; development of approaches to reduce contributions to sources of climate change such as GHG; monitoring program results; and refinement of programs based on the results. While they might start simply, an evolving variety of programs would be expected since global climate change can have numerous interconnected impacts.

California has a variety of programs in place to deal with climate change that involve forest and range resources. Examples include the following programs:

- California Air Resource Board's air quality and GHG tailpipe reduction standards;
- California Energy Commission's (CEC) Greenhouse Gas Emissions Inventory;
- CEC Public Interest Energy Research Program;
- Californina Public Utilities Commission and CEC Renewables Portfolio Standard;
- Global Climate Action Registry; and
- Joint Agency Climate Team to provide for agency coordination and program development.

The California Air Resources Board (CARB) is mandated to set air quality standards. Standards are already in place dealing with ozone, fine particulate matter, and use of prescribed fire in forest management. In June 2002, legislation was signed into law granting authority to the California Air Resources Board to establish automobile tailpipe standards for GHGs.

The California Energy Commission is the lead State department under the California Resources Agency for evaluating and responding to global climate change issues since 1988. They have prepared several reports that detail the inventory of greenhouse gases emitted in California and policy strategies to deal with those emissions.

CEC also administers the Public Interest Energy Research (PIER) program. Established in 1997, it is an electricity-related research program that supports public interest energy research and development. Required to provide at least $62.5 million per year through 2012 to conduct research, it is funded by a surcharge on electricity to electric customers of investor-owned utilities in California. PIER funding efforts are focused on several areas, including renewable energy. Forest and rangelands are the location of abundant and widely dispersed supplies of renewable energy resources, making renewable energy technologies excellent candidates for distributed energy generation. Examples are biomass, geothermal, and wind resources.

Another program is the Renewables Portfolio Standard (RPS) administered by the Californina Public Utilities Commission and the California Energy Commission. Under this program, retail sellers of electricity are required to increase their procurement of eligible renewable energy resources by at least 1 percent per year so that 20 percent of their retail sales are procured from eligible renewable energy resources by 2017. This will reduce reliance on burning of fossil fuels for generation of electricity, thus addressing a source of GHGs.

The Global Climate Action Registry was established in 2001. It is a non-profit voluntary registry for GHG emissions working in consultation with the State Air Resources Board. The purpose of the Registry is to help companies and organizations with operations in the state to establish GHG emissions baselines against which any future GHG emission reduction requirements may be applied. The Registry also can help participants obtain advice on how to use forest reservoirs as a mechanism to attain emissions reduction goals and the reporting of emissions results. In cooperation with the Resources Agency, the Registry is developing procedures and protocols for the monitoring, estimating, calculating, report-

ing, and certifying of carbon stores and carbon dioxide emissions resulting from the conservation and conservation-based management of forest reservoirs in California. Registry participants can include the results of those conservation activities as a participant's registered emissions results.

Commencing in 2001, a Joint Agency Climate Team (JACT) was formed to coordinate and integrate program activities related to climate change. Consisting of the California Resources Agency, Cal/EPA, State and Consumer Services Agency, Trade, Technology and Commerce Agency, the Department of Food and Agriculture, Department of Transportation, and the Governor's Office of Planning and Research, a number of proposed initiatives have been developed by JACT, including those that involve both the wildfire protection and forest management aspects.

Taken together, these and other programs show an aggressive response by California policy makers to global climate change concerns. Additional efforts are likely in such areas as GHG reduction, carbon sequestration and trading, research and development in renewable technologies, development of biofuels, increasing afforestation, land use policies that limit development on productive forestlands, and enhancing the State's capacity to project future climatic changes, assess impacts and evaluate solutions.

6 Socio-Economic Well Being

Socio-Economic Well Being Status and Trends

Socio-economic well being considers both the economic status and quality of life for people, along with the industrial structures that produce forest and rangeland products. The commodity and non-commodity resources produced by forests and rangelands affect socio-economic well being, particularly for residents in rural areas. California's forests and rangelands provide a wide variety of resources that benefit society and ultimately improve well being of all residents. Economically, the most significant goods and services are wood, forage, recreation, and high quality water supply. Other goods and services such as cultural resources, open space, and diverse wildlife habitats are also important but more difficult to quantify.

In addition to addressing the production of goods and services, the broader quality of life, or well being, of individuals, households, and communities associated with California's forests and rangelands must be considered. The well being of the people and communities within forest and rangelands is integral to any comprehensive assessment of these areas. As California's population and economy grow, the character of rural and urban areas will continue to change.

FRAP uses the concept of well being to capture the themes that are consistently discussed in local coffee shops, real estate offices, assessments of communities, and governmental initiatives to deliver services. Some of the recurring themes are income earning opportunities, the absence of poverty, educational quality, public safety, involvement in local civic and interest groups, and various aspects of a clean and enjoyable environment. The relative importance of such characteristics varies among individuals and communities but they all attract considerable attention.

Socio-Economic Well Being Indicators

- Income and Well Being Indices
- Regional Job and Wage Growth Trends
- Commodity and Non-Commodity Production and Use Trends
- Water Quantity and Use
- Status of Forest Products Industry
- Status of Range Livestock Industry
- Status of Forest and Rangeland Energy-Related Industry
- Status of Recreation Industries
- Timber and Rangeland Contributions to Funding Rural Infrastructure Needs

Photo courtesy of the National Park Service.

Socio-Economic Well Being

Representative Goal

Create and maintain conditions under which man and nature can exist in productive harmony to fulfill the social and economic requirements of present and future generations *(paraphrased from California Public Resources Code 21001 (E), Division 13. Environmental Quality, Chapter 1. Policy).*

Findings

- Economic status is lower for many forest and rangeland counties compared to statewide averages, but social well being measures are typically above statewide averages.
- Demands for timber products, livestock products, water, and aesthetic values such as open space and recreation continue to rise. Due to continuing increases in consumption and stable to declining outputs of forest products, California is becoming increasingly dependent on wood products imports, primarily from Oregon, other western states, and the southern United States.
- Water supply and use continue to be an ecological and economic theme in California. The intersection of ecological values of water and increasing needs for urban uses will remain a foremost challenge facing California in the future.
- Over the last decade, timber harvesting and sawmill production have declined. Overall production value for timber and paper products and range livestock products have been stable over the last decade.
- Several factors affect the range livestock industry: changes in consumption patterns in beef and sheep products, reliance on imports, and higher costs constraining profits; increasing emphasis to provide and protect a broad array of environmental services; and land development pressures that raise the value of rangeland over its worth for livestock operations.
- Biomass material as a source of statewide power generation has remained steady over the last decade (three percent of total power generation). Substantial unutilized biomass material is found statewide. Sustainability of nearly one-third of the statewide biomass power plants is in question due to lack of long term contracts.
- Outdoor recreational use of forests and rangelands are steady to increasing. Recreation use near metropolitan areas is a very substantial portion of total use particularly when considering its land base. In terms of visits, the metropolitan wildland parks provide approximately 50 percent of all visits but comprise only 13 percent of total public land available for outdoor recreation.

Income and Well Being Indices

On-line Technical Report:
http://frap.cdf.ca.gov/assessment2003/Chapter6_Socioeconomic/socio.html
Data Quality: All required data

Many studies have shown that income is a significant, but not the only, influence on overall well being at the household, community or regional scale. Numerous other cultural, historical, and local institutional factors play strong roles in determining overall well being. To evaluate the socio-economic well being of people in bioregions and counties dominated by forests and rangelands, FRAP used thirteen indicators from four non-income related themes of well being to construct a quantitative well being index (Table 37). The four themes are equity, education, safe and involved communities, and environmental quality. Examples of the non-income well being indicators are absence of poverty, educational quality, public safety, involvement in local civic and interest groups, and various aspects of a clean and enjoyable environment. While the relative importance of each individual indicator varies among individuals and communities, the composite index provides a balanced representation of the breadth of commonly-valued attributes.

Bioregions dominated by forest and rangeland counties (as determined by natural vegetation, population, and economic structure) include Klamath/North Coast, Modoc, Sierra, Sacramento Valley, and Central Coast. These bioregions are similar in that nearly all of them are below the California average in terms of per capita income but considerably above the average in terms of most other components of well being (Figure 73).

Strong positive influences from factors such as local family, community, and business support could be reasons for high composite well being index scores relative to income levels for counties above the California average. The primary challenge for most of the forest and rangeland bioregions appears to be diversifying and expanding their economies while maintaining the relatively high scores in other aspects of well being.

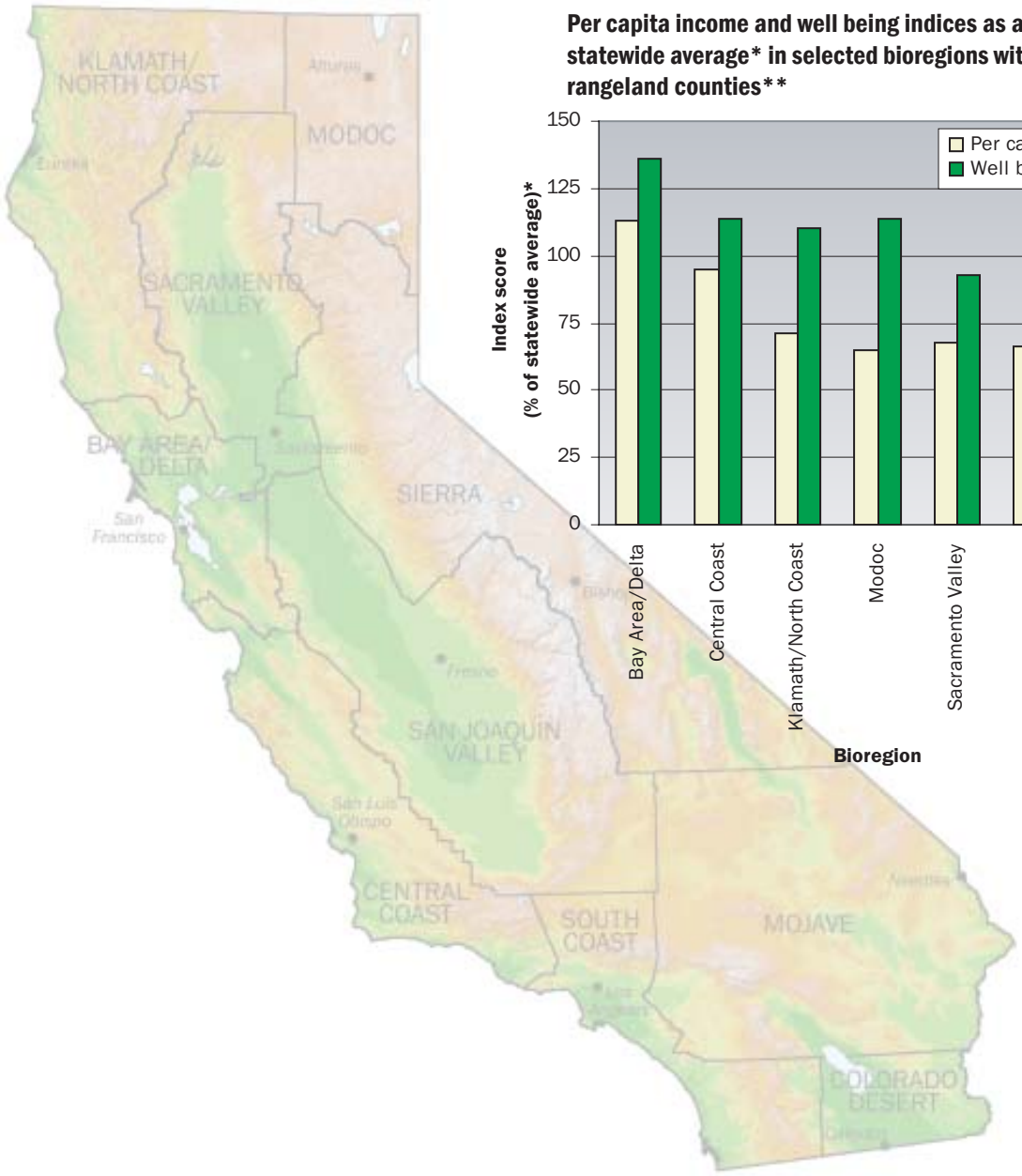
Table 37. Socio-economic themes and indicators used to create the composite well being index

Five themes	Indicators in the FRAP composite well being index	Other indicators not in the FRAP composite well being index discussed in companion technical report
Theme 1: Income	Per capita income	
Theme 2: Equity	Poverty rate Food stamp need Home ownership rate	Poverty rate (0–17 age only) Number of bankruptcies Number of new single family homes Number of new multi–family units
Theme 3: Investment in education	Per pupil spending Classroom computers per 100 students Percentage of students with SAT score over 1000	Classrooms with Internet access CD ROMs per 100 students Classrooms with wide area networks
Theme 4: Safe and involved communities	Physicians per 1000 population Voter participation Burglary rate	Violent crime rate Number of active watershed groups Number of active Fire Safe Councils
Theme 5: Environmental Quality of life	Short commute (less than 30 minutes) Natural amenity index Number of high particulate days	Unincorporated population density Air pollution – ozone

Source: FRAP, 2002e

Figure 73. Regional Socio-Economic Well Being Indicator

Socio-economic well being includes the economic status and several other measures of quality of life in rural forest and rangeland counties. Most bioregions with forest and rangeland counties have income levels below the California average but rank high on quality of life.

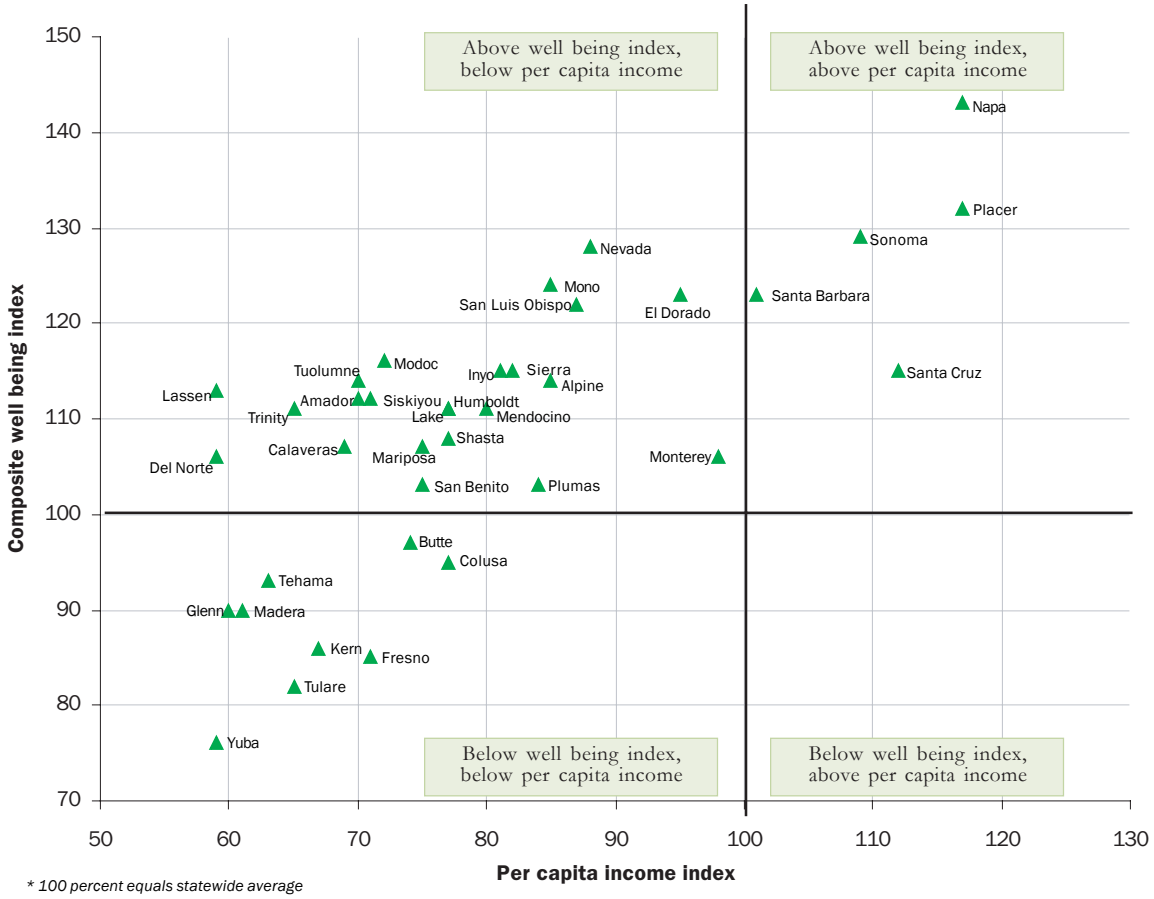


Per capita income and well being indices as a percentage of statewide average* in selected bioregions with forest and rangeland counties**

** 100 percent equals statewide average*
*** counties with more than 50 percent of area in forest and rangeland land covers, populations less than 250,000 people or no cities greater than 50,000 people, and economic output generated from timber production or grazing activites*
Source: FRAP, 2002e
Map: County-based bioregions

Figure 74 shows how individual forest and rangeland counties compare to the statewide average in terms of income and well being. The majority of these forest and rangeland counties rank relatively high for well being, but lag in income levels. Several counties—Napa, Sonoma, Placer, Santa Barbara, and Santa Cruz—rank high in both income and well being. Broad economic bases, nearby urban centers, and natural settings all contribute to their high rankings.

Figure 74. Per capita income and well being indices as a percentage of statewide average* in forest and rangeland counties



** 100 percent equals statewide average*
Source: FRAP, 2002e

Regional Job and Wage Trends

On-line Technical Report: http://frap.cdf.ca.gov/assessment2003/Chapter6_Socioeconomic/economicconditions.html

Data Quality: All required data

During the 1990s regional job and wage trends varied considerably. The overall regional measures capture the net result of the increases and declines of various employment sectors. Table 38 summarizes job growth, unemployment rates and wage growth for the regional economies as defined by California Economic Strategy Panel (CESP) (these generally conform to county-based bioregions). The most populous urban regions—the Bay Area, Southern California, Southern Border (San Diego) and Sacramento—had varying rates of job and wage growth but all had unemployment levels in 2000 below the statewide average. Less urbanized regions, on the other hand, had higher unemployment rates and low or even negative growth in average wages.

Table 38. Percentage change in job growth, unemployment rate, and growth in average wage by CESP region*

Region	1990-2000 job growth	2000 unemployment rate	1990-2000 growth in average wage
Bay Area	20	2.7	49
Central Coast	19	6.2	7
Central Sierra	18	6.3	-2
Greater Sacramento	27	4.8	13
Northern California	13	8.0	-1
Northern Sacramento Valley	19	8.3	2
San Joaquin Valley	21	13.9	1
Southern Border	23	4.1	19
Southern California	8	5.0	8
Statewide	16	5.2	19

** CESP regions generally conform to county-based bioregions.*
Source: California Employment Development Department, 2000; U.S. Bureau of Economic Analysis, 2002

Photo courtesy of Bureau of Land Management

Commodity and Non-Commodity Production and Use Trends

On-line Technical Report:
http://frap.cdf.ca.gov/assessment2003/Chapter6_Socioeconomic/economicconditions.html

Data Quality: Partial data

The status of resource use and production help identify demands on forests and rangelands as well as economic benefits to consumers. A better understanding of forest and rangeland industries and resources aids decision making on appropriate resource uses to support sustainability.

Several themes are germane to the status and trends of production and use within forest and rangeland regions:

- the regional economies of areas dominated by forests and rangelands are small compared to the overall statewide economy. They have proportionally less high value industries and high wage employment and proportionally more dependence on commodities and services related to forests and rangelands;
- forest and rangeland products are a significant component of regional agricultural economies in some parts of California but small components at a statewide level; and
- as consumers, Californians use vast amounts of commodities such as wood products, water, and range-fed animals. They also use traditional services like outdoor recreation and value ecosystem services such as clean water, wildlife habitats, biological resources, and open space. Many of these can and do come from California's forests and rangelands.

Californians, as consumers, have significant and increasing demands for commodities and services that come from forests and rangelands. Historically, California has met a considerable portion of these demands from its forests and rangelands. Numerous commodity production trends declined during the 1990s in part due to increased demand for other services such as higher water quality, wildlife habitats, and ecological reserves. As the demand for commodities such as timber and paper products has increased with growth in population and wealth, the increasing gap between California production and consumption has been met through imports. For example, California imports approximately three-quarters of its wood and paper products. Imports of livestock, beef, lamb, and related goods are also substantial.

New market and institutional linkages are emerging that connect forest and rangeland products to sustainable guidelines covering economic, ecological, and equity factors. Examples are approaches like the "Buy California" initiative for agricultural products and certification of forests managed under the Forest Stewardship Council or the Sustainable Forest Initiative (SFI).

The natural resources provided by forests and rangelands provide both economic and non-economic benefits to California. The demand, consumption, supply, and constraints on these resources are shown in Table 39.

Table 39. Production and use trends of selected traditional commodity and ecosystem services in forests and rangelands

Resource	Level of consumption	Supply/availability	Constraints	Opportunities
Traditional commodities and services				
Forest products: timber	Increasing	Decreasing availability due to new regulations, lawsuits, and increased costs.	Global competition, development, limits on public timber, T&E species, clean water laws, and tax policies	Long–term plans to lower regulatory costs, new products and niche markets. Certification for sustainable forest management, new technologies, income from complementary products and services
Forest products: energy (biomass)	Increasing	Decreasing but could rise	Initial infrastructure costs, energy pricing policies, high planning and regulatory costs, consistent policy integrating energy, fire, forest management, air quality, and water quality	Improved pricing and policies for renewables, enhanced private investment, and new technologies and products
Agriculture: range livestock	Per capita static; total consumption up	Historically cyclical	Development, exotic species, limits on public forage, water availability, T&E species, clean water laws, tax policies, and global competition	Improved range management, consolidation, diversification, improved tax/public policies, and new products and niche markets
Recreation	Increasing but uneven among recreation sectors, slightly increasing toward developed sites and wider range of experiences near urban areas	Uneven by recreation sector, quality of some experiences degraded, new experiences emerging, limited access makes some experiences unavailable	Low public funding, maintenance backlog, liability concerns, transport cost and congestion, and environmental impacts of "overuse" of existing sites	Additional funding, new technologies, new products/"experience" sets, more use of private providers and partnerships, and improved access
Resource-based activities in urban areas	Increasing	Increasing where public or private funding is available	Financing, commercial scale facilities, cost competitiveness, regulatory oversight, technology maturity	Landfill mitigation using organics for energy products
Water quantity	Increasing, especially for human and unique water–based habitats	Limited quantity with current shortage growing to 2020.	Weather, infrastructure, institutions related to pricing and ground water replacement, and T&E and water quality laws	Conservation, new technologies and products, improved pricing and demand management, and new storage
Wildlife as a commodity	Increasing, varies by game species	Uneven, varies by game species	Habitat and population dynamics, past land use legacies	Improved habitat, increased private ventures, and new breeding technology
Ecosystem services				
Air quality	Increasing	Limited, improving selectively	Funding, interbasin transport, global climate change, wildfires, continued development and auto use	Improved technology, use of methods less harmful to air quality, new institutions for pollution offsets, trading, and dealing with interbasin transport
Carbon sequestration	Increasing where cost is less than CO_2 production limits	Increasing	Accounting systems and markets just being developed, existing part of carbon load	Development of accounting and market structure to reimburse sequestration
Water quality	Increasing	Limited, improving selectively	Regulations, past land use impacts, limited restoration funds, lack of sizeable and equitable funding mechanisms	Regulatory change, new technology, increased funding for restoration, and improved information
Habitat restoration—fish	Increasing	Increasing	Funding, exotic species, water availability to moderate flows, continued habitat loss, weather patterns, adequate information to support decision making	Successful habitat restoration and management; new technologies; and new institutions for cost sharing/incentives with private landowners; better monitoring protocols being developed; increased funding via water bond initiatives
Habitat restoration—wildlife	Increasing	Limited	Available funding, exotic species impacts, urban development, habitat loss and fragmentation, limited information, and wildfire	Increased funding, improved information and management, new technologies, policy changes to enhance landowner cooperation
Urban forests/open space	Increasing in communities	Limited, high conversion pressure	Funding and available land base, institutional responsibility for long term maintenance	Increased funding, development of new community/non-profit based institutions
Wilderness allocation	Increasing	May increase with recovery of human-impacted areas; may increase or decrease as social concepts of wilderness change	Conflicts with current land uses, lack of management of threats such as exotics, severe fire, etc. May require Congressional action	Increased public and private funding and new institutions
Ecological reserves	Increasing	Limited	Complexity of identifying effective expansion priorities. Cost of acquiring new parcels, exotics, climate change	Increased public and private funding and new institutions

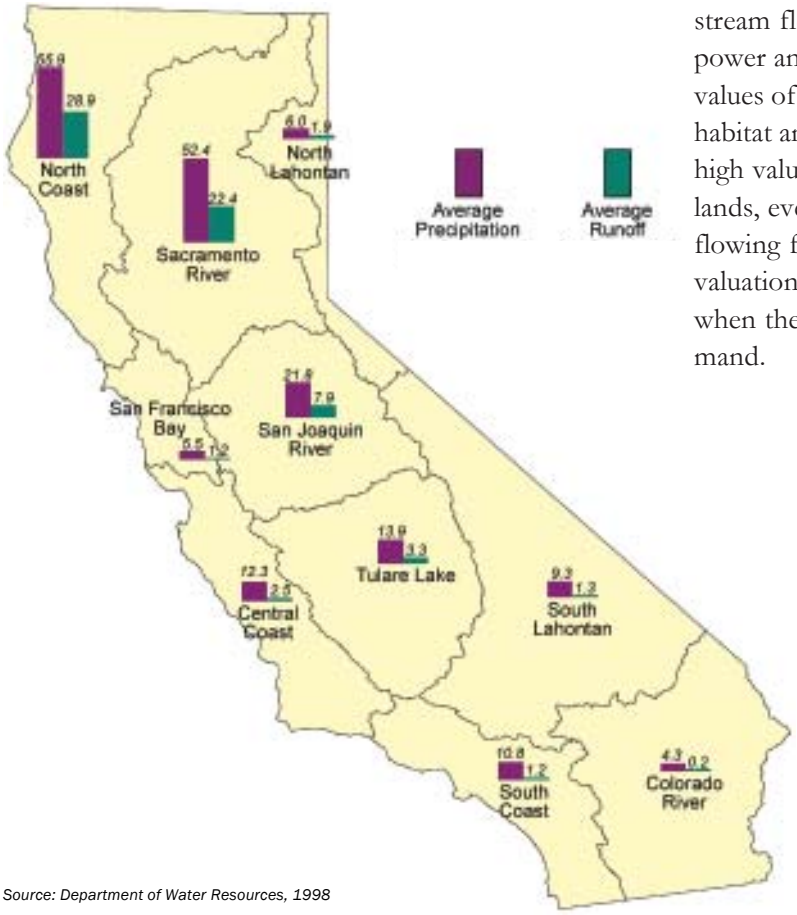
Water Quantity and Use

On-line Technical Report:
http://frap.cdf.ca.gov/assessment2003/Chapter6_Socioeconomic/water.html

Data Quality: All Necesssary Data Available

Water remains the State's most important, valuable, and controversial resource. The importance of water to the State has many reasons: 1) water is an essential, non-substitutable commodity needed for human uses; 2) usable water is a scarce resource in many parts of the State; 3) water deficiencies (droughts) and excesses (floods) are recurring problems to the State; 4) water represents the State's most economically valuable natural resource; and 5) water is essential for ecological functions.

Figure 75. Average annual precipitation and runoff (million acre-feet per year)



Source: Department of Water Resources, 1998

Most of the headwaters of the State's streams and rivers are found within forested landscapes. Their associated vegetation and soils are valuable for absorbing snowmelt and rain, storing moisture, providing shade to cool water temperatures and helping hold hillslopes in place. In return, Californians receive quality drinking water, recharged aquifers, reduced flooding, water recreation, habitat for fish and wildlife, and scenic beauty .

In California, more than 70 percent of the State's average annual runoff comes from the northern part of the State above Sacramento, where rainfall and forest cover are greater than in the southern half (Figure 75). National forest lands represent 20 percent of the State's land area but contribute about 45 percent of the total runoff, or 33 million acre feet per year. National forests also provide 9.5 million acre feet for off-stream use (e.g., diverted into irrigation canals and municipal storage) (U. S. Forest Service, 2000).

The Forest Service estimates that the annual value of water from its lands in California at almost one billion dollars, based on values of withdrawal to off-stream use at $40 per acre foot. Forest Service values for in-stream flow are $17 per acre foot (e.g., hydroelectric power and recreation). These values do not include the values of waste dilution, channel maintenance, aquatic habitat and wetland functions. This estimate shows the high value and relative importance of national forest lands, even though it understates the true value of water flowing from them. However, as in the case of all water valuations, highest monetary values are only obtained when they are delivered on a schedule of need and demand.

Water use is classified as being for urban, agricultural, and environmental purposes in California. Over 79.5 million acre feet of water were used in California in 1995. When in-stream and wetland uses are accounted for, the largest use is for environmental purposes (Table 40). Environmental water represents quantifiable water dedicated to this use by legislative or regulatory processes. It is considered the sum of dedicated flows in state and federal wild and scenic rivers, in-stream flow requirements, required outflows to the Bay-Delta, and applied water demands of managed freshwater wildlife areas.

Over the next decade, regulatory controls for water uses are expected to increase. Controls such as CALFED's Bay-Delta operations, Federal Energy Regulation Commission re-licensing of power facilities, Endangered Species Act, Colorado River usage concerns, and recent California ballot initiatives all lead to increased demands for environmental water uses. Ecological uses of water also represent a mandatory allocation of water, even in drought years. This means that ecological uses are met first, often at the expense of other urban or agricultural uses.

According to the Department of Water Resources (1998), the supply of water was insufficient to meet demand for water in 1995 and is projected to be insufficient through 2020, especially during a drought year. Statewide, the imbalance is exacerbated by population growth, with the State's population expected to grow from 32.1 million in 1995 to 47.5 million in 2020, an increase of over 15 percent. Agricultural water use is expected to decline due to the conversion of farmland to urban use (Table 40).

Water for urban uses represents the largest expected increase (rate and total quantity) by 2020. Urban uses represent 97 percent of the expected increased demand for water by 2020. Population growth is expected to drive increased water demand for urban uses.

The *California Water Plan* (Department of Water Resources, 1998) identifies the many efforts being attempted to better balance water use and supply. As noted above, the future water supply reliability is in doubt for average water years but especially during drought years (Table 41). Imbalances also vary from region to region within the State, with areas of rapid population growth showing the greatest need. The strategy to address the imbalance involves both demand reduction as well as water supply augmentation options.

Specific strategies involve developing additional surface storage facilities, exploring conjunctive use of groundwater storage areas, water recycling, and desalting, water marketing, and weather modification. Water marketing is the process of buying, leasing, or selling water or water rights to gain access to a water supply. California has no formal water market, but there are a number of major efforts to improve the effectiveness of water markets. Some types of vegetation management can increase water runoff yields but there is still little evidence that significant changes can be achieved on river basin scales without major environmental impacts.

Table 40. Applied water use in average water year conditions, 1995 and 2020 (million acre-feet)

Water use	1995	2020 *(projected)*	Change
Urban	8.8 (11%)	12.0 (15%)	+3.2 (+4%)
Agricultural	33.8 (43%)	31.5 (39%)	– 2.3 (–4%)
Environmental	36.9 (46%)	37.0 (46%)	+0.1 (0%)
Total	79.5	80.5	+1.0

Source: Department of Water Resources, 1998

Table 41. Statewide water budget for year 2020 with existing facilities and programs (million acre-feet)

	2020 – average water year	2020 – drought water year
Water use	80.5	66.0
Water supplies		
Surface water	65.0	43.4
Groundwater	12.7	16.0
Recycled and desalted	0.4	0.4
Total	78.1	59.8
Balance	–2.4	–6.2

Source: Department of Water Resources, 1998

Status of Forest Products Industry

On-line Technical Report:
http://frap.cdf.ca.gov/assessment2003/Chapter6_Socioeconomic/forestindustry.html
Data Quality: All required data

The forest products industry in California is composed of several sectors. These include forestry and logging, basic wood products manufacturing, value-added wood products manufacturing, and paper manufacturing. Both the lumber and wood products industry and the paper and allied products industry, as a percentage of total California Gross State Product, have declined steadily since 1980 (Figure 76). This reflects the growing diversification and growth of California's economy.

Total consumption of lumber dropped during the recession of theearly 1990s, and has increased since then. The future consumption of lumber, in large part, depends on the demand for housing in California, including renovation and remodeling, and is projected to increase. Consumption of paper in California has been much more stable over the last three decades, with a steady upward trend that already includes a fairly high rate of paper recycling.

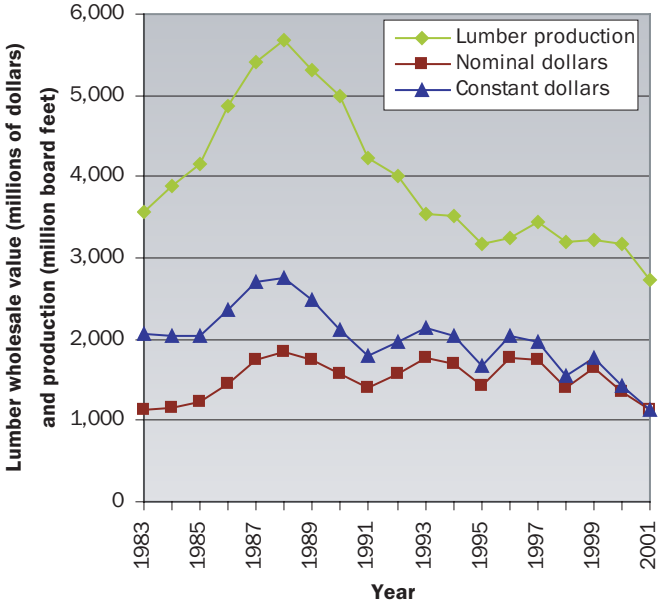
Lumber production in California reached a low in 2001 of just over 2.7 billion board feet with an approximate wholesale value of $1.1 billion dollars (Figure 77). This is the lowest year in the last two decades, continuing to follow an overall downward trend both in number of sawmills and lumber output.

To meet the growing demand for lumber and other forest products, a demand that is equivalent to over 10 billion board feet of lumber, paper, and other wood products annually, Californians rely heavily on imports. Estimates of wood product inflows from other states into California indicate at least three billion board feet of lumber was imported from other western states (Western Wood Products Association, 2002). In 2002, Oregon was California's single largest supplier of lumber. Additional lumber was also imported from Canada as well as other countries and southern states. In addition, California imports nearly all of its pulp and paper.

Figure 76. Lumber, wood, paper, and allied products Gross State Product as a percentage of total California Gross State Product, 1980–2000 (1996 constant dollars)

Source: U.S. Department of Commerce, 2002

Figure 77. Lumber production and wholesale value in current and 1990 constant dollars, 1983–2001



Source: Western Wood Products Association, 2002

California will continue to rely on wood imports in the future. This is made even more likely because substantial supplies of wood are reaching maturity from investments in timber plantations in foreign countries while public concerns over in-state timber harvesting are continuing.

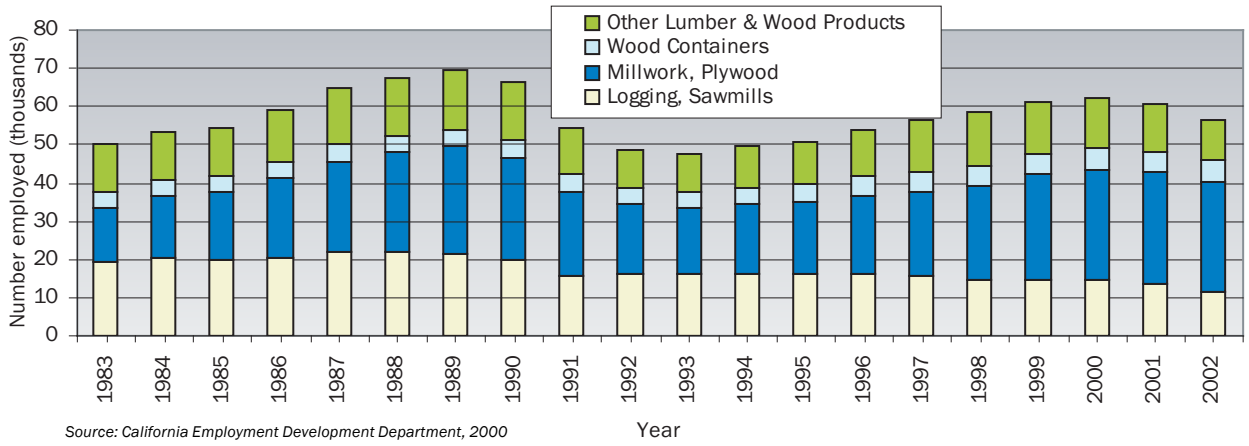
Employment levels provide a measure of the importance of the industry to the rural socio-economic system and the dependency of communities on these industries. Statewide employment trends from 1983 to 2002 in the Wood Products Sector (Standard Industry Classification 24) are shown in Figure 78. Statewide employment peaked in 1989–90 and bottomed out in 1993–94.

The total employment in the wood products industry fluctuates with the overall economic cycle. In addition to improvements in labor productivity, total employment has been strongly influenced by the expansion in the output of value-added wood products.

As lumber production declined, the wood remanufacturing industry has become the major employer of timber-related workers in California. These jobs are typically located in urban areas far from forests and rangelands. Within California, production of wood products other than logging and sawmills is located mostly in southern California. Much of the employment in this sector is located in five counties—Los Angeles, Orange, Riverside, San Bernardino, and San Diego (Figure 79).

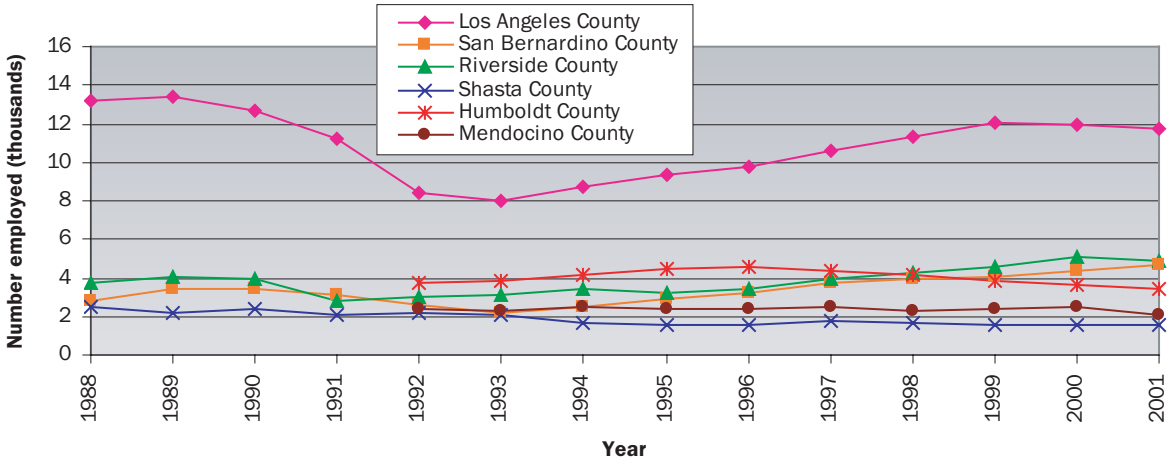
The forest products industry is still the single largest employer in several counties. Yet, local economic significance of the forest products industry has declined as most local economies have diversified and other sources of income such as transfer payments have grown (Table 42).

Figure 78. Lumber and wood products employment by subsector of Standard Industry Classification 24, statewide



Source: California Employment Development Department, 2000

Figure 79. Lumber and wood products employment for selected counties, 1988–2001



Source: California Employment Development Department, 2000

Table 42. Percentage of total civilian workforce in wood products employment and percentage of personal income from transfer payments for selected counties

County	Wood products employment (%) 1992	1996	2001	Transfer payments (%), 2000
Tehama	5.4	6.2	5.9	23
Humboldt	6.3	7.6	5.8	20
Mendocino	5.9	5.7	4.7	19
Siskiyou	4.1	4.7	4.0	25
Yuba	2.2	2.9	2.8	28
Shasta	3.0	2.2	2.1	21
Amador	5.4	4.1	1.4	18
Del Norte	3.1	2.0	1.3	27
Placer	1.0	0.8	0.9	9
Butte	1.0	0.7	0.8	21
El Dorado	1.2	0.8	0.7	11
Riverside	0.5	0.6	0.7	14
San Bernardino	0.4	0.5	0.6	15
Calaveras	0.7	0.5	0.3	21
Los Angeles	0.2	0.2	0.2	13
Statewide	0.3	0.3	0.3	11
Statewide non-metropolitan				19
Statewide metropolitan				11

Source: California Employment Development Department, 2000

Status of Range Livestock Industry

On-line Technical Report:
http://frap.cdf.ca.gov/assessment2003/Chapter6_Socioeconomic/rangelivestock.html

Data Quality: All required data

Livestock production, primarily cattle and sheep foraging on forests and rangelands, has been the dominant renewable resource use on California's hardwood, shrub, grassland and desert lands for decades. Cattle and sheep convert forage from lands that are generally too dry, steep, rocky, or otherwise unsuitable for crop production into high quality meat protein, leather, wool, and a variety of other products. The livestock industry in California not only creates economic benefits to the forest and rangeland communities, but also supports substantial ecosystem services such as recreation opportunities and preservation of open rangeland that provides wildlife habitat, healthy watersheds, and open space.

Several factors affect the range livestock industry.

- changes in consumption patterns in beef and sheep products, reliance on imports, and increased international competition in livestock and meat production;
- lower prices and higher costs constraining profits;
- consolidation in the market and processing structure of the United States livestock industry;
- increasing emphasis to provide and protect a broad array of environmental values;
- land development pressures that raise the value of rangeland over its worth for livestock operations; and
- the evolution of ways to reimburse ranchers for environmental services, such as through conservation easements.

Consumers in America are eating more chicken, turkey, and fish, and buying less red meat (U. S. International Trade Commission, 1999). Until the late 1990s, per capita beef consumption had been declining, but is now increasing. Based largely on increases in population growth, total consumption of beef in California is projected to increase in the next decade (National Cattlemen's Beef Association, 2002).

American livestock producers, including those in California, have higher land, labor, and other costs of production than do producers in many other countries. Retail prices for red meat are also strongly influenced by worldwide supplies of cattle, sheep and related meat products. Overall, the trend in prices for producers of cattle products declined in the 1990s. This was accentuated in recent years when the U. S. dollar was strong relative to the currencies of other beef and sheep exporting countries such as Australia and New Zealand. The net effect has been that the profit margins of livestock producers have been squeezed by depressed market prices and higher feed costs.

To increase profits, California's cattle industry has focused on increased marketing activities since the production side of the industry is already highly efficient. The California Cattlemen's Association and University of California Cooperative Extension (UCCE) livestock advisors in county offices collaborate in this effort.

There is a substantial movement of cattle into and out of California. Because of abundant grassland, it is common for operators to purchase cattle from outside California, ship them to California to forage on winter and spring grass, and send them out of state for finishing and processing. In 2001, approximately 400,000 head of cattle were brought into California with an estimated 60 percent going to winter pasture and the remainder to feedlots.

Although it is a net exporter of calves, California still has a feedlot presence. While small in comparison to Kansas, Nebraska, and Texas, in 2000 and 2001, California had the fifth highest number of cattle and calves in feedlots with over 1,000 head capacity in the United States, with well over half in Imperial County. However, the number of cattle marketed from feedlots has fallen consistently since the mid-1980s to below 600,000 animals per year from 1993–1999.

Most meat processing plants are located outside California, especially in the Midwest. This is because feed lots are located outside the State where feed and other costs are lower. The emphasis is on "boxed-beef" technology where carcasses are butchered into individual cuts and then packed and shipped from the slaughtering plant. This approach is capital intensive and has significant economies of scale. Large amounts of boxed-beef are shipped back into California.

Sales of beef cattle account for over 90 percent of the income generated from livestock operations on forests and rangelands (beef cattle farms excluding feedlots). Statewide, the real value of cattle sold from these farms declined 23 percent between 1982 and 1997 (NASS, 2001). In 2001, based on production value, cattle and calves were the leading agricultural commodity in nine counties—Calaveras, Imperial, Mariposa, Nevada, Plumas, Shasta, Sierra, Trinity, and Tuolumne.

Approximately 1.4 million cattle were sold from beef cattle farms excluding feedlots in 1997. Regionally, the greatest number of cattle have been sold from the two San Joaquin Valley regions and South Coast/Mojave/Colorado Desert (Figures 80 and 81).

Statewide sheep production has declined over the last decade. In 1999, the statewide value was $58 million. Top California counties for sheep production are Kern, Solano, Imperial, Fresno, and Merced. While each of these counties contains open rangeland, a large portion of their contribution comes from production in feedlots.

The profile of the structure of California's rangeland beef cattle industry shows several key characteristics:

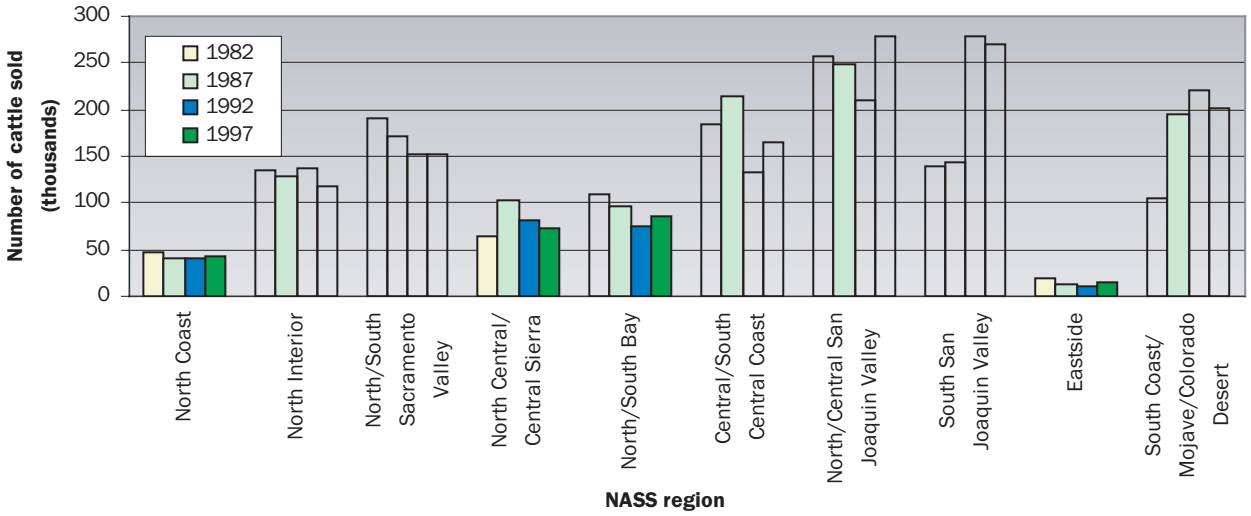
- cattle inventories cycle every eight to 12 years based on the biological nature of cattle production and how producers react to market prices;
- most of the inventory of animals is on large farms;
- smaller farms are an important part of the industry but their total production is much less than larger ownerships; and
- inventory is higher in the central and southern portions of California.

Cattle inventory on all farm types in California has ranged from about 4.5 million head in 1996 to 5.1 million head in 2000. Cattle inventory on beef cattle farms excluding feedlots remained stable between 1992 and 1997 with 1.9 million head of cattle and increased to over two million head by 2002.

Figure 80. National Agricultural Statistics Service (NASS) regions

Source: Compiled by FRAP from National Agricultural Statistics Service, 2001

Figure 81. Number of cattle sold from beef cattle farms excluding feedlots, 1982–1997



Source: National Agricultural Statistics Service, 2001

Photo courtesy of Gary Cramer, USDA Natural Resources Conservation Service.

Inventories vary by farm size and region, with production normally concentrated in farms 500 acres or more in size. Since 1982, the inventory has been spread across fewer farms. The Eastside, North Interior, and Central/South Central Coast had a high proportion of their inventories on farms greater than 500 acres. In contrast, South San Joaquin Valley and South Coast/Mojave/Colorado Desert had a relatively smaller proportion of their inventories on farms greater than 500 acres (Figure 82).

Smaller cattle farms (less than 500 acres) provide approximately 25 percent of the range livestock industry cattle inventory. This class of small farms is characterized by having many owners, lower production levels, and goals different than large farm owners. On the smallest farms (one to 49 acres), these lands often reflect management goals such as hobby livestock interests and use of land for "ranchette" residences. These farms often have very complex management issues and are subject to land development pressures.

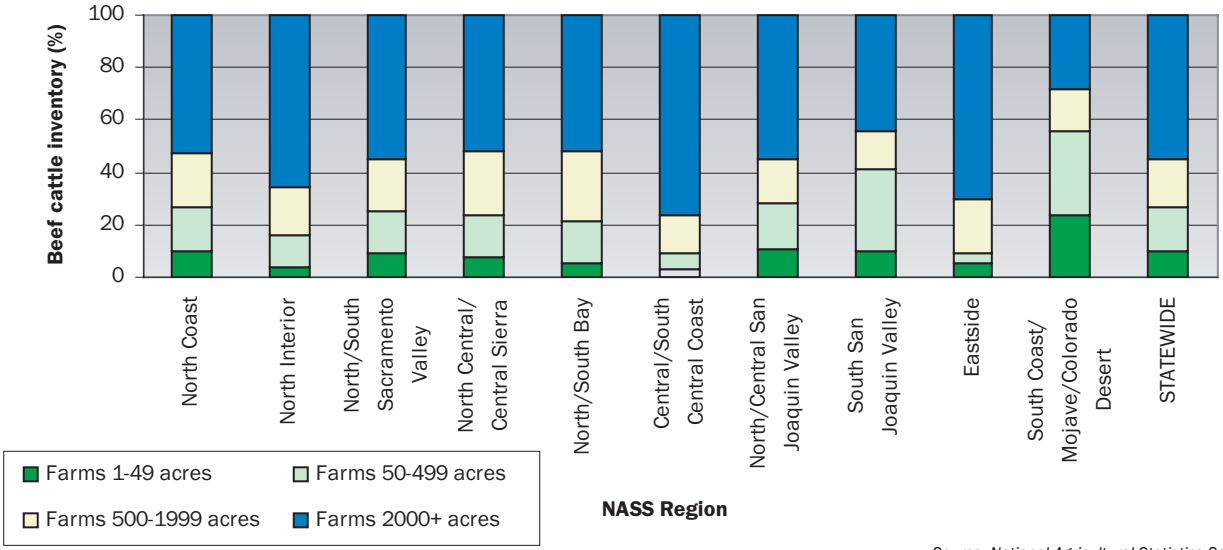
Continuing urban pressure may drive land use conversions even when ranch owners would prefer to continue existing operations. A recent survey in Contra Costa, Alameda, and Tehama counties suggests that urban ranchers fear local land use conversions and expect that if their ranch is sold it would be converted to urban land uses. In contrast, most rural ranchers felt less threatened by local land use conversions and wanted their property to be a productive ranch even if sold. Most ranchers enjoyed ranching and its associated family life, but felt that urban California was becoming more hostile to the livestock industry. In the urban sample, no new ranches had appeared in ten years (Liffman et al., 2000).

With the ranching industry financially constrained, alternate forms of income are critical to keep ranches in operation. This is especially important given key locations of many large ranches currently under development pressure and the desire of ranchers to continue their way of life.

Conservation easements between ranchers and land trusts provide a form of non-ranch income. They typically involve the sale of development or conversion rights and agreement on restrictions or specific land use practices that address escalating regulatory costs. Nonprofit land trusts have been expanding in California. There are over 130 land trusts now operating in the State, including the California Rangeland Trust founded by the range community itself. These trusts are funded from a variety of sources, and play a key role in facilitating local conservation easements for ranchers and farmers.

In the opinion of some observers, California's beef cattle industry is at a crossroads. Many operators are nearing retirement age and may likely exit the industry. The processing sector remains outside of California and market opportunities, especially for smaller producers, are limited. Even in forest and rangeland areas where cattle ranching has been stable in recent years, the business side of ranching will need to remain profitable if the industry and associated land use patterns are to survive.

Figure 82. Percentage inventory of beef cattle on beef cattle farms excluding feedlots by farm size, 1997



Source: National Agricultural Statistics Service, 2001

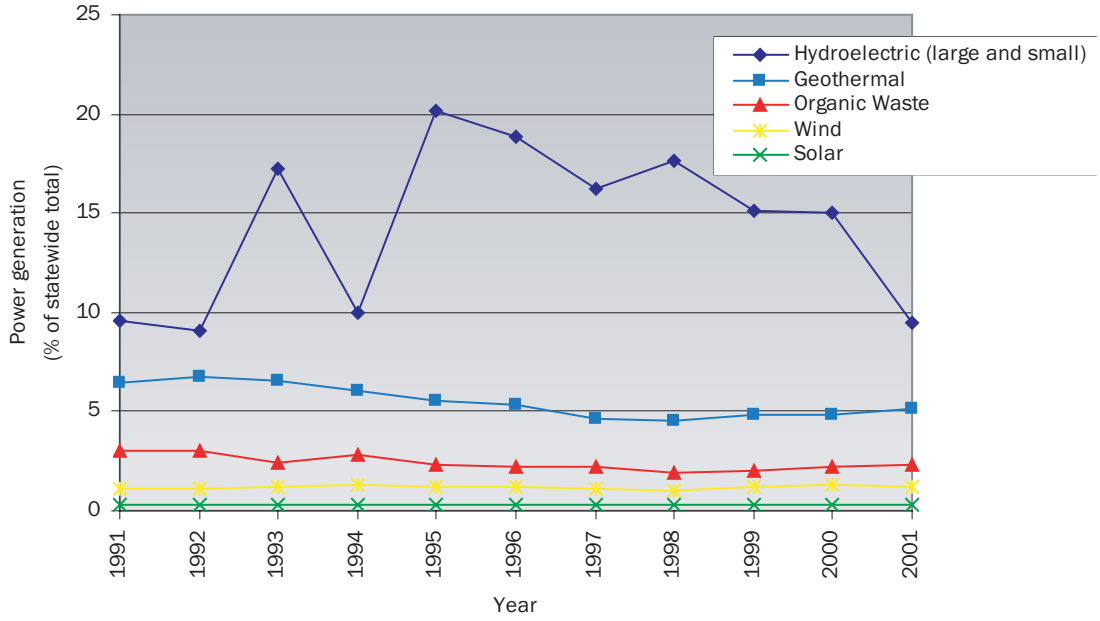
Status of Forest and Range Energy-Related Industry

On-line Technical Report:
http://frap.cdf.ca.gov/_assessment/Chapter6_Socioeconomic/energy.html
Data Quality: All required data

Hydroelectric (both large and small), geothermal, biomass, and wind energy generation are related to forest and rangeland resources. Over the last two decades, the relative importance of hydro, wind, biomass, and geothermal energy production has varied, and over the last five years, the relative contribution of hydroelectric has declined (Figure 83).

Extensive investments have been made in California's electricity producing infrastructure. Geothermal, biomass, wind, and waste to energy power plant capacities vary by region. Geothermal and wind resources offer the most immediate potential for increased electrical generation. Biomass also has the potential to expand, but will take substantial investments to realize significant additional output. Largely unutilized sources are forest slash and forest thinnings (Table 43). As of 2002, the California Biomass Energy Alliance reports that its 17 member companies operate 36 biomass-fueled power plants in California. Collectively, capacity is about 720 megawatts of generating capacity at an initial industrial investment of over $2.5 billion. About two-thirds of these power plants have power purchase agreements through 2006. Most of the other third had agreements only through 2002 and lack longer-term guarantees. Therefore, the sustainability of approximately 20 percent of existing capacity is questionable in the long run.

Figure 83. Percentage of statewide annual total power generation for five sources important to forests and rangelands, 1991–2001



Source: California Energy Commission, 2002a

Table 43. Gross production and current use of biomass on forests and rangelands (million bone dry tons per year)

Waste source	Gross production	Current use		Excess biomass
		Fuel	Other uses	
Lumber mill	5.5	1.75	3.25	0
Forest slash	4.5	0.25		2.5
Forest thinnings	3.8	0.25		1.4
Chaparral	7.7			0.8
Urban wood	3.2	1.0	0.5	0.7
Urban yard	3.9	0.2	0.5	1.2

Source: California Energy Commission, 2002a

Status of Recreation Industries

On-line Technical Report:
http://frap.cdf.ca.gov/assessment2003/Chapter6_Socioeconomic/recreation.html
Data Quality: partial data ◐

Outdoor recreation is an important use for most forests and rangelands, both public and private, in California. In addition to the scenic value of these lands, the variety of outdoor recreational opportunities available on forests and rangelands is a significant component of the quality of life for many Californians and a major attraction for many out-of-state visitors. Providing a succinct summary of outdoor recreation in California is challenging due to the tremendous diversity in nearly every facet of this topic—land ownership, levels of use, types of activities, roles of private service providers, and probable future trends.

Understanding the major trends and characteristics driving recreation in California will help meet the goal of providing recreational opportunities for Californians. Major tends and characteristics include:

- **Population growth:** With the state's population expected to grow from 34 million in 2000 to 45 million by 2020, increases in total use are expected. This is particularity true in California's urban areas where most of the population resides. Other rapidly growing areas include inland areas such as the foothills of the Sierra, the Sacramento and San Joaquin Valleys and inland empire of the southern California such as Riverside and San Bernardino counties.
- **Demographic changes:** Changing age and cultural patterns, including increasing proportion of multi-ethnic Americans and an aging baby boomer population, will drive new demands on recreation resources.
- **Changing patterns of use:** Emerging patterns of use include shorter duration trips and a wider variety of activities such as nature study activities and adventure sports.

Recreation Use

Table 44 summarizes the areas, visits, and standardized 12-hour recreational visitor days (RVDs) by major providers as well as by the location in relation to metropolitan areas. Approximately 95 percent of the public land available for outdoor recreation is in federal ownership but over 70 percent of the visits occur on state and local government properties. Most local, many state, and some federal properties are located near metropolitan areas (defined as being within an hour drive of one of California's major metropolitan centers). As a group, these metropolitan areas represent around 13 percent of the area available for outdoor recreation but provide 50 percent of all visits.

The pattern of metropolitan area units having much higher per acre use rates (often five to 10 times as high) is consistent across ownership types and vegetation types. Table 45 illustrates use intensity for a range of units from the most intensely used areas (urban beaches) to remote wilderness areas. All trends point to increases in outdoor recreation in metropolitan public areas while use trends for more remote public areas are flat or even declining in some cases. Use rates tend to drop off rapidly as areas become more distant to population centers. The facilities that experience overcrowding, such as picnic areas, campgrounds, and trails, are typically those with high day use and close proximity to metropolitan areas.

The National Park Service (NPS) has 22 major sites across California and collects the most consistent and

Table 44. Outdoor recreation on forests and rangelands by provider and location, 2002

	Area available for recreation	Visits*	12-hour RVDs**
Total in millions	45	184	138
	Available area (%)	**Visits (%)**	**12-hour RVDs (%)**
Major provider			
State Parks	3	43	31
Regional Parks	1	22	12
National Park Service	16	18	13
U.S. Forest Service	45	6	29
Bureau of Land Management	34	4	9
Location			
Metropolitan areas	13	50	40
Non-metropolitan areas	87	50	60

** "Visits" refers to a single trip by a person regardless of length of stay.*
*** "Recreational Vistor Day" is a visit by one person for a 12-hour length of stay.*
Sources: FRAP, 2003

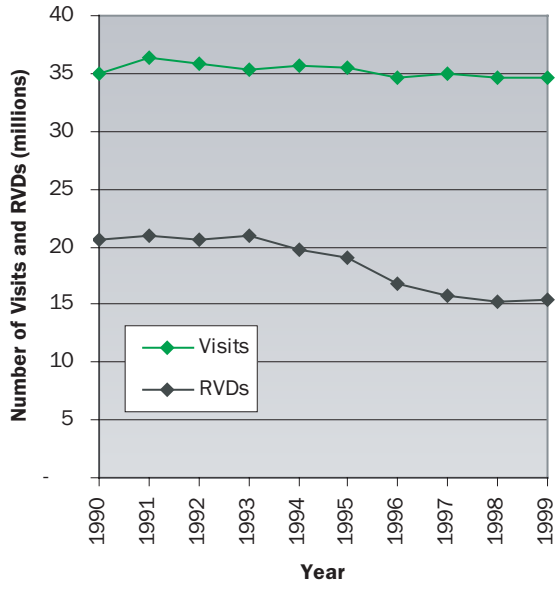
accurate use data on both the number of visits and how long each visit lasts. Figure 84 illustrates a flat trend in the number of visits but a 26 percent drop in the average length of stay during the 1990s. While unique factors (temporary and permanent closures due to floods, fire, and landslides) have affected major parks such as Yosemite, the overall trend appears to be one of people making more short visits and fewer multi-day visits. A study for a subset of California State Parks most closely related to forests and rangelands, showed a small increase in use over the decade with most visits occurring near metropolitan areas.

Table 45. Recreation use intensity for select use areas, 2002 (millions)

	Area	Visits*	RVDs**	RVDs/ acre
State Parks - Southern California beaches	0.05	28	11	224
Other metropolitan parks	0.77	72	29	37
USFS - metropolitan national forests	3	10	22	4
USFS - rural national forests	11	2	18	1
USFS wilderness	6	0.4	2	0.4

** "Visits" refers to a single trip by a person regardless of length of stay.*
*** "Recreational Vistor Day" is a visit by one person for a 12-hour length of stay.*
Sources: FRAP, 2003a

Figure 84. Visits* and Recreational Visitor Days on National Park Service parks in forests and rangelands, 1990–1999**



** "Visits" refers to a single trip by a person regardless of length of stay.*
*** "Recreational Vistor Day" is a visit by one person for a 12-hour length of stay.*
Source: compiled by FRAP from National Park Service, 2001

Recreation Activity Types

The most popular types of outdoor recreation in California are associated with walking and all forms of trail use, beach visits, sightseeing, and picnicking. In many cases, the vegetation and physical features of forests and rangelands are primarily a backdrop for these activities. The best data on the types of recreational activities more directly dependent on forest and rangeland settings comes from the recent U.S. Forest Service surveys of recreational activities on national forests. Table 46 summarizes the major activities of visitors based on new statistical surveys completed on eight of the 20 national forests in California. The sample covered four national forests adjacent to major metropolitan areas, Los Angeles, San Diego, Sacramento, and Reno, and four national forests far from metropolitan areas. Use patterns were similar across both metropolitan and non-metropolitan forests for all activities except for fishing where the non-metropolitan forests have considerably higher use rates.

Table 46. Major activities of visitors to eight national forests in California as a percentage of total visits, 2002

Activity	Percentage of visitors
Viewing	48
General relaxation	43
Hiking/Walking	37
Skiing	24
On road driving	18
Developed camping	14
Fishing	14
Off Highway Vehicles (OHV)	9
Mountain biking	6
Hunting	4
Minor forest products collection	3
Designated wilderness	3

Source: compiled by FRAP from National Visitor Use Monitoring Program, U.S. Forest Service, 2002A

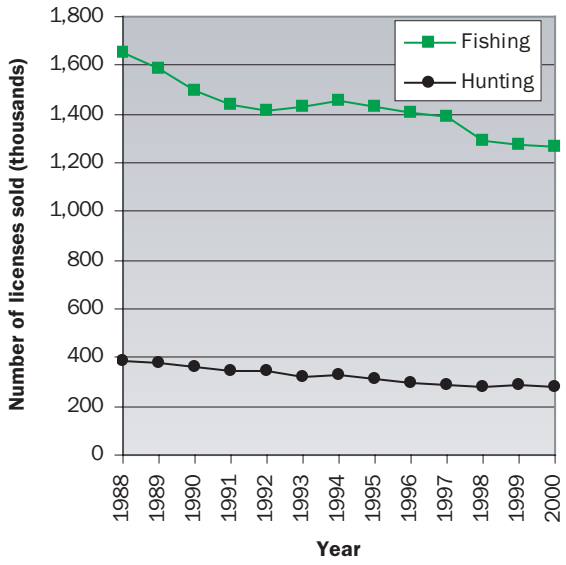
Use preferences are also evaluated by the California Department of Parks and Recreation (CDPR). In a public opinion poll conducted in 2002 by CDPR, camping, an activity closely associated with forests and rangelands, rated highest among all recreation activities in terms of latent demand and public support. That is, what the public would like to do more and what the public thinks government agencies should fund.

In addition to the decline in the average length of stay, another significant trend has been the decline in the relative importance of fishing and hunting in the overall mix of outdoor recreational activities. Figure 85 illustrates the trends in the number of fishing and hunting licenses sold by the California Department of Fish and Game. While the value of license fees represents a larger portion of total fees paid by users than their numbers of visits suggest, the declining trends illustrate the changing nature and greater mix of outdoor recreational activities in California.

Considerable outdoor recreation also occurs on privately owned forests and rangelands, especially on parcels owned by individuals rather than businesses. Recent surveys suggest that around half of all owners of non-industrial forest and rangeland properties in the Pacific Coast states (California, Oregon, and Washington) allow their land to be used for recreation by their extended family and friends (Teasley et al., 1999). With over four million acres of non-industrial forest land and an even larger area in small to medium rangeland parcels in California, this represents a significant portion of outdoor recreation.

In addition, much of the outdoor recreation on forests and rangelands occurring on publicly owned lands is often accompanied by recreational services provided by private sector businesses and concessions. The publicly owned land and facilities support both benefits to the user of low-cost or no-cost recreational opportunities as well as significant business and employment opportunities that provide additional value-added services to users. One of the most significant examples of this complementary relationship is the number of private campground sites across the state and in the forest and rangeland regions. As Table 47 illustrates, private campgrounds represent the majority of sites.

Figure 85. Annual number of fishing and hunting licenses sold by the Department of Fish and Game, 1988–2000



Source: California Department of Fish and Game, 2001b

Jackson, Amador County

Economic Impact

Private campgrounds are just one example of the economic contributions of outdoor recreation to California's overall $64 billion travel spending business in 1998. Approximately $3 billion was related to camping, $3 billion to fishing, $2.3 billion to wildlife viewing, and $0.8 billion to hunting. In addition, forests and rangelands are an important component of the scenic value of travel to areas such as the Napa Valley and the Tahoe Basin. The overall growth in travel spending in forest and rangeland regions during the 1990s suggests that the economic value of outdoor recreation is increasing faster than the number of visits (Table 48).

Implications of the status and conditions of wildland recreation

Summarizing the results of the recreation use, supply, and activity preferences provides insight to the future needs of wildland recreation in California.

- Participation rates for most activities associated with forests and rangelands are growing, and for some quite significantly. With growing population, demand for all wildland recreation will increase in absolute numbers, even though some activities may show stable or declining participation rates.
- Recreation use near metropolitan areas is increasing and many sites are intensely used. Accommodating quality experiences for users while protecting the natural resources will be increasingly challenging.
- More user conflicts are likely to result as the scope of activities expands and user group demands overlap.
- Recreational providers must adapt their facilities to be relevant to the changing user profile.
- Water related recreational sites will continue to have the highest intensities of use and risks of loss of ecological values.
- Coordination between and among public agencies at all levels of government, non-profit land trusts, and private forest and rangeland operators will be needed in the future. Coordination should include strategically acquiring land and easements and providing opportunities in response to recreation demands.

Table 47. Campsite inventory for selected bioregions and statewide, 1999–2000

County-based bioregion	Private	City-County	CA State Parks	USFS	NPS	Other federal	Utilities	Total
Bay Area/Delta	4,812	631	1,324	0	0	0	0	6,767
Central Coast	6,709	1,341	3,238	1,262	92	991	0	13,633
Klamath/North Coast	12,822	730	2,360	652	133	484	15	17,196
Modoc	8,071	0	707	4,663	645	144	441	14,671
Sierra	12,738	1,429	1,770	9,762	2,734	1,890	177	30,500
Statewide	91,498	8,692	15,178	19,391	5,668	4,252	633	145,312

Other federal includes BLM (Bureau of Land Management), COE (U.S. Army Corps of Engineers), and BOR (Bureau of Reclamation); USFS: USDA Forest Service; NPS: National Park Service
Sources: compiled by FRAP from Dean Runyan Associates, 2000a

Table 48. Travel spending and percentage change by selected bioregions and statewide, 1992–1998 (million constant dollars)

County-based bioregion	1992	1993	1994	1995	1996	1997	1998	Percentage change 1992-1998
Bay Area/Delta	12,005	12,556	13,107	13,819	15,052	16,640	17,779	48
Central Coast	3,714	3,873	3,981	4,021	4,338	4,756	4,873	31
Klamath/North Coast	986	1,055	1,150	1,224	1,274	1,331	1,373	39
Modoc	75	81	88	92	99	103	104	39
Sierra	2,457	2,662	2,852	3,068	3,113	3,356	3,567	45
Statewide	47,543	49,014	50,803	52,548	55,961	61,301	64,424	36

Source: compiled by FRAP from Dean Runyan Associates, 2000b

Timber and Rangeland Contributions to Funding Rural Infrastructure Needs

On-line Technical Report:
http://frap.cdf.ca.gov/assessment2003/Chapter6_Socioeconomic/contributions.html

Data Quality: All required data

Provision of adequate infrastructure like roads and programs such as public health are key to economic development and high quality lifestyle. For the most part, statewide discussions over the provision of infrastructure in California have been focused on urban areas. At the same time, the infrastructure needs in California's forest and rangeland counties are significant.

Rural areas are competing as part of California's regional economy and must be able to offer attributes that attract industries and retain workers. Most of these rural economies have traditionally been dependent on agriculture, mining, forestry, and ranching. As these industries have declined, tourism has become more important to local economies. While tourism offers promise, it also brings special infrastructure needs.

Of special concern for social and economic sustainability is the ability to supply infrastructure in California counties with significant forest and rangeland resources. For the most part these counties are rural, meaning they have fewer than 250,000 residents and no single city with more than 50,000 residents, as classified by the U.S. Census. A number of these counties have over 50 percent of their area in forests and rangelands and significant economic output from forest and rangeland activities. Per capita expenditures vary greatly by county and special district. More than half of rural counties have less spending per capita for recreation, soil conservation, library services, sanitation, and water than the State average. In the case of fire protection expenditures provided by special districts, ten rural counties significantly exceed the State average. For the fiscal year ending June 30, 1999, 16 of these forest and rangeland counties were more reliant on taxes and special benefit assessments than the statewide average. Hence, they tend to be more sensitive to changes in the fiscal structures that affect property taxes or special benefit assessments.

In past decades, tax revenue associated with timber harvesting on private and public lands has been a source of significant revenue to many local rural governments in California. Given the growth in California's economy and changes in the funding structure of local government, timber-related revenue has become a progressively smaller percentage of total revenue sources for local governments. Three factors have led to decreased importance of timber-based revenues for counties and school districts: 1) increased availability and reliance on non-timber sources of local revenue; 2) changes in state funding for education that make up for yield tax declines; and 3) federal legislation providing a revenue floor to rural governments formerly dependent on national forest receipts.

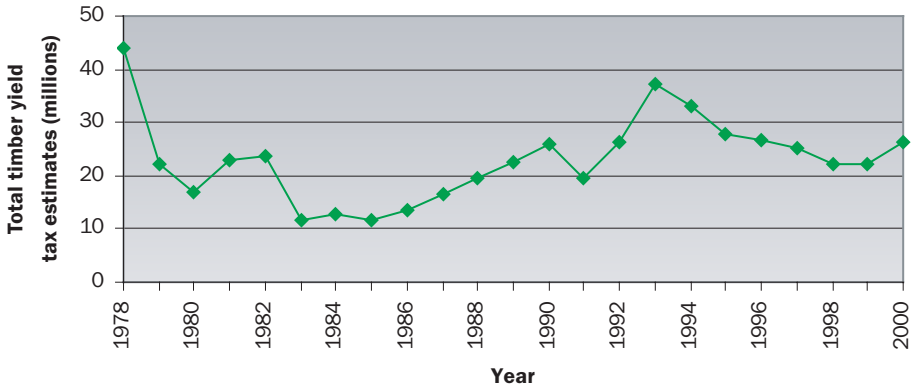
Timber harvested in California is subject to a yield tax, which is a percent tax on the value of timber when it is cut. The yield tax is currently 2.9 percent of assessed timber value at time of harvest. Yield tax differs from an ad valorem tax which annually taxes timber property and standing tree value regardless of when timber is harvested. A small property tax is also levied against private lands zoned for timber production. Over the last two decades, the timber yield tax peaked in 1978 and again in 1993 at well over $30 million statewide (Figure 86). During the 1990s, the yield tax averaged approximately $25 million. Based on the average from 1978 to 2000, the counties with the highest yield tax receipts are Humboldt, Mendocino, Siskiyou, Del Norte, Shasta, Trinity, and Plumas.

Historically, revenue from federal lands has come from payments by federal agencies, including in-lieu payments by the Forest Service and the Bureau of Land Management. A large portion of these federal payments come from receipts for timber harvesting on national forests. These payments declined dramatically over the 1990s, as federal timber harvests declined (Figure 87). In response to this trend across the West and other states, federal legislation was enacted (Secure Rural Schools and Community Self Determination Act of 2000 [PL 106–393]) that provides a revenue floor to rural governments formerly dependent on national forest receipts. Since 2002, a steady level for California was set at approximately $65 million.

Overall, the total annual tax and in-lieu of tax revenues from timberlands in 2000 was approximately $100 million. This revenue includes $65 million of in-lieu payments from national forest timberlands, $26 million from timber yield taxes, $8 million from timberland property taxes for lands with Timber Production Zone (TPZ) status, and small amounts from Bureau of Land Management and property taxes from timberlands without TPZ designation. Additional funding does come from resources on federal lands, but statewide, total funds amount to less than one percent of all revenue sources to local government.

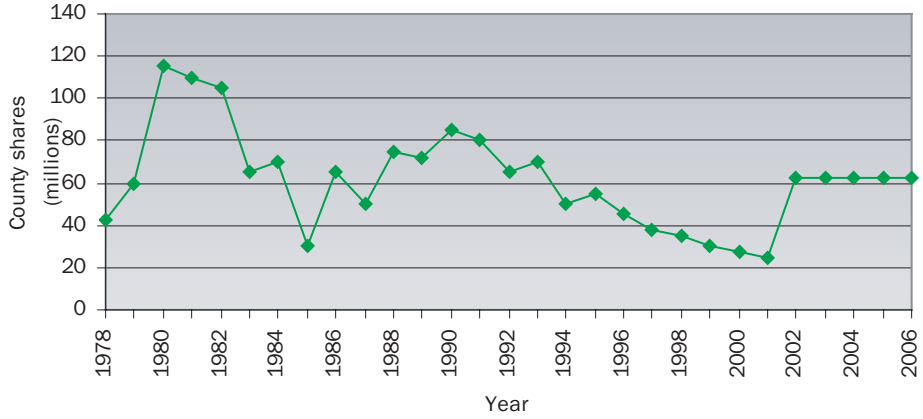
With timber related revenues for local governments constrained, rural economic policy is challenged by the fact that economic growth can be limited by inadequate infrastructure, operating funds, and technical assistance. Over the last decade, Californians especially have been willing to invest in education and programs for open space, parks, habitat, and improved air and water quality. However, at the local level, taxpayers have resisted raising taxes. Combined with the limited ability of local governments to raise funds under the current system of public finance, planning for and provision of local services in some forest and rangeland counties can be difficult.

Figure 86. Timber yield tax payment estimates from all ownerships, 1978–2000 (nominal dollars)



Source: California State Board of Equalization, 2000.

Figure 87. Actual and projected county shares from national forest receipts in California, 1978–2006 (nominal dollars)



Source: U.S. Forest Service, 1999.

Governance Impacts on Forest and Rangeland Resource Sustainability

Governance is the framework of laws and institutions through which decisions are made about use, management, investment, and conflict resolution on California's forests and rangelands. The framework includes the legislative, executive and judicial branches of government. These occur at various levels—federal, state, regional, and local. Private market institutions, voluntary associations such as watershed groups, and international forums are also involved.

Laws and agency jurisdictions apply to nearly 20 categories of public values, including special, cultural, and scientific values. For example, both federal and state laws cover coastal resources, wild and scenic rivers, wilderness, and cultural/historic sites. Multiple agencies often have authority over a specific resource type on private or public land. In addition, administrative boundaries historically tend to follow resource or topographic definitions rather than ecological considerations. A complex overlap of jurisdictions results in relationship to the conservation and management of forests and rangelands.

At the federal level, at least 70 laws and Executive Orders relate to California's forests and rangelands. Some of these specifically reference conservation or sustainable management as goals; others only relate indirectly. The most significant laws for California have been the federal Endangered Species Act, Clean Air Act, and Clean Water Act. Six federal agencies play a key role in the way public lands containing forest and rangeland resources are managed in California. These include the U. S. Forest Service (USFS), Bureau of Land Management (BLM), National Park Service (NPS), U. S. Fish and Wildlife Service (FWS), U. S. Environmental Protection Agency (EPA), and National Marine Fisheries Service (NMFS).

At the state level, over 30 laws and Executive Orders deal with aspects of forests and rangelands. A number of departments, boards, and commissions within the Resources Agency and the California Environmental Protection Agency have regulatory influence on private forest and rangeland management. Several state agencies own and manage forest and rangeland properties for a variety of goals. The California Wildlife Conservation Board and various conservancies hold easements and contractual commitments from landowners to ensure management of specific environmental protection and/or enhancements.

In California, local government also can affect the use of agricultural and natural resource lands. Influence occurs in a variety of ways, particularly through zoning and nuisance ordinances, the General Plan process, land use policies, and project review under the California Environmental Quality Act. In addition, some counties, especially those in the San Francisco and Monterey Bay regions, fund extensive acquisition and easement programs for forests and rangelands.

At every agency and level of government, California's institutions for forests and rangelands have dealt with many issues over the last decade. Concerns and conflicts over air and water quality, open space, oaks, old growth, fish, and wildlife have resulted in significant changes in management of public lands and restrictions on private landowners. At the same time, the public has supported billions of dollars in funding for programs of acquisition, restoration, and habitat improvement.

There has been an increasing presence of federal and state agencies providing funding at the watershed level, as well as development of robust watershed and community groups at the local level. The role of non-profit organizations has greatly expanded, especially in facilitating negotiation of agricultural and conservation easements, wherein a landowner gives up rights to subdivide and sell land for development in exchange for tax benefits and/or payment.

The result of this strong interest is a very complex and uncoordinated mix of approaches taken at different levels of government to management, investment, and conflict resolution. For example, regulations are mixed with market or conservation incentives, cost sharing, funding for acquisition and easements, tax policies, and information sharing and education. The effectiveness of these tools in promoting forest and rangeland sustainability is inconsistent and in some cases, counter to broader goals. Therefore, it is important to gauge the impact of governance factors on sustainability.

Governance Indicators

- **Regulatory Jurisdictions over Management Activities**

Regulatory Jurisdictions over Management Activities

On-line Technical Report:
http://frap.cdf.ca.gov/assessment2003/Chapter7_Governance/legal.html

Data Quality: Additional development ?

Public lands are currently subject to restrictions that curtail timber harvesting, grazing, and other commodities. Management on privately owned forests and rangelands is also heavily influenced by regulation or voluntary frameworks. Often similar to management guidelines on public lands, they include the following measures:

- plans to protect and restore fish and fish habitat;
- landscape level environmental review such as watershed assessment or cumulative watershed effects analysis;
- Board of Forestry rules requiring consideration of sustained growth and timber harvest;
- development of plans that address threatened and endangered terrestrial and aquatic species;
- application of CEQA requirements to Fish and Game Stream Crossing Permits; and
- stronger application of federal Clean Water Act requirements by Regional Water Quality Control Boards (RWQCBs).

The result has been a growing overlap of regulatory frameworks and legal requirements. These include reserve designations, watershed policies by agencies on federal lands, regulatory approaches on privately owned forest lands, and voluntary approaches on privately owned rangelands. The expected impacts of regulation to sustaining biological diversity and improving soil and water conditions is approximated in the following summary.

FRAP ranked each bioregion to reflect the percent of forests and rangelands where specific regulatory requirements, or lands of particular concern under the Forest Practice Rules (FPRs) (steep slopes, riparian areas, and late successional forests), are likely to dictate the amount and type of land management activities permitted. These Special Management Zones focus on timber management, grazing, and other land use actions. Bioregions with substantial portions of land in special management zones are likely to have greater attention directed towards protection of biological diversity, ecosystem structures, and soil and water quality. The following are the regulatory or unique land formations used to identify these zones:

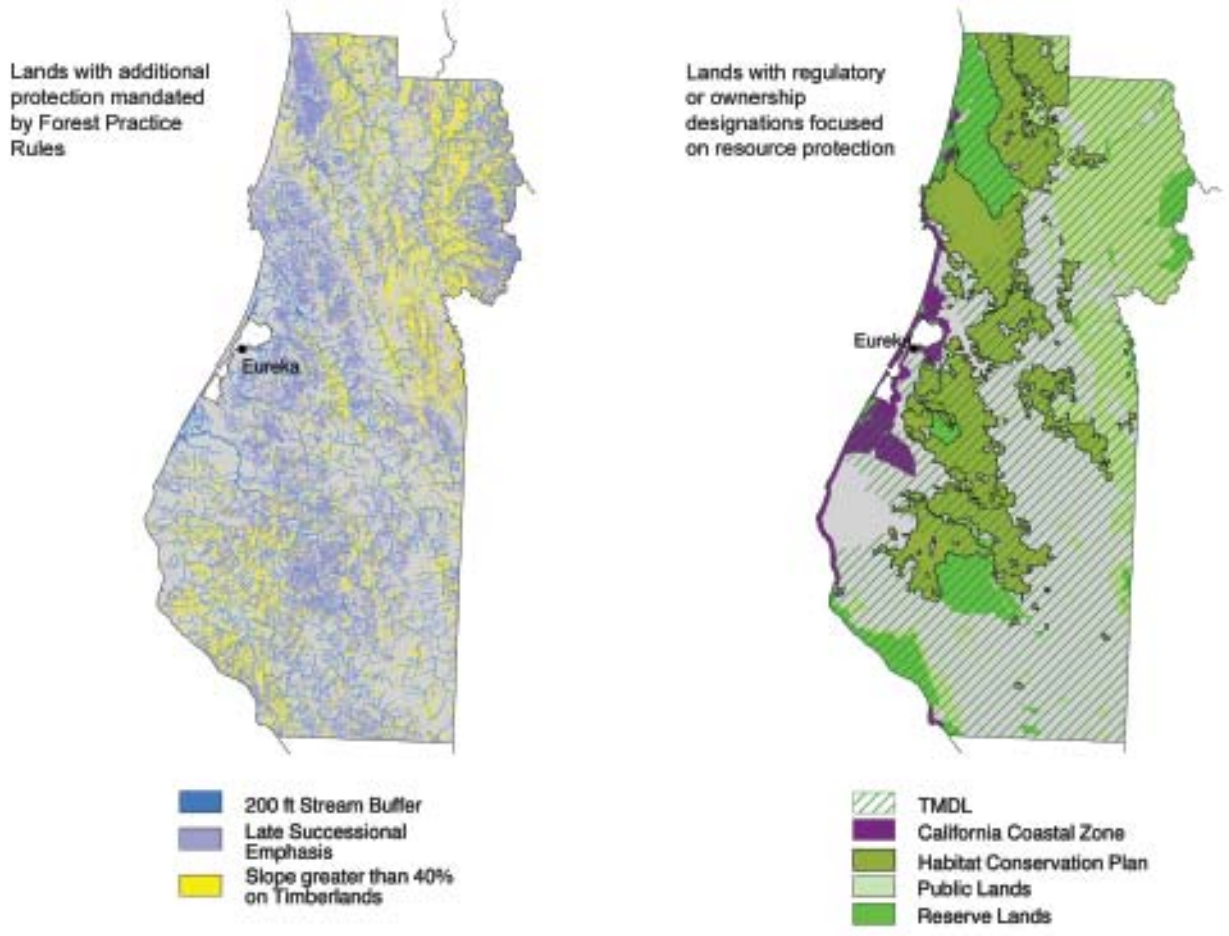
- California Coastal Zone designation;
- Habitat Conservation Plans and Natural Community Conservation Plans;
- public lands;
- reserves (excludes most extractive management and commodity production);
- forested lands with slopes over 40 percent;
- perennial stream riparian areas;
- late successional forests (LSF) (approximate extent as defined by Forest Practice Rules);
- watersheds with Total Maximum Daily Load (TMDL) plans; and
- voluntary or mandatory county oak ordinances on hardwood rangeland areas.

Of the over 80 million acres of forests and rangelands, 73 percent have special regulatory laws and plans, zoning ordinances, and ownership designations focusing on protection of resource values including the basic Forest Practice Rules and CDFA requirements. Profiles of each bioregion show that the highest proportions of special management zones on forests and rangelands are in the Klamath/North Coast (90 percent) and Mojave and Colorado Desert bioregions (over 80 percent) (Figure 88).

Results of the analysis suggest that most forests and rangelands where significant management activities occur have some multiple regulatory foci or designations that can contribute to the protection of unique habitats, biological diversity, soil and water quality, and aquatic systems. For example, over 90 percent of Humboldt County has a regulatory designation or a land form that can key special review for impacts from logging or grazing (Figure 89). However, the extent of government regulation does not necessarily predict the actual level of environmental stewardship and protection.

Success of sustaining ecological values will depend on good land management practices and a willingness to expend limited financial resources, both public and private. To a certain extent, investments on private forest lands are compelled by requirements of the FPRs, but more investments will likely be needed over time.

Figure 89. Special Management Zones, Humboldt County



Source: FRAP, 2003g

The legal system has been the most significant factor in resolving conflict, on both public and private lands. Throughout the 1990s, litigants filed numerous lawsuits regarding resource issues. On public lands, lawsuits have led to federal actions that more aggressively protect threatened and endangered species, such as the northern and California spotted owls. Lawsuits challenging implementation of the federal Clean Air and Clean Water Acts have also led to more stringent requirements in California.

On private lands during the 1990s, 24 lawsuits were settled regarding timber harvesting. The reasons behind many of these lawsuits relate to objections by neighbors, the public, and interest groups concerning the location and extent of harvesting or the impacts on water supplies, amenities, and threatened or endangered species. Other issues addressed by these legal proceedings included the timely provision of information to the public and the quality of environmental impact analyses contained in proposed timber harvest plans.

Results of litigation in California on public lands include improvements in agency information and analysis, as well as a management focus on the public involvement process. Examples include lawsuits that led to the Northwest Forest Plan, wildlife consultation and forest planning efforts in southern California national forests, and attempts to address water quality issues in public, forested watersheds of the Sierra and North Coast. State agencies have had to make similar kinds of adjustments. Private landowners have had to develop ways to work with the public, anticipate litigation, and often provide the resources necessary to defend their actions in court. The time and cost incurred by the landowners results in limited effectiveness in terms of cost and on-the-ground stewardship and protection.

California voters have increasingly been asked to resolve very complex issues formulated as ballot propositions. Ballot propositions have been advanced relating to several issues: forest practices, range and wildlife management, and investment in water, air, parks, habitat, and related infrastructure. Initiatives approved through the ballot box have focused on protecting wildlife from certain control methods, acquiring habitat, and funding stream restoration, upper watershed work, and other projects related to improved water supply.

Photo by Lynn Betts, USDA Natural Resources Conservation Service.

among federal agencies, states, local governments, tribes and the interested publics. The Plan seeks to reduce the impacts of wildland fires on communities and natural and cultural resources.

At the heart of these cooperative fire threat efforts is the need to work with the public to protect communities in the WUI. A high level of growth in the WUI is placing more citizens and property at risk of wildland fire around metropolitan areas, and increasing ecosystem health problems across the landscape. These plans recognize that many of the past century's traditional approaches to land management have resulted in development of unnaturally dense, diseased, or dying forests and treatment of wildlfire has contributed to more severe fires and created widespread threats to communities and ecosystems.

The movement towards localized resource governance and problem-solving using watersheds as the theme has become popular countrywide, but particularly so in the West. Efforts are denoted by many terms including partnerships, councils, advisory groups, initiatives, committees, programs, or forums. Watershed councils or partnerships work to improve status quo conditions. Relationships between agencies and the watershed community were improved through these collaborative processes as indicated by better cooperation, coordination, and communication. In an evaluation of regional and local watershed partnerships in California and Washington, U. C. Davis researchers found that primary success factors included adequate time (duration of four years or more), interpersonal trust, and technical information regarding the watershed.

Community watershed activities, Arroyo Seco, Los Angeles County, California.

Multiple state programs fund local watershed activities, including assessment, planning, implementation, monitoring, outreach, and operational support. However, the majority of the available funding is reserved for project implementation. Many federal, local, and private sources of funding also benefit watershed partnership efforts.

Many watershed groups have also formed and are operating as collaborative partnerships. There are well over 100 watershed partnerships in California representing varying levels of activity. The number varies each year due to group disbandment and new formation. By their nature, such groups may be able to better involve the local landowners and the public. They are better able to define common problems and address solutions. Government agencies may be involved or even facilitate the process and provide funding, but the context is decidedly local.

During the last decade, many public education and awareness efforts have attempted to convey the concept of forest and rangeland sustainability to the public. At least 19 federal laws mandate federal agencies to maintain educational programs related to forest and natural resource sustainability, seven of which specifically concentrate on forests. There are multiple educational programs that cover aspects of forest sustainability as well. Both the federal and state governments significantly influence environmental education, including areas that relate directly to forests and rangelands. The nongovernment sector is also a major factor in the educational process. In addition, many educational programs exist as partnerships between the public and private sector.

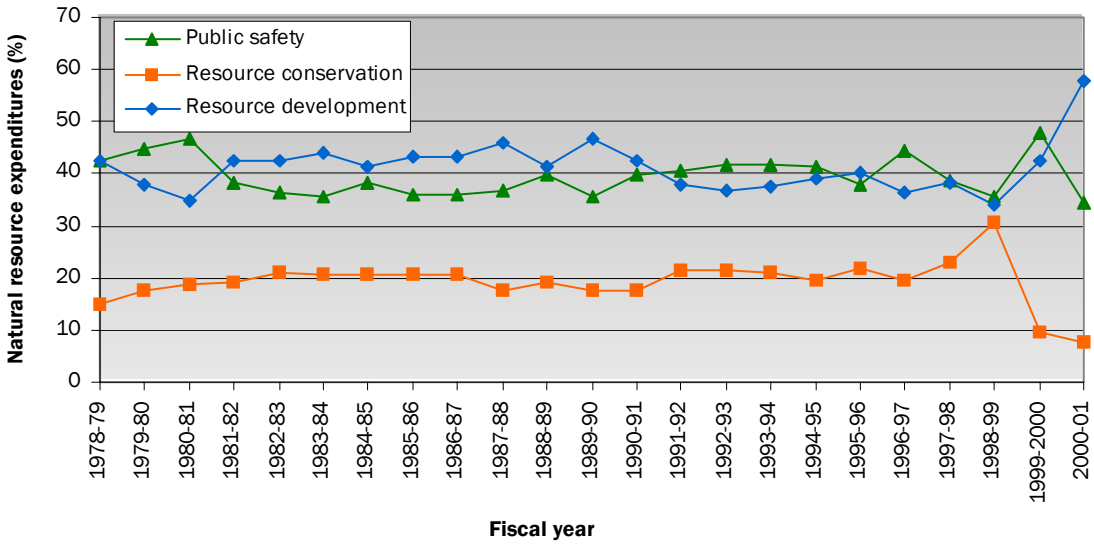
resources. Resource development focuses on lands, waterways, or other resources developed for recreational or economic use. Public safety programs focus on maintaining a safe environment for users of the resource and the resource itself. These include both hazard response and public education programs for emergencies or to prevent accidents.

No explicit study has been made to separate investment in forest and rangeland resources among the resource conservation, resource development, and public safety programs within the California Resources Agency. However, while expenditures in total nominal dollars for some programs that contain forest and rangeland elements have increased, forest and rangeland expenditures as a percentage of program spending has been stable (Figure 91).

Along with resource conservation, public safety and resource protection have been among the top two levels of state expenditure. Both the state and federal government make substantial investments in personnel and equipment to respond to wildfire. Federal and state agencies each spent over $200 million in 2002–03 for fire preparedness.

The state and federal governments also spend considerable funds to reduce the risk of wildland fire. California's Vegetation Management Program burns an average of 31,282 acres through 60projects. Following severe wildfires in 2000, the Secretaries of Agriculture and the Interior developed the National Fire Plan which is aimed at managing severe wildland fires, reducing fire impacts on rural communities, and ensuring effective firefighting capacity in the future. The National Fire Plan was developed to address five key points: firefighting, rehabilitation and restoration, hazardous fuel reduction, community assistance, and accountability. Under the plan, allocations for hazard and fuel treatments in California for fiscal year 2002 exceeded $67 million. Federal agencies targeted 143,673 acres with 71,213 of those acres in the wildland urban interface (WUI).

Figure 91. Percentage of annual natural resource expenditures on forests and rangelands within the California Resources Agency, by program category, 1978–2000



Source: Compiled by FRAP from PPIC, 2003 fide Silva, 2002

Policy Challenges and Options

Consistent with other recent forest assessments outside of California, this assessment frames the underlying forest and rangeland policy issues around sustainability. Defined by the Bruntland Commission Report, sustainability is "meeting the needs of the present without compromising the ability of future generations to meet their own needs." Assessing sustainability requires addressing social, economic, and environmental dimensions with respect to our forests and rangelands. To be most effective, policies must consider crosscutting actions that simulatneously address the broad criteria that encompass sutainability.

By law, the next step is for the California State Board of Forestry and Fire Protection to use this assessment to draft a Forest Policy Statement. Then, the Board must hold hearings on both the Assessment and the Policy Statement.

The Assessment ultimately raises the question of whether existing institutions can deal with the complexity of California's forest and rangeland resources. The challenge is to integrate these issues into a cohesive policy that works toward common ends.

Policy Challenges and Options for California's Landscapes

To promote sustainability, policies must address the environmental, economic, and social dimensions of forests and rangelands (Figure 92). Sustainable forest conditions must simultaneously address a wide range of habitats and species, maintain productive lands, protect soil, water, and air quality as well as improve social well being.

Forest policies that deal with uncertainty and promote sustainability will play out differently based on land management and use patterns throughout California's forests and rangelands. Policies must also be tailored to the unique spatial characteristics of the problem, from small watersheds to large bioregions. At various levels of spatial resolution, a number of landscape classifications with similar current and potential management options can be used to more accurately define the key challenges and options. The basic landscape types are Urban, Agriculture, Working, and Reserve. The Working Landscape is further broken up into Private, Public, Rural Residential and Sparsely Populated subcategories.

The Assessment identified a number of general challenges that occur in one or more landscape classes at the same time and are often connected by direct proximity or shared components (Figure 93). Policies and solutions must consider the wide variety of ownership patterns, management goals, and constraints that occur in each of the landscape classes for overall landscape-level goals to be achieved. In most cases, a mix of management actions (e.g., stewardship, protection, restoration) will be required in each class to address the challenges. Typical concerns of each landscape follow.

Figure 92. Components of forest and rangeland resource sustainability

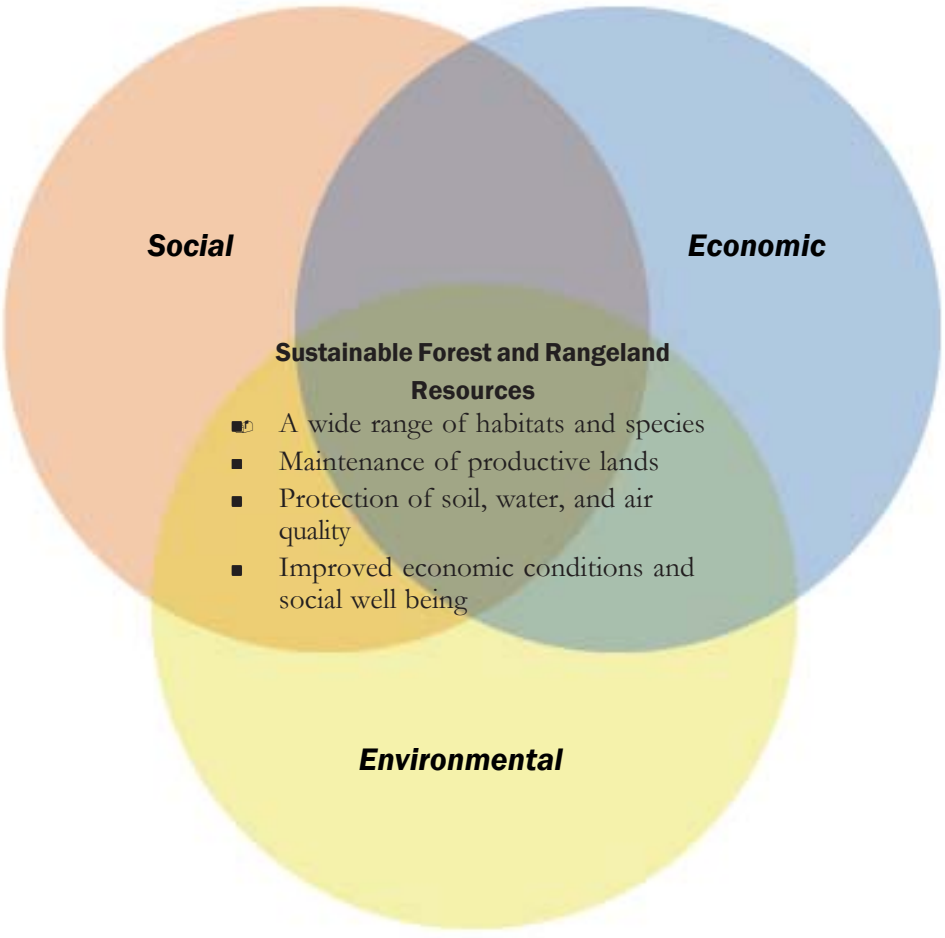


Figure 93. Policy challenges and landscapes

	Challenges	Landscapes Affected by Challenges
1 Biological diversity	Gaps in Wildlife habitat structure Decline in some native species Using all landscapes to meet biological diversity goals	
2 Productive capacity	Declining land base and administrative withdrawls of land available for timber and range production Risks and impacts from increased forest stocking levels Decline in rangeland area and availablitiy	*Urban*
3 Forest health	Managing forest structure for productivity, habitats, and forest health goals Management of metropolitan and interface forests and rangelands Public understanding of management practices Forest and rangeland conversions Fuels buildup risks to ecosystem and human assets Elevated pest damage related to forest stocking levels Emerging pest and disease threats to unique habitats and livestock health Impacts of exotic and invasive species to biological diversity and rangeland productivity Increasing air pollution in several regions	*Agriculture* *Metropolitan* *Rural Residential*
4 Soil conservation and water quality	Improve watershed condition Fish habitat restoration Measure cumulative watershed impacts from multiple users	*Working/Private*
5 Forests and climate	Understanding and responding to climate change	*Working/Public*
6 Socio–economic well being	Rising consumption and statewide limitations on California commodity output Meeting changing demands for recreation and open space Meeting costs of resource protection Incentives for private production of ecosystem services Maintaining large landholdings in resource industries Weak economies in rural communities	*Reserves*
7 Governance	Complexity of regulatory oversight Limited policy integration Conflicts over forest and rangeland management practices Coordination in research and information sharing Standardized, comprehensive information systems	

Urban

The physical concerns for forest and rangeland resources in urban areas are usually related to street trees, "green" neighborhoods, urban parks and landscapes, urban stream systems, gardens, and botanical reserves. Wood and wood waste recycling and composting are also importsnt resource issues. Urban areas are the primary end users of natural resource products. Water conservation, reduced consumption, and recycling are all examples of strategies to reduce demands on natural resources.

Management concerns include reduction of fuel hazards where wildfire is a concern, flood control, planting and maintenance of street trees and landscapes, pest control, stream restoration, preservation of old trees, provision of additional urban "green" space and recreational opportunities, and promoting wood recycling programs and technologies.

Metropolitan forests and rangelands near Mount Diablo.

Metropolitan Forests and Rangelands

One other category has been developed in the Assessment to account for the unique importance of lands near urban areas. Metropolitan forests and rangelands refer to the forests and rangelands within the urban area and its six-mile surrounding buffer. This region contains a wide variety of Management Landscape classes. Primary public concerns in metropolitan forests relate to lifestyle amenities such as open space, regional parks, protection of landscapes, and provision of outdoor recreation. Public safety issues such as downstream flooding and protection from wildfire are also critical. Commodity production such as grazing or timber management continues on a constrained basis with higher costs than in more rural areas. Impacts of management on water supplies, traffic, and noise are of concernin some places. Watershed and habitat protection typically receive increased management attention. Heightened public interest and values in metropolitan forests and rangelands can create the paradox of greater economic pressure to convert to more intensive land uses.

Key challenges in metropolitan forests and rangelands will relate to the provision and management of open space, protection from flooding and fires, management of regional park watersheds and vegetation, and pest control. Resolving issues between neighbors and landowners that continue to produce commodities will remain an important challenge.

Agriculture

The agriculture classification refers to areas that are devoted to irrigated agriculture and are not forests and rangelands. This includes intensive agriculture such as row crops, vineyards, orchards, and irrigated pasture. It is significant to forest and rangeland policies for a number of reasons. First, while these lands have historically absorbed much of the development pressure, a growing proportion of development will occur on rangelands in the coming decades. Second, a significant source of loss of rangelands has been conversion to agricultural uses such as vineyards while the conversion of forests to rangelands has decreased. And third, irrigated pasture plays a significant role in feed for beef cattle and other livestock that also use rangelands.

Policy concerns in this class relate to the fiscal stability of farms with range and forest components, the conversion of rangeland to development, and the habitat impacts of expanding irrigated agriculture into forests and woodlands. Another secondary concern is that livestock disease that starts in dairy herds can spread to beef cattle, so continued attention is necessary to overall livestock health programs.

Development pressure on coast live oak groves, Arroyo Grande. Photo by Roland Muschenetz..

Rural Residential

Roughly half of the eight million acres of California used for residential or commercial purposes has less than one structure per acre. These low density, or rural residential, areas maintain considerably more of the natural vegetation than urban or suburban development but still fragment the landscape with structures, roads, and active use. These uses often diminish the value of the lands for many animal and plant species sensitive to human activities. The motivations driving the conversion of land to low density residential use include the new resident's desire to live away from more densely populated urban areas, a rural lifestyle, a chance for a part-time "hobby" farm, more solitude, and open space. To individual property owners the transformation is beneficial to them even if it may reduce value related to the previously less fragmented forests or rangelands.

Commodity production such as timber harvesting and grazing often continues on a limited basis compared to less fragmented areas. In addition to the values appreciated by the owners these lands also provide considerable open space and recreational values to non-owners who live nearby or visit the areas. Conflicts over management activities that affect water supplies, visual aesthetics, traffic, and noise are typically higher in rural residential areas than in less fragmented areas. The importance of adequate infrastructure to protect public safety and provide emergency services also increase.

Some of the most serious challenges in recent years are related to the increasing number of homes in the wildland urban interface at significant risk from wildfire. In many areas pests and diseases such as eucalyptus borer, bark beetle, and sudden oak death are increasing the number of dead trees and increasing wildfire risks. The design and implementation of socially appropriate resource management activities to reduce fire risk are generating concerns that both too little and too much is being undertaken.

Working/Private

Working/Private landscapes are those lands in private ownership with sparse housing density (less than one unit per 20 acres). They are used for a variety of purposes with commodity production often as the primary focus. These areas, where the role of private investment for production of energy, lumber, and livestock is coupled with supportive policy tools can potentially play the biggest role in maintaining lands in an unfragmented condition. In addition, these areas still provide for habitat restoration or management, recreation, and dispersed living space. These areas provide significant traditional ecosystem services as complements to the primary revenue producing management goals. A number of these lands, especially near urban areas or key ecological resources, could be protected directly from residential development through various types of easements.

Management concerns in these areas vary. Larger ranchers and timber growers face limited profitability and a variety of production constraints. Smaller landowners with significant portions of the private forest and rangeland resources have more diverse objectives and have fewer management resources to deal with increasingly complex challenges. Wildfire remains a threat to landowners, as do some pests and exotics. In some locations, downstream flooding is an important issue to residents.

Communities reliant on these lands also have experienced decline in the number of jobs based on resource-based industries. The overall economic base has diversified in most areas and the social well being in rural areas tends to be good. However, a number of the more rural communities face difficulties in their ability to provide jobs, programs, and infrastructure.

Perhaps more than any other category, the largest number of issues outlined by the Assessment will apply to the Working/Private class. This is because the land area is so large, more closely tied to commodity production, and often receiving limited attention from local government.

Working/Public

The Working/Public landscapes are those lands in public ownership with sparse housing density. For the most part, these are federally owned and managed more for ecosystem restoration and services, recreation, and habitat than are comparable private lands. Commodity production is still significant, especially on the most productive lands. Furthermore, by the nature of their public ownership, most of these lands are protected from conversion from development.

The focus of issues on these lands relates in part to location and in part to the category of concern. For example, day-use recreation is paramount in southern California where four national forests are within easy driving distance of millions of people. Conversely, concerns over protecting endangered species and old growth forests are relevant to California and citizens across the United States.

Past management legacies, wildfire, exotics, and pests are ongoing concerns to public forest and rangeland managers. Reducing fire hazard near communities is a focus of the recent National Fire Plan. These efforts are likely to expand. Public agencies continue to restore watersheds and habitat with budget restrictions. Public conflict will most probably continue over the goods and services produced from public lands.

Reserves

Reserves are permanently protected from conversion of natural land cover and have mandated management plans in operation to maintain ecological processes or a primarily natural state. They are often established through acts of legislation and examples include national parks, federal and state wilderness areas, and the University of California Natural Reserve System. State parks also often have reserve functions in addition to their recreational uses. Lands are acquired through a variety of funding sources— federal, state, joint federal-state, local funding, and non-profit conservancies. Conservancies are a small but growing part of California's strategy to acquire and manage key land resources either in full or through limited purpose easements.

Selective additions to the Reserve system may be necessary to protect wildlife and fish habitat, scenic vistas, and unique habitats. Policy questions relate to how this can be accomplished with limited funding and how differences in opinion can be resolved about the size of reserve systems necessary for the habitats or ecosystem types in most in need of protection.

Tools for the Working Landscape

A wide variety of tools are available in the policy tool box to address the challenges on forests and rangelands. In many cases, more than one tool can be used. While not exhaustive, examples are suggested for each policy challenge for lands in the Working Landscape (Figure 94). Still further detail is possible, such as focusing issues on specific categories of the landscape or geographic locations like bioregions, counties, or watersheds. However, since the possibilities are nearly unlimited, additional details await guidance from the California State Board of Forestry and Fire Protection.

Figure 94. Tool box for the Working Landscape

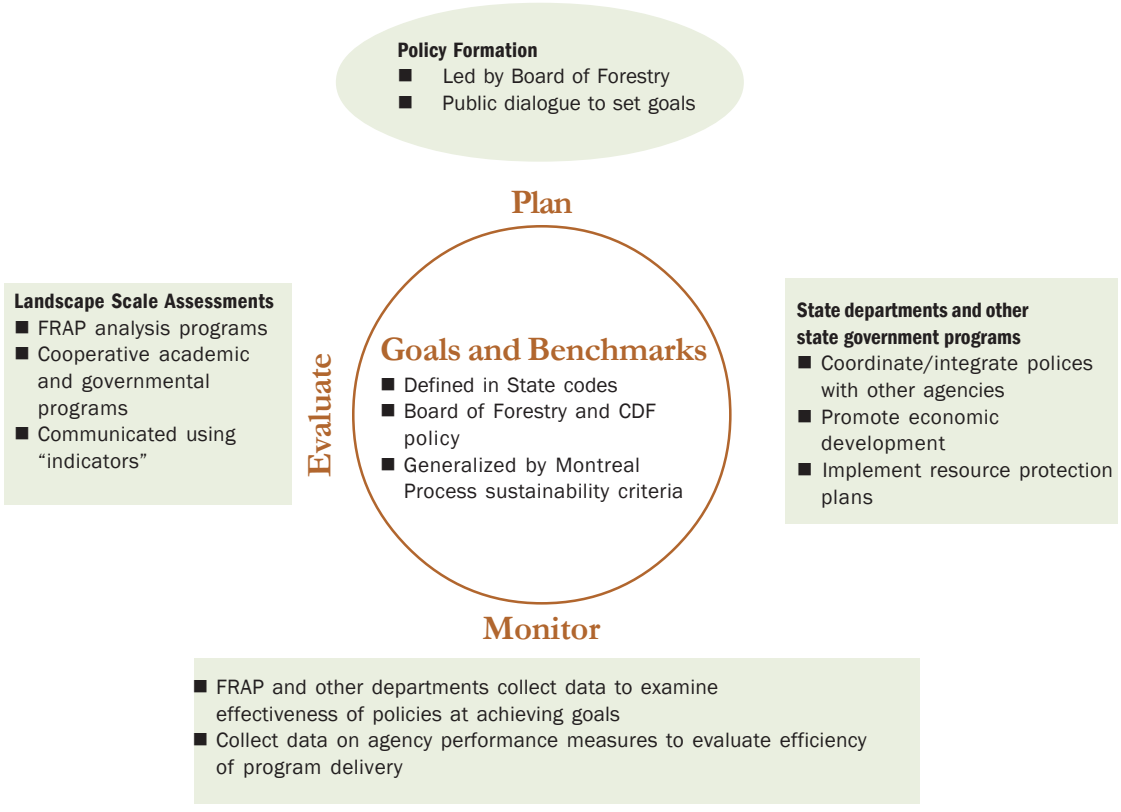
Detailed Policy Goals and Benchmarks, Challenges, and Options

The process used in this Assessment leading to development of forest policy incorporates the Continuous Improvement Cycle concept, a fundamental part of total quality management (Evans and Lindsey, 1996). The basic premise is that by measuring conditions and comparing them to benchmarks, deficiencies can be identified and new policies can be developed to improve conditions.

To some extent, FRAP has completed two parts of the cycle. It has collected information (**Monitor**) and used indicators to measure (**Evaluate**) the status and trends of forest and range conditions important to sustainability (Figure 95). The next parts of the cycle are to compare the findings to current goals (**Benchmarks**) and adapt policy to respond to conditions (**Plan**). The final part is to implement new policy (**Act**), including the use of adaptive management plans that focus on experimental actions while closely monitoring results.

After reviewing the findings of the suite of indicators, several observations can be made regarding the most prominent challenges facing California's forest and rangeland resources. These challenges were identified in part by comparing the status and trends findings to goals established in state law or policy, or by the Montréal Process Criteria themselves. The intent of comparing forest and rangeland resource status to goals and sustainability criteria is to help identify the most obvious conditions that deviate from established benchmarks. This provides the opportunity to bring forward the most pressing challenges and begin the discussion on changes needed to existing policies and programs to help correct undesirable conditions and trends. Complete discussion of the most prominent policy challenges follows.

Figure 95. Using the Continuous Improvement Cycle in the 2003 FRAP Assessment



Adapted from the Oregon Department to Forestry " Changes in the 2003 Forestry Program for Oregon"

Biological Diversity

Goals and Benchmarks

- Conserve, protect, restore, and enhance any endangered species or any threatened species and its habitat (California Fish and Game Code, Section 2050).
- Protect and preserve all native species of fishes, amphibians, reptiles, birds, mammals, invertebrates, and plants and their habitats, threatened with extinction, or those experiencing a significant decline which, if not halted, would lead to a threatened or endangered designation (California Fish and Game Commission Policy on Endangered and Threatened species).
- Encourage the preservation, conservation, and maintenance of wildlife resources…to maintain sufficient populations of all species of wildlife and the habitat necessary to achieve beneficial use and enjoyment of wildlife, intrinsic, and ecological values, and to provide for economic contributions to the citizens (California Fish and Game Code, Section 1801–1802).
- Protect forest lands and aquatic resources by focusing on protection of wildlife habitat, rare plants, and biodiversity; maintenance of habitat connectivity and related values; protection of riparian habitats, oak woodlands, ecological old growth forests, and other key forest types and seral stages that are poorly represented across landscapes and regions {that} support biodiversity and maintenance and restoration of natural ecosystem functions (California Public Resources Code, Section 12210, California Forest Legacy Program Act of 2000).
- The hardwood resources of California should be managed for the long-term perpetuation of their local and broader geographic representation and to continue to provide for their inherent natural and biological values and processes. These values and processes may include, but are not limited to, regeneration, plant species composition, vegetation structure and age class distribution, water quality, and other biotic and abiotic resources (California Board of Forestry and Fire Protection Joint Policy on Hardwoods).
- Acquire and restore to the highest possible level, and maintain in a state of high productivity, those areas that can be most successfully used to sustain wildlife, and which will provide adequate and suitable recreation (California Fish and Game Code Section 1301, Wildlife Conservation Law of 1947).

Policy Challenges

Wildlife habitat structure gaps

California retains over 85 percent of its presettlement era natural landscapes. While expansive natural areas are still intact, some habitats have diminished by over 60 percent in some regions.

California has a wide variety of forest structures. However, uncertainty remains over the amount and arrangement of successional stage structure and special habitat elements required to sustain diversity. Several unique habitats, such as low elevation riparian forests, are at a small percentage of their original distribution. Old growth forests have limited current total extent (14 percent of all conifer forests) compared to higher levels that existed centuries ago. Current structural profiles indicate extensive dense forest structures with areas of large trees abundant (31 percent of conifer forest land). These dense forests are capable of both providing some of the attributes of old growth forests in the near term as well as the ability to grow into old growth forests in the long term.

One of the greatest concerns about the conservation of biological diversity on forests and rangelands is low density housing, called parcelization. This currently affects 3.2 percent of forests and rangelands and will expand over time. These lands are at high risk to additional development, further altering habitats and possibly degrad-

ing resources. Several bioregions have substantially higher levels of parcelization with the highest current levels in the South Coast and Sacramento Valley bioregions, affecting more than 10 percent of forests and rangelands. All regions, however, still have significant areas in Working landscapes.

Decline in some native species

Regulatory listings of threatened and endangered species are continuing to rise, particularly in plant and fish species. While population numbers of many species are stable, some large mammal species, bird species, and amphibians considered common in forested habitats are showing decreasingly stable populations.

Using all landscapes to meet biological diversity goals

Management patterns of forests and rangelands include 23 percent in Reserve status, where management objectives are oriented towards ecological protection and other non-consumptive recreation values. The remaining 77 percent are in the Working status, lands managed for wide range of ecological and commodity uses. Specific habitats with low areal extents and at risk from land use impacts are of particular concern

High public costs of acquisitions and high private costs of use restrictions impede development of effective reserve scenarios; uncertainty of how to assess value of working landscape increases uncertainty for sustainable management. The Working landscape is expected to supply increased ecosystem services at expense of production and profitability.

The high public cost of new acquisitions and the high private cost of new uncompensated use restrictions limit the cost-effectiveness of many current approaches. More innovative and equitable approaches to promote the positive role of the Working landscapes in providing ecosystem services are necessary.

Policy Options

Policy options for wildlife habitat structure gaps

- Provide incentives for creation of open canopy and late seral stage habitat on non-federal lands.
- Strengthen analysis of cumulative impacts of land uses on terrestrial habitat.
- Improve mapping and monitoring technologies and systems.
- Strengthen collaboration between regulatory agencies, and public industry in addressing wildlife habitat concerns.
- Use long-term plans for larger scale analysis and monitoring schemes.
- Expand and focus use of conservation easements and incentives.
- Develop focused research program on State Forests for wildlife habitat.

Policy options for decline in some native species

- Continue to develop HCPs, NCCPs, or other long-term plans that provide for landscape level analysis, protection, and resource use.
- Develop additional reimbursement mechanisms that preserve habitat.

Policy options for using all landscapes to meet biological diversity goals

- Recognize the continuing importance of ecosystem services from the Working landscape and support innovations in approaches.

Productive Capacity

2 Goals and Benchmarks

- Achieve Maximum Sustainable Production while maintaining other values (Z'Berg-Nejedly Forest Practice Act).
- Maintain prime timberland; promote establishment of growing stock; balance of timber size classes; diversity of quality characteristics; more efficient utilization (California State Board of Forestry and Fire Protection Handbook, Chapter 0334).
- Insure that a cover of trees of commercial species, sufficient to utilize adequately the suitable and available growing space, is maintained or established after timber operations (California Public Resources Code, Section 4561–4563.5, Z'Berg-Nejedly Forest Practice Act).
- Improvement of brush covered lands through site selection, clearing, and revegetation (California State Board of Forestry and Fire Protection Handbook, Chapter 0335).
- Encourage use of range improvements designed to enhance fire hazard reduction, stabilization of soil, water conservation, and betterment of game habitat (California State Board of Forestry and Fire Protection Handbook, Chapter 0335).

2 Policy Challenges

Declining land base and administrative withdrawls of land available for timber production

California has 7.3 million acres of private timberland, of which 5.4 million acres are classified into the Timberland Production Zone (TPZ). Larger TPZ owners form the category most likely to grow and harvest timber on a continuing basis. Smaller owners are much more varied and many hold timberlands for non-timber growing reasons. Increased planning requirements, operational limitations, and habitat protection have all increased the expense of timber growing on private land, potentially making conversion a more viable option.

The private land base capable and available for timber production (timberlands) is slowly declining due to conversions to non-timber uses such as housing, agriculture, and roads. Approximately 76,000 acres have been converted between 1984 and 1994. In addition, over 170,000 acres have been statutorily withdrawn (devoted to wilderness, parks, and monuments) between 1984 and 1994.

From a statewide perspective a much greater area of timberland has become "unsuitable" due to federal managment plan designations that substantially limit timber production on their 10 million acres.

Risks and impacts from increased forest stocking levels

Private timberland growing stock volume has increased by 16 percent between 1977 and 1997, following a period of decline between 1950 and 1977. Periodic growth of trees on private timberlands now far exceeds harvest levels. Harvests been 64 percent of growth between 1984 and 1994, indicating increasing inventories and sustainable levels of resource use. Private harvest levels for the 2000–2002 period have continued to decline compared to the 1984–1994 period. Growth now far exceeds harvest levels across all ownerships, especially on federal lands. In some areas, this pattern has led to an increasing inventory of unutilized timber and dense forest stands. In addition to the unrealized opportunity to

sustainable generation of wood products for society, overstocked forests can have increases in pests susceptiblity and fire risk as well as loss of biological diversity values for species dependent on open, less dense forest settings.

Declining Rangeland Base

One factor affecting the productive capacity of rangelands is the declining rangeland base. This results both in less land available for grazing and reduction in other ecosystems services derived from rangelands. Such factors as conversion of lands to other uses, parcelization of larger lands into smaller lots associated with rural residential development, administrative withdrawals, management plans directing use away form riparian areas, and decreased grazing allotments on public land, all contribute to a limitation of the land base available for grazing.

Approximately three-quarters of a million acres of non-federal rangeland have been converted to other uses between 1982 and 1997 (NRCS, 2000), with projection of an additional two million of rangeland development by 2040, primarily in the Sierra foothills and southern California. Millions more have been administratively withdrawn on public lands, and grazing permit issuance on public lands continues to decline. Additionally, in some bioregions, over 10 percent of rangelands are parcelized with rural residential housing further constraining use and indicating possible denser development to follow.

Ecological limitations to rangeland use

Productive capacity of lands to support grazing, wildlife, and related uses has been degraded by several factors. These include exotic species invasion, changes in ecological functions such as wildfire cycles and climate alteration, introduction of diseases that threaten livestock, and non-sustainable types of grazing pactices. The spread or colonization of exotic plant species outside their historic distribution is an indicator of rangeland health and trends in productivity. Successfully established invasive exotics often expand rapidly due to lack of natural controls. Because they displace native species and alter ecosystem functions, the occurrence of exotics in California rangelands has significant ecological and economic consequences affecting productive rangeland management.

A significant example of the limitations on ecological conditions is the introduction of cheatgrass (*Bromus tectorum*) in much of the sagebrush steppe of northeastern California. This has reduced the perennial grass component and altered the influence of fire on shrub species. Another illustration is the expansion of the conifer woodlands into grasslands of northern California caused by fire exclusion, overgrazing of livestock, and wetter climatic conditions. A third example is the decline of aspen stands throughout the Sierra bioregion due to the lack of fire and other disturbances which foster aspen propagation and establishment.

2 Policy Options

- Consider alternative land trust arrangements that retain the productive capacity of forests and prevent either conversion to non-timber uses or full administrative/regulatory exclusion from timber management.
- Increase active management in forest stands at highest risk due to increased stocking levels. Prioriization of management activities can coincide with meeting other objectives such as fire reduction near urban areas or adaptation of stands to meet biological diversity needs.

Forest Health

3 Goals and Benchmarks

Land Management Activities

- Enhance productive capacity of soils, stock and increase growth of young stands, fully use mature stands and mortality from young stands, and encourage efficient harvesting and processing of wood products (California State Board of Forestry and Fire Protection Handbook, Chapter 0334).

- When producing socially desirable commodities and services, assess impacts and consider alternatives (California Public Resource Code, Section 21050).

Land Development

- Maintain optimum amount of timberland (California Timberland Productivity Act of 1982).
- Discourage urban expansion into timberland and conversion (California Timberland Productivity Act of 1982).
- Timber operation shall not be restricted due to lands use changes (California Timberland Productivity Act of 1982).
- …protect California's land resource, to insure its preservation and use in ways which are economically and socially desirable in an attempt to improve the quality of life in California (Government Code Section 65030, Declaration of State Policy and Legislative Intent for the Environmental Goals and Policy Report).
- Support and encourage voluntary, long-term private stewardship and conservation of California's oak woodlands to promote biologically functional oak woodlands over time and protection of oak trees providing superior wildlife values on private lands (California Fish and Game Code Section 1362, Oak Woodlands Conservation Act).

Wildfire

- Create unit operation fire control plans that make direct immediate and aggressive continuing attacks on all unwanted fires in or threatening state responsibility areas (SRA) (California State Board of Forestry and Fire Protection policy memos and CDF Handbook, Chapter 0340).
- Implement environmental modifications as the most effective means for reducing conflagration by applying fuels reduction and fire defense improvements in land use planning (California State Board of Forestry and Fire Protection policy memos and CDF Handbook, Chapter 0340).
- …classify lands within SRA in accordance with the severity of fire hazard present for the purpose of identifying measures to be taken to retard the rate of spreading and to reduce the potential intensity of uncontrolled fires that threaten to destroy resources, life, or property (California Public Resources Code Section 4201, Article 9. Fire Hazard Severity Zones).

Pests and Disease

- Maintain forest resources from damage from wildfire and natural enemies (California State Board of Forestry and Fire Protection policy memos and CDF Handbook, Chapter 0352).
- Promote health and vigorous conditions to minimize losses from pests; provide advice to assist landowners on manipulation of forest competition (California State Board of Forestry and Fire Protection policy memos and CDF Handbook, Chapter 0352).
- Obtain expeditious control of potentially devastating pests. (California State Board of Forestry and Fire Protection policy memos and CDF Handbook, Chapter 0352).
- Expand the current efforts to slow the spread of sudden oak death (Public Resources Code, Section 4750.1).

Exotic and Invasive Species

- Control the introduction and spread of exotic plant and animal species (California Fish and Game Code, Section 2116 to 2160).
- Ensure that the potential effects of introductions (of exotic species) will not have unacceptable negative impacts on native species, agriculture interests, and public health and safety (California Fish and Game Commission policy on Endangered and Threatened Species).
- The destructive impact of invasive and often poisonous noxious weeds is profound, affecting California's cropland, rangeland, forests, parks, and wildlands. Control programs' goals for noxious shall include, increasing the profitability and value of cropland and rangeland; decreasing the costs of roadside, park, and

waterway maintenance; reducing the fire hazard and fire control costs in the state; protecting the biodiversity of native ecosystems; maintaining the recreational and aesthetic value of open space, recreational, and public areas (Food and Agricultural Code Sections 7270 and 7272.5).

Air Pollution

- Promote and protect public health, welfare, and ecological resources through the effective and efficient reduction of air pollutants while recognizing and considering the effects on the economy of the State (Mission of the California Air Resources Board).
- Coordinate efforts to attain and maintain ambient air quality standards, to conduct research into the causes of and solution to air pollution, and to systematically attack the serious problems (California Health and Safety Code, Section 39003).
- Control and eliminate air pollutants for the protection and preservation of the public health and well being, and for the prevention of irritation to the senses, interference with visibility, and damage to vegetation and property (California Health and Safety Code, Section 43000).

3 Policy Challenges

Land Management Activities

Managing forest structure for productivity, habitats, and forest health goals

Forest structure is the major determinant of productivity, habitats and forest health. Outside of national parks and wilderness areas, the majority of California's forests have been managed for decades explicitly for commodity production with very effective fire suppression. Forests within national parks and wildnerness areas have also been affected by fire suppression. Forest management through the manipulation of stand structure, regeneration, and forest fuels (especially surface fuels) will need to integrate the multiple goals of long term forest productivity, the provision of diverse wildlife habitats, and the promotion of forest health.

Management of metropolitan forests and rangelands

Metropolitan forests and rangelands, the six-mile interface of forest and rangelands and urban areas, are the most viewed forest and rangeland landscapes in the state. The mix of land uses near metropolitan and denser rural areas provides both limits and opportunities for forest management. Major risks to loss of habitat are from fire, pests, and development. While commodity production may be limited, there is significant production of ecosystem services. Because of the often-intensive public uses near these areas, issues include potential risks for soil loss and water quality degradation, a high variety of uses, the reduction of open space, and damage from wildfire, and pests, and public safety. Working/Private forests and rangelands represent a large component of these areas. The long-term continuation of social amenities within metropolitan forests depends on the economic feasibility of continued commodity-based land management in Working/Private forests and rangelands.

Public understanding of management practices

Management activities, such as logging, grazing, and water withdrawals can diminish ecological values due to simplification of habitats and impacts on water quality. This is true whether it occurs in a specific place, anywhere in California, or another state or country. The same forests and rangelands where natural resource management occurs also provide considerable ecological and social values that could be totally lost if converted to intensive urban or agricultural uses.

Forest management as a tool to meet economic and social values will continue to raise public concerns especially when it occurs near communities with limited exposure to resource management. In many cases, some degree of forest managment will often be the most effective tool to achieve goals such as fire risk reduction, willife habitat improvments,m or control of invasive species.

Land Development

Forest and rangeland conversions

Development is a significant driver to loss and degradation of native habitat. This impact is likely to come from outright loss of natural land cover to urbanization and degradation of continuity and structures through increases in low housing density (parcelization). Other impacts related to development include reduced water quality and loss of open space that contributes to quality of life.

Over the past 15 years, 933,000 acres of non-federal forests and rangelands have been converted to urban or other uses (NRCS, 2000). Over the next 40 years, approximately 10 percent of the current forest and rangeland base (2.6 million acres) are projected to be impacted by development (high density urbanization and low density parcelization). This loss is similar to the past 15 years and over this period will exceed projected loss to agricultural lands.

Certain forest and rangeland habitats may be more affected by development. Hardwood Woodlands, Shrub, and Desert land cover types are likely to be most impacted. The South Coast, Sierra, and Mojave bioregions are projected to have the greatest extents and percentages of the land base affected.

Impacts to losses of forests and rangelands affect the full spectrum of sustainability criteria. Ecosystem services such as maintenance of biological diversity and soil and water quality are impacted via habitat loss, simplification, fragmentation, and loss of water-related ecosystem services. Productive capacity impacts relate to loss land base from which to socio-economic commodities. Well being impacts include localized economic impacts, loss of open space, and export of environmental damages to commodity producing regions outside the State.

Wildfire

Fuels buildup risks to ecosystems and human assets

Wildfire and prescribed fire (purposely set fire) has a dual role in California. Wildfire can destroy valuable resources and property and degrade our quality of life through smoke and negative visual impacts. On the other hand, it provides an essential ecological function by cycling nutrients, modifying habitat for wildlife, and increasing forest health by decreasing woody material making forests less susceptible to pest, disease, drought, and pollutant stresses.

With current levels of fire at a fraction of the amount of the presettlement era, the nature of fire has also changed to one of less frequent, more intense fires.

The combination of successful suppression efforts, limited prescribed fire, and some management legacies have led to high levels of fire threat to many natural and human assets. It is currently estimated that 48 percent of the State has vegetative conditions promoting Very high or Extreme fire threats.

Several ecosystems are at high risk to intense fire resulting in destabilizattiopn of biological diversity and ecological functions such as water cycling and soil productivity. Most forest and rangeland bioregions have 60 to 80 percent of their natural vegetation at high risk to ecological damage from wildfire.

Human health, quality of life, and human assets (houses and property) are also at risk from wildfire. Over 7.8 million acres are in the wildland urban interface (WUI), including nearly 3.2 million homes that are highly threatened by wildfire. The Sierra bioregion has the most area of WUI at significant risk and the South Coast bioregion has the most homes threatened.

Pests and Disease

Elevated pest damage and risk related to high forest stocking levels

Pests and diseases are natural processes when operating in normal historical ranges or low levels. They perform necessary roles in ecosystem processes such as pollination, nutrient cycling, and thinning of overstocked forests. Elevated levels of pests and diseases create economic losses to timber, reduce aesthetic qualities, and can affect biological diversity by shifting structures and composition that favor one species over another.

Peak levels of mortality from insects to conifer forests have declined since the early 1990s where five to 10 percent of many forest stands were destroyed. Low levels of mortality are typically less than one percent damage per year in forested areas. Recent combinations of drought stresses and vegetation stocking and decadence have resulted in very high levels of mortality,

often over 50 percent in the San Bernardino and Peninsular ranges of southern California.

Management actions have an important affect on future levels of pest damage. Of particular concern is where overstocked forest lands make trees less vigorous and susceptible to drought and insect damage. In the next 15 years, over 15 percent of the conifer forest in the State are at risk to pest damage due to overstocking. Some bioregions, including the Modoc and South Coast, have approximately 25 percent of the conifer forest at risk.

Emerging pest and disease threats to unique habitats and livestock health

Emerging pest concerns involve introduction of new, often exotic pest that have potential for impacting biological diversity by destroying unique host habitat. These pests and diseases include sudden oak death (SOD), which affects coast oak woodland habitat in the Bay Area/Delta bioregion, eucalyptus borer which is prevalent in the urban South Coast bioregions, and Pitch canker, which affects closed cone pine habitats of the Bay Area/Delta and Central Coast bioregions.

Exotic and Invasive Species

Impacts of exotic and invasive species to biological diversity and rangeland productivity

Invasive non-native species alter ecosystem structure, composition, and processes and out-compete and exclude native plants and animals. Effects also include changing ecosystem function by changing disturbance regimes such as frequency and intensity of fire, altering hydrologic cycles, and increasing soil erosion rates.

Invasive species also have a considerable effect on the productive capacity of forests and rangelands through diminished production or increased costs for control. Economic impacts to range resources include reduced forage production and increased road maintenance costs.

Over 76 non-native invasive plants are found to have impacts on forest and rangeland resources in California. 42 of these are of greatest concern because of their ability to aggressively spread and cause higher levels of impact to biological diversity. Regional presence of non-native invasive plants show high numbers of the most detrimental species are found in the Bay Area/Delta, South Coast, Central Coast, and Klamath/North Coast bioregions.

Non-native animal species are of major concern to biological diversity. Overall, approximately 14 percent of California's animal species (terrestrial and aquatic vertebrate) are established non-natives. Introduction of non-native fish species is considered one of the three main reasons (habitat change and over-fishing being the other two) for the endangerment or extinction of what once were some of the most abundant native fish species in aboriginal California. Introduced fish make up 53 of California's 120 freshwater species.

Increasing air pollution in several regions

Air pollutants are readily generated and transported to forests and rangelands throughout many air basins. Recent trends suggest high levels of air pollutants are likely to continue in several air basins in the southern and eastern portions of California where urban activity, transportation, and agricultural pollution sources generates waste that is transported via westerly wind flows.

Regions of most concern for air pollution impacts are those that most recently have shown trends toward increasing levels of air pollution. These include the San Joaquin, Sacramento, and southern portions of the Mountain Counties' air basins.

Ozone, combined with other stressors such as drought, makes forest resources more vulnerable to disease, fire, and pests. The southern Sierra Nevada mountain forests are very susceptible and have a considerable amount of affected areas. Ozone damage to forests and woodlands reduces growth and can increase tree mortality.

3 Policy Options

Land Management Activities

- Maintain support for urban forestry and stream restoration programs.
- Enhance cooperation between agencies and groups with an interest in metropolitan forests.
- Retain strong fuel reduction, fire protection, and pest control programs.
- Improve reporting of activities, such as acquisition of open space, to a statewide database.
- Enhance curriculum focus on metropolitan forest issues in forestry schools.
- Focus on achieving agreement on desired landscape goals and then address potential practices and conflicts.
- Learn from experiences of The Nature Conservancy, other non-profits, and regional parks on how to explain management needs.
- Review role of environmental certification in providing for broader acceptance of management tools.
- Provide for public input into decision making and monitoring.
- Strengthen skills of resource professionals regarding public involvement and public values.
- Continue strong support for focused management practices, such as fuel reduction and control of exotics and pests.

Land Development

- Maintain tax-related zoning.
- Focus part of local general plans and related project design on integration and protection of productive areas.
- Increase use of easements and land banks.
- Anticipate growth areas and focus them away from the most productive forests and rangelands.

Wildfire

- Maintain support for Fire Safe Councils.
- Expand support for biomass industry based on its public values such as reduction of fuels and forest wastes.
- Strengthen fuel breaks and other fuel related parts of project design in land use plans.
- Increase funding for pre-fire projects.
- Develop arrangements for long-term fuel supplies from federal lands.
- Maintain research funding for utilization of small logs, biofuels, etc.
- Continue to work with California Air Resources Board regions to meet air quality standards and maintain sufficient burn days.
- Streamline environmental review processes related to fuel reduction.
- Balance investment priorities between areas with many acres of significant fire threat (Sierra and Modoc) with regions of few acres but many houses threatened.
- Substantial investment will be required to reintroduce fire into the forests and rangelands to manage threats to ecosystems and people. These investments include information systems to support planning and decisions, site specific and regional project planning, implementation of burning operations, and implementation of mechanical vegetation operations aimed at reducing hazardous fuel build up.

Pests and Disease

- Maintain and improve early detection capability.
- Develop overall plan to guide forest and rangeland pest research and control, including public involvement.
- Expand research on control methods.
- Maintain California Department of Food and Agriculture quarantine capacity.
- Enhance support for County Agricultural Commissioners, University of California researchers, and landowner participation.

Exotic and Invasive Species

- Strengthen support for California Department of Food and Agriculture program on prevention, eradication, and education.
- Focus on the development of control methods, both chemical and non-chemical.
- Enhance support for county Agricultural Commissioners, University of California researchers, and landowner participation.
- Promote efficient and effective control programs and strategies characterized by efforts that prevent invasions and quickly detect new occurrences so that the species may be removed or contained before spreading.

Air Pollution

- Continue to work with California Air Resource Boards and local Air Pollution Control Districts to address concerns over use of prescribed fire and particulate matter from forest and rangeland management activities.
- Maintain periodic assessments of impacts of ozone and other pollutants on forest and rangeland vegetation and aquatic resources.
- Develop improved modeling of air quality impacts of wild and prescribed fire.
- Promote development of fuel reduction and forest management alternatives that minimize use of fire and production of air contaminants.

Soil Conservation and Water Quality

4 Goals and Benchmarks

- Ensure that soil erosion associated with timber operations is adequately controlled to protect soil resources, forest productivity, and water quality (Z'Berg-Nejedly Forest Practice Act, Article 5, 4562.5).
- Ensure the protection of beneficial uses that are derived from the physical form, water quality, and biological capability of streams (Z'Berg-Nejedly Forest Practice Act, Article 5, 4562.7).
- Protect forest lands and aquatic resources by focusing on protection of water quality, fisheries, and water supplies (California Public Resources Code, Section 4111).
- Controllable water quality factors shall conform to the water quality objectives contained herein. When other factors result in the degradation of water quality beyond the levels or limits established herein as water quality objectives, then controllable factors shall not cause further degradation of water quality. Controllable water quality factors are those actions, conditions, or circumstances resulting from man's activities that may influence the quality of waters of the State and that may reasonably be controlled (State Anti-Degradation Policy, Basin Plan, Chapter 3, Water Quality Objectives).
- Recover harvestable steelhead and salmon populations, restore watersheds, and so contribute to building healthy communities (Board of Forestry and Fire Protection and Fish and Game Commission Joint Policy on Pacific Salmon and Anadromous Trout).
- Quantity and quality of the waters of this state should be apportioned and maintained respectively so as to produce and sustain maximum numbers of fish and wildlife (California Fish and Game Commission policy on Endangered and Threatened Species).
- Activities and factors which may affect the quality of the waters of the state shall be regulated to attain the highest water quality which is reasonable, considering all demands being made and to be made on those waters and the total values involved, beneficial and detrimental, economic and social, tangible and intangible (California Water Code, Section 13000–13002).

4 Policy Challenges

Measuring cumulative watershed impacts

Continuing efforts to increase watershed information and understanding of watershed processes are necessary to facilitate improvements in watershed conditions and protect soil and water resource values. Comprehensive watershed assessments must also provide information necessary for determining water quality conditions and the causes of any water quality and beneficial use impairments.

While there is broad agreement on the importance of linkages between management practices, soil conditions, channel conditions, and cumulative watershed effects, a consensus is lacking on how to measure, monitor, or evaluate effects. Much of the difficulty relates to the episodic and random nature of the events that can drive major negative changes in watershed conditions. Most past and recent studies indicate that unpaved roads are the primary human-caused source of sediment. The environmental significance of these or any other sources of change depends on complex interactions between new changes, background conditions, and ongoing rates of recovery or degradation.

Improving watershed condition and restoring fish habitat

Forest and rangeland watersheds typically provide high water quality runoff compared to other land uses. However, many watersheds have legacy impacts of historic land uses, ongoing land use changes, and episodic, intense wildfires that have degraded water quality and aquatic habitat conditions. In-stream habitat quality, including water quality and quantity, is a critical factor in anadromous salmonid population levels. A combination of in-stream habitat conditions and other environmental influences have contributed to a long-term downward trend in populations of specific salmon stocks. This is reflected in the listing of salmonid stocks under state and federal endangered species acts.

Watershed management and restoration—including sustainable resource management, retention of in-stream water levels for aquatic species, protection of watershed values key to maintaining water quality and aquatic habitat, and implementation of fish habitat restoration projects—have emerged as important and complex issues in forest and rangeland management. Landowners have been taking steps to improve watershed conditions and aquatic habitat by improving their management practices and implementing restoration projects. In degraded watersheds, improving water quality, and aquatic habitat requires identifying, prioritizing, and addressing current and historic land use impacts on these values.

4 Policy Options

- Continue support for watershed assessments using common watershed models and risk assessment capacity, enhancing cooperative mapping and monitoring techniques, and using long-term plans for large scale analysis and monitoring schemes.
- Continue monitoring, especially to link in-stream conditions to hillslope processes. Incorporate in-stream monitoring technologies to track effectiveness of regulations and restoration efforts.
- Increase options for long-term plans (such as Rangeland Water Quality Management Plans) by forest and range landowners and connect plans to eased regulatory process requirements at the plan level.
- Foster collaboration between regulatory agencies, the general public, and private landowners including integrating Timber Harvest Plan review and rules and Total Maximum Daily Load requirements.
- Maintain funding and increase landowner incentives for restoration projects and maintain support for urban stream restoration.
- Use the Demonstration State Forests as a venue for testing and demonstrating watershed assessment approaches and restoration techniques.
- Conduct focused research on the dynamics of fish populations and their linkages to in-stream conditions and land uses.

5 Goals and Benchmarks

- Acquire and develop data and information on global climate change for use in reducing or mitigating the production of greenhouse gases including net reductions through the management of natural forest reservoirs (California Public Resources Code Section 25730, Climate Change Inventory and Information).
- Update the inventory of greenhouse gas emissions …[and] information on relevant current and previous energy and air quality policies, activities, and greenhouse gas emissions reductions and trends since 1990 (Public Resources Code 25730, California Energy Commission).
- Global warming would impose on California … compelling and extraordinary impacts including potential reductions in the state's water supply due to changes in snow pack levels; adverse health impacts from increases in air pollution; adverse impacts upon agriculture and food production caused by projected changes in the amount and consistency of water supplies and significant increases in pestilence outbreaks; projected doubling of catastrophic wildfires due to faster and more intense burning associated with drying vegetation; and significant impacts to consumers, businesses, and the economy of the state due to increased costs of food and water, energy, insurance, and additional environmental losses and demands upon the public health infrastructure (Findings and Declarations section of AB 1493, Pavley, Chapter 200, Statutes 2002).
- …encourage voluntary actions to achieve all economically beneficial reductions of greenhouse gas emissions from California sources (Health and Safety Code 42800, California Climate Action Registry).
- The state's tradition of environmental leadership should be recognized through the establishment of a registry to provide documentation of greenhouse gas emissions levels voluntarily achieved by sources in the state. The registry will provide participants an opportunity to register greenhouse gas emissions information in a consistent format using publicly reviewed and adopted procedures and protocols (Health and Safety Code, Section 42801, California Climate Action Registry).
- To promote stable electricity prices, protect public health, improve environmental quality by ameliorating air quality problems by reducing the burning of fossil fuels, stimulate sustainable economic development, create new employment opportunities, and reduce reliance on imported fuels, … implement the California Renewables Portfolio Standard Program to attain a target of 20 percent renewable energy (California Public Utilities Code,399.11).

5 Policy Challenges

Understanding and responding to climate change

Environmental and climate change impacts on forest ecosystems are likely to include shifts in the growth and geographic range of different forest types; increases in the frequency of fire and insect outbreaks; changes in the carbon storage function of some forests (e.g., from sinks to sources); enhanced stressors (ozone, nitrogen deposition, land use change); resulting increases in public safety risks from more fire and dead trees; and potential extirpation of plant and animal species in isolated pockets or changes in their range. Increased uncertainty can limit investment and extreme events can put operators out of business increased risks to public safety from fire, flood, exotics, and disease.

California's forests and rangelands can also provide a unique role in affecting global impacts from greenhouse

gas emissions (primarily carbon dioxide, $C0_2$). Forests provide a large "sink" to sequester (capture) atmospheric $C0_2$ emitted from point and non-point pollution sources.

5 Policy Options

- Promote conservation of forest lands and vigorous stands which can significantly contribute to large-scale air pollution reduction. Maintain healthy forests which are vital to protecting resources from air borne waste impacts and which provide opportunities to contribute to pollution reduction through carbon sequestration.
- Promote forest health and conserve forest lands from land use changes by providing financial opportunities to land owners who are managing their lands in ways that positively influence carbon storage.
- Create markets for carbon and other ecosystem services to provide additional funds to landowners.
- Refine carbon sequestration accounting and carbon trading mechanisms.
- Maintain and adjust capacity and flexibility of emergency services related to natural process such as flooding, disease, and wildfire.
- Develop a contingency plan for ecological impacts of climate change, including seed banks and land trades adjusted to ranges of vegetation types.

Socio–Economic Well Being

6 Goals and Benchmarks

- Create and maintain conditions under which man and nature can exist in productive harmony to fulfill the social and economic requirements of present and future generations (California Public Resources Code 21001 (E), Division 13. Environmental Quality, Chapter 1. Policy).
- A continued and predictable commitment of timberland and investment for growing and harvesting timber are necessary to ensure…the long-term economic viability of forest products industry and stability of local resource-based economies (California Timberland Productivity Act of 1982).
- Protect and encourage farming and ranching operations that are operated in a manner that protects and promotes healthy oak woodlands (California Fish And Game Code, Section 1362, Oak Woodlands Conservation Act).
- Encourage outdoor recreation opportunities for the citizens of California [for contribution] to a healthy physical and moral environment, [and to] contribute to the economic betterment of the state (California Public Resources Code Section 5096.72, State Beach, Park, Recreational, and Historical Facilities Bond Act of 1974).

6 Policy Challenges

Rising consumption and statewide limitations on commodity output

California's consumption of wood products, livestock products, water, and biomass continues to rise while in-state production from our forests and rangelands is declining or remaining considerably below sustainable levels of production. These trends essentially export some of the environmental impacts of renew-

able resource use practices and limit innovation towards sustainable resource management practices that also meet social needs.

More than three quarters of Californias lumber consumption and nearly all of its paper and pulp consumption is now imported from other states and foreign countries. California had already the highest percentage of its forests in parks and reserves and implemented some of the strictest standards on forest management on private lands before California's production and consumption trends substantially diverged in the 1990s.

The range livestock industry has produced a relatively stable supply of products over the past decade in spite of low wholesale prices and increasing operating costs. In addition to the population driven increases in demand, there is also an increase in the social value of the substantial ecosystem services provided by the range livestock industry through the maintenance of largely unfragmented natural vegetation, open space and recreational opportunities. However, there are signs that conversion to smaller residential parcels may accelerate around expanding metropolitan areas where many family run operations alerady face the challenge of operating within increasingly residentially dominated environments.

Water supply and use continues to be a major ecological and economic theme in California. The challenge of addressing the ecological values of water and water-dependent ecosystems and the increasing needs for urban uses will continue to challenge California. Forest and range management impacts on water runoff, surface storage, and groundwater storage are increasingly becoming part of the larger issues of water management.

California's demand for electricity will continue to grow. Based on recent legislation, an increasing portion of that demand must be met from renewable supplies such as biomass, solar, and water. Biomass material as a source of statewide power generation has remained steady over the past decade at three percent of total power generation. Substantial unutilized biomass material exists statewide, especially within public and private forests, but harvest and other cost limitations must be addressed if more forest biomass fuel is to used.

Meeting changing demands for recreation and open space

Outdoor recreational use of forests and rangelands is an important component of our overall quality of life. Public wildlands near metropolitan areas comprise only 13 percent of the statewide area, but provide over half the statewide recreational visits. Private wildlands near metropolitan areas also provide considerable recreational opportunities as well as valuable open space. High management costs and competing pressures for alternate land uses may constrain the long term recreational possibilities for both public and private lands near major population centers.

Meeting costs of resource protection

Much of the cost of providing for socially valued activities such as fire protection, control of pests and exotic plants, vegetation management after catastrophic disturbances, and resource management planning has been provided by private entities and public sector departments engaged in resource management and commodity production. As the economic viability of many of these natural resource industries and departments declines, there may be an increasing level of unmet resource protection costs that could require additional public funding.

Limited incentives for private production of ecosystem services

The current regulatory environment has limited incentives for landowners to produce the highly valued ecosystem services that are provided by forests and rangelands. Landowners are often reluctant to disclose presence of threatened and endangered species because of the fear of a land "taking" and the belief that the regulatory framework inhibits innovations and may limit investment in restoration activities due to uncertainyy of outcomes.

Land use restrictions designed to enhance ecosystem services will also reduce traditional employment and revenue production that may or may not be compensated by other on-site or off-site employment and revenue production. This may lead to lower overall provision of ecosystem services.

Maintaining large landholdings in resource industries

Economic and regulatory uncertainty may drive some large forest products industries and large ranches to consider discontinuing some of their operations and selling holdings for residential or recreational uses. This could have consequences such as a reduction of species dependent on unfragmented landscapes; less long term investment in range resources, tree planting, road system improvements, and stream restoration projects; and less management of dangerous fuel levels. The loss of major economic operations could also have significant negative impacts on local employment and economic activity.

Weak economies rural communities

Compared to the State as a whole, income levels are lower and unemployment rates are higher in most forest and rangeland counties. While forest and rangeland commodity products such as timber and livestock are a significant part of some regional economies, total values of these products is a small component of the statewide Gross State Product. As total output drops, many of the remaining employment is consolidating and shifting closer to metropolitan areas.

Losses of the human and infrastructure resources as a result of the reduced natural resource economic contributions is likely to be a fall-out of losses of these structures. This is particularly true in very rural communities, where economic diversification has not occurred. The lack of resources for infrastructure investment limits investments in natural resource needs such as soil and water restoration, road maintenance, and fuels reduction.

Although the economic well being indicators are often weak and many rural counties are effectively using their social resources to provide an above average level of well being, successful approaches will require attention to both economic and social infrastructure at the community level.

6 Policy Options

Policy options for rising consumption and statewide limitations on California commodity output

- Develop an economic strategy that builds on comparative advantages of California industries vis a vis local and international economies.
- Promote more aggressive tax policies to favor development of innovative forest and rangeland technologies to meet production and conservation goals.
- Foster development of markets for new products and services, certification of wood and livestock products, and market mechanisms for carbon sequestration.
- Broaden remuneration methods to landowners for non-commodity products that complement commodity production.
- As a policy choice, accept further decline in forest and rangeland industries, reliance on imports, and probable land use changes towards development.

Policy options for meeting changing demands for recreation and open space

- Develop a coordinated plan to define needed statewide recreational expansion on forests and rangelands with protection of environment.
- Promote local community and government efforts to acquire and managed additional open space and recreational lands.
- Encourage relevant expansion of private land and service capacities.

Policy options for meeting costs of resource protection

- Develop an overall policy for California resources that integrates approaches to fuel reduction, fire detection and protection, and prevention and control of exotics and pests.

- Continue to provide wildland fire protection sufficient to protect watersheds, habitat, riparian areas, flood-prone areas, and other factors.
- Maintain state and federal capacities to respond to pests and public safety threats.

Policy options for incentives for private production of ecosystem services

- By policy, recognize the overall role of private landowners in producing ecosystem services.
- Focus on long-term plans and conservation easement conditions that clarify land tenure questions and are approved as alternatives under Forest Practice Rules that reduce compliance costs to landowners.
- Examine use of systems of environmental management that depends on certified, insured and guaranteed operations rather than a permit with civil enforcement.
- Develop watershed approaches to permits and restoration activities that reward landowners for attaining socially desired future conditions.
- Refine trading and credit system for habitat provision, pollution reduction, and carbon sequestration.

Policy options for maintaining large landholdings in resource industries

- Recognize the continued importance of large scale unfragmented ownerships in the working landscape that are dependent on resource based activities.
- Develop analysis of profitability limits at the industry levels and examine if state policies can be improved to assure both private and public benefits of large unfragmented holdings.
- Maintain tax policies that encourage retention of land ownerships in parcels that are economic to manage.
- Identify where new regulatory approaches are possible such as the use of environmental certification or long-range plans.
- Track the levels of management that will be permitted on federal lands and how they relate to overall resource supplies and protection strategies.
- Strengthen monitoring and adaptive management approaches for individual parcels as well as larger landscapes.
- Develop strategies to limit litigation costs by focusing on topics of common agreement such as exotics, pests, fuel reduction, and restoration activities.

Policy options for weak economies in local communities

- At the state level, promote diversification and strengthening of these communities and local economies.
- Foster community capacity to build restoration and other grants into support for local forest products, range, recreation, and ecosystem service industries.
- Continue to leverage existing local watershed groups and Fire Safe Councils.
- At the state level, develop additional supports to biomass industry.
- Identify, make available, and guarantee fuel supplies from some sections of public lands.

Governance

Goals and Benchmarks

- Encourage prudent forest management to serve public need for timber, with consideration of watershed protection, wildlife, and recreation (Z'Berg-Nejedly Forest Practice Act).
- Maintain regulation to assure productivity of timberlands are restored, maintained, and enhanced (Z'Berg-Nejedly Forest Practice Act).
- Protect and manage ecosystems, biological communities, and landscapes by developing and adopting a coordinated regional strategy that ensures protection of biological diversity and the maintenance of economic viability throughout California (California Biodiversity Council Memorandum of Understanding).
- Encourage investments based on expected harvests (California Timberland Productivity Act of 1982).
- Strengthen incentives, investment for enhance of forest resource productivity (California State Board of Forestry and Fire Protection Handbook, Chapter 0330, General Board Policy).
- Enlarge forestry research and information programs for factual decision making (California State Board of Forestry and Fire Protection Handbook, Chapter 0330, General Board Policy).
- Make and enforce such regulations as are necessary and proper for the organization, maintenance, government, and direction of the fire protective system for the prevention and suppression of forest fires (California Public Resources Code, Section 4111).
- Protect forest lands and aquatic resources and long-term conservation of productive forest lands by providing an incentive to owners of private forest lands to prevent future conversions of forest land and forest resource (California Public Resources Code, Section 12210, California Forest Legacy Program Act of 2000).
- Encourage private and public investments in, and an improved management of, forest lands and resources within the state to ensure adequate future high quality timber supplies, related employment, and other economic benefits, and the protection, maintenance, and enhancement of a productive and stable forest resource system for the benefit of present and future generations (California Public Resources Code, Section 4791 Part 2.5. Forest Resources, Chapter 1. Forest Resources Improvement).
- Encourage and support the development of coordinated and complementary strategies and solutions for watershed management across land ownership and agency jurisdictional boundaries (California Public Resources Code, Section 30907, Watershed, Clean Beaches, and Water Quality Act).

Policy Challenges

Complexity of regulatory oversight

Regulatory impacts on management activities are extensive on all forests and rangelands. Of the over 80 million acres of forests and rangelands, three-quarters have physical characteristics or zoning restrictions, such as steep slopes or riparian areas, that guide and often limit management activities such as timber harvesting, grazing, and water withdrawals. Increasing federal regulatory influence based on clean water, clean air, and species protection will continue to have an additional dominant impact on resource management on private and public lands.

Lack of policy coordination and integration

Multiple regulations sometimes work at cross-purposes and can discourage investment, incur substantial taxpayer funded regulatory costs, and add uncertainty that increases costs to landowners. Coordination and integration of policies, laws, and regulation particularly in the forest management, wildfire, and energy fields is needed to accomplish goals.

Conflicts over forest and rangeland management practices

Property rights and land tenure arrangements continue to be interpreted in the courts, suggesting continued contention between meshing environmental goals, property rights, and the enhancement of the public goods. In some cases, the socially valued conditions in contention will be harder to sustain on private forests and rangelands if regulatory requirements result in increasing operating costs and decreasing revenues that drive disinvestment or land use conversion.

Standardized, comprehensive information systems

The lack of standard information limits the ability to analyze needs, priorities, and program effectiveness. For example, watershed assessment often lacks consistent information, which may limit watershed value protection. Inadequacies ultimately lead to increased costs, duplication, and time delays regulatory incentive and market based systems. Additional committment is needed for information systems that facilitate monitoring and promote management strategies based on adaptive management approaches that effectively implement better approaches.

Coordination in research and information sharing

There is a need to coordinate research and effectively share and disseminate information. This will facilitate the adoption of new technologies and practices that could improve biological diversity, productivity, soil and water quality, and well being.

7 Policy Options

Policy options for levels of regulatory oversight and policy integration

- Conduct an analysis of the impact of overlapping mandates and review processes in an effort to streamline current structure.
- Connect policies for investment in energy and carbon sequestration to landowner incentives.
- Strengthen ability to use long term plans and forest certification to meet rules.
- Examine use of system of environmental management that depends on certified, insured and guaranteed operations rather than a permit with civil enforcement.

Policy options for conflicts over forest and rangeland management practices

- Focus on achieving agreement on desired landscape goals and then address potential practices and conflicts.
- Learn from experiences of The Nature Conservancy, other non-profits, and regional parks on how to explain management needs.
- Review role of environmental certification in providing for broader acceptance of management tools.
- Provide for public input and decision making and monitoring.
- Strengthen skills of resource professionals regarding public involvement and values.
- Continue strong support for focused management practices, such as fuel reduction and control of exotics and pests.

Policy options for limited coordination in research and information sharing

- Develop overall forest and rangeland research plan for California.
- Increase use of web-based portals for public access.
- Maintain the forest and rangeland extension functions at University of California and applied programs at California State University.
- Continue to hold research symposia to share results.
- Increase foundation support for research.

Policy options for standardized, comprehensive information systems

- Develop and maintain a system of recording easement boundaries and purposes in a central database.
- Continue to develop interagency agreements that set standards for information sharing and use.

Appendix

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Data Quality Index

The data and information used in the Forest and Range 2003 Assessment use many information sources to describe current conditions and predict future trends. The online technical report, Assessment Information Systems, outlines the types and general information topics created, adapted, or adopted for the Assessment. Information comes from a variety of sources, with original research conducted by FRAP and widely available government agencies' information constituting the two largest sources of information.

The vast expanse of ecological, economic, and social context in the Assessment, and the data needed to evaluate this context, were guided by the Criteria and Indicators for the Conservation and Sustainable Management of Temperate and Boreal Forests, commonly known as the "Montreal Process". FRAP then adopted or modified this list to evaluate sustainability questions most relevant to California. To provide information for the indicators, FRAP created unique information to measure the condition, relied on existing datasets that discretely provided information, or manipulated existing data to provide answers to that were not previously reported.

The Assessment Summary includes an evaluation for each indicator on the quality of available data sources. The evaluation of the data is based on the framework used by the The Heinz Center, *The State of the Nation's Ecosystems: Philosophy, Framework, and Findings* (Heinz, 2002). Three different groups of data quality are included:

● **All Required Data** Generally, these data must meet three criteria: 1) scientifically credibility; 2) provide information on a substantial majority of the resource or issue; 3) have measurements repeated at regular intervals in the future (Heinz, 2002); and 4) have more than one period of measurement.

An example of this data quality would be the USFS Pacific North West Experiment Station Forest Inventory and Analysis (FIA) published reports called Timber Resource Statistics for Resource Areas of California. These reports reflect nationwide projects authorized by federal statute. The reports reflect results of databases from statistically based field plot samples which are remeasured at specified intervals. Other examples include FRAP's Land Cover Mapping and Monitoring Program which uses numerous data sources to generate a statewide, GIS–based data set of habitat types. The program completes mapping updates on a five year cycle.

◐ **Partial Data** Data are accurate but are not available at levels of thematic, geographical, or temporal specificity comparable to best available data sets; may not be in sufficient quantity or adequate form to support statewide monitoring; may be the result of a one-time evaluation effort; and/or additional processing of data is needed.

? **Additional Development** Criteria to measure indicator are not well defined and agreed upon. Available data comes mainly from unique projects.

Below is an index of the indicator data quality evolution used in the Assessment Summary.

Indicators for Status and Trends of Forest and Rangeland Resources

Biological Diversity
◐ Historical Loss of Forests and Rangelands
◐ Parcelization of Forests and Rangelands
● Area and Distribution of Habitat Types
● Conifer Forest Structural Characteristics—Size and Density
◐ Old Growth Forests
● Area and Distribution of Hardwoods
◐ Management Classification and Distribution of Habitats
◐ Population Status of Native Species
◐ Status of Endangered, Threatened, and Sensitive Flora and Fauna

Productive Capacity

- Actual and Potential Growth of Trees on Timberland
- Forest Land Available for Timber Production
- Characteristics of Timberland Growing Stock
- Timber Growth Versus Harvest Between 1984 and 1994
- Rangeland Available For Grazing
- Rangeland Grazing Capacity Compared to Use

Forest Health

- Land Management and Resource Outputs
- Metropolitan Forests and Rangelands
- Location of Range Livestock Management Activities
- Impacts from Timber Production
- Lands in Reserve Status
- Projected Loss and Alteration of Land Cover Due to Housing Development
- Projected Loss and Alteration of Hardwood Land Cover Due to Development
- Wildland Fire Threat
- Proportion of Forests and Rangelands Susceptible to Ecosystem Health Risks from Wildfire
- Proportion of Housing Units in the Wildland Urban Interface at Significant Risk from Fire
- Proportion of Conifer Forest Areas at High Risk to Pest Damage through 2015
- Identification of Emerging Pests and diseases
- Presence or Absence of Range Livestock Diseases
- Presence of High Impact Non-native Invasive Plants
- Proportion of Non-native Animal Species Relative to Total Species
- Presence of Weed Control Programs
- Trends of Air Pollution Levels Expressed in Non–attainment Days

Soil Conservation and Water Quality

- Land Use in Watersheds
- Regulatory Status of Water Quality Impairments
- Trends in Salmon Populations
- Monitoring Results of Private Timber Management Practices
- Monitoring, Watershed Assessment, and Cumulative Watershed Effects

Forests and Climate Change

- Impacts of Climate Change on Forest and Rangeland Resources
- Effects of Forests on Carbon Levels
- Trends in Green House Gas Emission Reduction
- Programs to Reduce Emissions of Greenhouse Gases

Socio–Economic Well Being

- Income and Well Being Index
- Regional Job and Wage Growth Trends
- Commodity and Non-Commodity Production and Use Trends
- Status of Water Quality, Forest Products, Range Livestock, Forest and Rangelands Energy-Related Resources, and Recreation Industries
- Timber and Rangeland Contributions to Funding Rural Infrastructure Needs

Governance

- Regulatory Jurisdictions Over Management Activities
- Level of Conflict
- Level of Cooperation, Information Sharing, and Education
- Governance Resource Investments

Montreal Process Indicators

Conservation of biological diversity

Ecosystem Diversity:

1) Extent of area by forest type relative to total forest area;
2) Extent of area by forest type and by age class or successional stage;
3) Extent of area by forest type in protected area categories as defined by IUCN2 or other classification systems;
4) Extent of areas by forest type in protected areas defined by age class or successional stage;
5) Fragmentation of forest types;

Species Diversity:

6) The number of forest dependent species;
7) The status (threated, rare, vulnerable, endangered, or extinct) of forest dependent species at risk of not maintaining viable breeding populations;

Genetic Diversity:

8) Number of forest dependent species occupying a small portion of former range;
9) Population levels of representative species from diverse habitats

Maintenance of productive capacity of forest ecosystems

10) Area of forest land and net area of forest land available for timber production;
11) Total growing stock of both merchantable and non-merchantable tree species on forest land available for timber production;
12) The area and growing stock of plantations of native and exotic species;
13) Annual removal of wood products compared to the volume determined to be sustainable;
14) Annual removal of non-timber forest products (e.g., fur bearers, berries, mushrooms, game), compared to the level determined to be sustainable

Maintenance of forest ecosystem health and vitality

15) Area and percent of forest affected by processes or agents beyond the range of historic variation;
16) Area and percent of forest land subjected to levels of specific air pollutants or ultraviolet B that may cause negative impacts on the forest ecosystem;
17) Area and percent of forest land with diminished biological components indicative of changes in fundamental ecological processes or ecological continuity

Conservation and maintenance of soil and water resources

18) Area and percent of forest land with significant soil erosion;
19) Area and percent of forest land managed primarily for protective functions;
20) Percent of stream kilometres in forested catchments with altered stream flow and timing;
21) Area and percent of forest land with significantly diminished soil organic matter;
22) Area and percent of forest land with significant compaction resulting from human activities;
23) Percent of water bodies in forest areas with significant variance of biological diversity;
24) Percent of water bodies in forest areas with significant variation pH, dissolved oxygen, levels of chemicals, sedimentation, or temperature change;
25) Area and percent of forest land experiencing an accumulation of persistent toxic substances

Maintenance of forest contribution to global carbon cycles

26) Total forest ecosystem biomass and carbon pool, and if appropriate, by forest type, age class, and successional stages;
27) Contribution of forest ecosystems to the total global carbon budget, including absorption and release of carbon;
28) Contribution of forest products to the global carbon budget

Maintenance and enhancement of long–term multiple socio–economic benefits to meet the needs of societies

Production and Consumption:

29) Value and volume of wood and wood products production, including value added through downstream processing;
30) Value and quantities of production of non-wood forest products;
31) Supply and consumption of wood and wood products, including consumption per capita;
32) Value of wood and non-wood products production as percentage of GDP;
33) Degree of recycling of forest products;
34) Supply and consumption/use of non-wood products;

Recreation and Tourism:

35) Area and percent of forest land managed for general recreation and tourism;
36) Number and type of facilities available for general recreation and tourism;
37) Number of visitor days attributed to recreation and tourism, in relation to population and forest area;

Investment in the Forest Sector:

38) Value of investment, including investment in forest growing, forest health and management, planted forests, wood processing, recreation and tourism;
39) Level of expenditure on research and development, and education;
40) Extension and use new and improved technologies;
41) Rates of return on investment;

Cultural, Social, and Spiritual Needs and Values:

42) Area and percent of forest land managed to protect the range of cultural, social, and spiritual needs and values;
43) Non-consumptive use forest values;

Employment and Community Needs:

44) Direct and indirect employment in the forest sector;
45) Average wage rates and injury rates in major employment categories;
46) Viability and adaptability to changing economic conditions;
47) Area and percent of forest land used for subsistence purposes

Legal, institutional, and economic framework for forest conservation and sustainable management

Legal Framework:

48) Clarifies property rights, provides for appropriate land tenure arrangements, recognizes customary and traditional rights of indigenous people, and provides means of resolving property disputes by due process;
49) Provides for periodic forest-related planning, assessment, and policy review;
50) Provides opportunities for public participation in public policy and decision-making related to forests and public access to information;
51) Encourages best practice codes for forest management;
52) Provides for the management of forests to conserve special environmental, cultural, social and/or scientific values;

Institutional Framework:

53) Provide for public involvement activities and public education, awareness, and extension programs;
54) Undertake and implement periodic forest-related planning, assessment, and policy review;
55) Develop and maintain human resource skills across relevant disciplines;
56) Develop and maintain efficient physical infrastructure to facilitate the supply of forest products and services;
57) Enforce laws, regulations and guidelines;

Economic Framework:

58) Investment and taxation policies and a regulatory environment which recognize the long-term nature of investments and permit the flow of capital in and out of the forest sector;
59) Non-discriminatory trade policies for forest products;

Capacity to Measure and Monitor Changes:

60) Availability and extent of up-to-date data and statistics;
61) Scope, frequency, and statistical reliability of forest inventories, assessments, monitoring and other relevant information;
62) Compatibility with other countries in measuring, monitoring, and reporting on indicators;

Research and Development:

63) Development of scientific understanding of forest ecosystem characteristics and functions;
64) Development of methodologies to measure and integrate environmental and social costs and benefits into markets and public policies;
65) New technologies and the capacity to assess the socio-economic consequences associated;
66) Enhancement of ability to predict impacts of human intervention on forests;
67) Ability to predict impacts on forests of possible climate change.

Glossary

actual growth: The net increase of timber growing stock volume between two measurement periods.

afforestation: The establishment of a forest in an area where preceding vegetation or land was not forest (Helms, 1998).

age class: one of the intervals into which the age range of trees is divided for classification e.g. 10 years age class.

agriculture: A management landscape class where the primary use is agriculture (crops, orchards, vineyards, irrigated pastures, and other farming activities). Human impact on natural ecological processes is significant, but presumed to retain some habitat value for some native species.

animal unit month: The amount of forage needed by an "animal unit" (AU) grazing for one month. The animal unit in turn is defined as one mature 1,000–pound cow and calf.

APHIS: Animal and Plant Health Inspection Service.

AUM: See animal unit month.

BDT: See bone dry ton.

beef cattle farms excluding feedlots: Cattle farms classified by the National Agricultural Statistical Service excluding principle crop farms with cattle and cattle feedlots.

biological diversity: The variety of life over some spatial unit; The broadly diverse forms into which organisms have evolved and is considered at three levels: genetic, species, and ecosystem.

biological legacy: A biologically derived structure or one component inherent from a previous ecosystem including large trees, snags, or down logs (Helms, 1998).

biomass: Plant material that can be converted into fuel.

bioregion: An area that includes a rational ecological community with characteristic physical (climate, geology), biological (vegetation, animal), and environmental conditions.

BLM: U.S. Bureau of Land Management.

BMP: Best Management Practice.

the Board: See BOF.

BOF: California State Board of Forestry and Fire Protection.

bone dry ton: A bone dry ton is that quantity of material that would weigh 2,000 pounds when dry.

boxed–beef: Refers to the process whereby carcasses are butchered into individual cuts and then packed and shipped from the slaughtering plant.

browse: To feed on leaves, young shoots, and other vegetation.

bull: A sexually mature adult bovine.

calf: A sexually immature young bovine.

California Wildlife Habitat Relationship system: The California Wildlife Habitat Relationship system is a state-of-the-art classification system for California's wildlife. CWHR contains life history, management, and habitat relationships information on 675 species of amphibians, reptiles, birds, and mammals known to occur in the State. CWHR products are available for purchase by anyone interested in understanding, conserving, and managing California's wildlife.

canopy closure: Canopy closure is measured by the ground area covered by the crowns of trees or woody vegetation as delimited by the vertical projection of crown perimeters and commonly expressed as a percent of total ground area.

carbon dioxide: A colorless, odorless, non-combustible gas, present in low concentrations in the air we breathe (about three hundredths of one percent by volume). Carbon dioxide is produced when any substance containing carbon is burned. It is also a product of breathing and fermentation. Plants absorb carbon dioxide through photosynthesis.

carbon sequestration: The ability of forests or other natural systems to "sink" or store carbon, thereby preventing it from collecting in the atmosphere as CO_2. Forests absorb carbon when they break down CO_2 during photosynthesis.

carbon sink: A carbon pool (forests and other ecosystems) that has more carbon flowing into it than flows out. Forests are the best sinks because they are the most efficient means of taking carbon out of the atmosphere and storing it for the long term.

carbon storage: The process of storing carbon in leaves, woody tissue, roots, and soil nutrients.

cattle: Domesticated bovine animals as a group regardless of sex or age, including cows, steers, bulls, and oxen.

cavity nesting: Cavity nesting birds are those that nest in

holes (cavities) in trees and are divided into two groups. Primary cavity nesters can excavate their own holes in trees and snags, while secondary cavity nesters are dependent upon natural cavities and abandoned sites excavated by primary cavity nesters.

CBC: California Biodiversity Council.

CDF: California Department of Forestry and Fire Protection.

CDFA: California Department of Food and Agriculture.

CEQA: California Environmental Quality Act.

clearcutting: The felling of all trees in a designated area in one operation.

CO_2: See carbon dioxide.

condition class: Condition classes are a function of the degree of departure from historical fire regimes resulting in alterations of key ecosystem components such as species composition, structural stage, stand age, and canopy closure.

conifer: Trees belonging to the order Gymnospermae, comprising a wide range of trees that are mostly evergreens. Conifers bear cones and have needle-shaped or scalelike leaves. In the wood products industry the term "softwoods" refers to the conifers.

Conifer Forest: A land cover type where the overstory canopy occupied by trees of which 50 percent or more are conifers. Conifer Forests are generally located in higher elevation mountainous areas and have commonly recognized evergreen tree species such as ponderosa pine (*Pinus ponderosa*) or redwood (*Sequoia sempervirens*).

Conifer Woodland: A land cover type where the overstory canopy occupied by trees of which 50 percent or more are conifers. Conifer Woodlands are generally located on the east side of the Sierra Nevada mountains and the southern regions of the state. These woodlands are generally dominated by small, brushy trees species such as California juniper (*Juniperus californica*) or pinyon pine (*Pinus edulis*).

conservation easement: A restriction deeded to a qualified third party that permanently limits certain activities on real property, in order to protect conservation values such as biodiversity, water quality, wildlife habitat, or carbon sequestration. The restriction stays with the property through successive owners. The restriction reduces the "highest and best" economic use of the property so that the property's value reflects only the allowed uses. If the landowner donates the easement as a gift, this reduction becomes a charitable tax deduction. An easement also can be sold to non–profit or government agencies to provide revenue.

County–based bioregion: Geographic grouping of counties based county administrative boundaries and grouped with respect to common environmental, economic, and physical conditions.

CWE: Cumulative Watershed Effects.

CWHR: See California Wildlife Habitat Relationship.

DBH: See diameter at breast height.

Desert: A land cover type including Desert Shrub and Desert Woodland land cover types. Includes shrub vegetation in arid portions of the State, with greater than two percent vegetation, scattered assemblages of a wide variety of shrub species, and tree vegetation in arid portions of the State, with greater than two percent ground cover and the presence of desert tree species such Joshua tree (*Yucca brevifolia*) and California fan palm (*Washingtonia filiferia*).

developed land: An NRI definition comprising large urban and small built–up areas, as well as roads and railroads not included in urban/built–up areas.

development: A human settlement pattern having a density of more than one housing unit per 20 acres.

diameter at breast height: Tree trunk diameters measured at breast height, defined as the diameter of the tree 4.5 feet (1.37 meters) above ground on the uphill side of the tree.

disturbance regime: A natural or human caused event like floods, fire, and storms that shape vegetative composition and seral stage.

down logs: Portions of trees that have fallen to the ground that are at least 10 feet long and at least 10 inches in diameter as measured on the large end.

easement: A right, such as a right of way, to make limited use of another's real property.

ecological integrity: A qualitative description of an ecosystem, or natural community, where the components (types of species, soil etc.), structures (arrangement of components), and processes (flows of energy and nutrients) are highly maintained and intact. Lands with ecological integrity generally have not been subjected to significant human influences or disruption of natural pro-

cesses, such as fire, floods, and nutrient and hydrological cycling.

ecosystem: The interacting system of a biological community and its nonliving environmental surroundings.

ecosystem health: A biological community and its nonliving environmental surroundings functioning within a normal range of variability; The capacity to maintain ecosystems structures, functions and capabilities to provide for human need.

ecosystem function: The operational role of ecosystem components, structure, and processes.

ecosystem processes: The flow or cycling of energy, materials, and nutrients through space and time.

ecosystem services: The beneficial outcomes, for the natural environment, or for people, that result from ecosystem functions. Some examples of ecosystem services are support of the food chain, harvesting of animals or plants, clean water, or scenic views. In order for an ecosystem to provide services to humans, some interaction with, or at least some appreciation by, humans is required.

ecosystem structure: Spatial distribution or pattern of ecosystem components.

endangered species: Any species, including subspecies or qualifying distinct population segment, which is in danger of extinction throughout all or a significant portion of its range.

EPA: U.S. Environmental Protection Agency.

ESU: See evolutionary significant unit.

evenaged stand: A forest stand or forest type in which relatively small (10–20 year) age differences exist between individual trees. Evenaged stands are often the result of fire, or a harvesting method such as clear–cutting or the shelterwood method; Forest stand where more than 70 percent of the tree stocking falls within three adjacent, decadal, age classes.

exotic or non–native species: A species of plant or animal introduced from another country or geographic region outside its natural range (Helms, 1998).

extirpation: Driven out or eliminated from an area.

feedlots: A plot of ground on which livestock are fattened for market.

FIA: See Forest Inventory and Analysis.

fire exclusion: The lack of natural or man-caused forest fires due to wildfire suppression activities.

fire frequency: A broad measure of the rate of fire occurrence in a particular area. For historical analyses, fire frequency is often expressed using the fire return interval calculation, whereas in the modern–era where data on timing and size of fires are recorded, fire frequency is often best expressed using fire rotation.

fire regime: A measure of the general pattern of fire frequency and severity typical to a particular area or type of landscape: The regime can include other metrics of the fire, including seasonality and typical fire size, as well as a measure of the pattern of variability in characteristics.

fire rotation: An area–based average estimate of fire frequency, calculated as the length of time necessary for an area equal to the total area of interest to burn. Fire rotation is often applied to regionally stratified land grouping where individual fire–return intervals across the variability of the strata (i.e., the fine scale pattern of variation in timing of fires) is unknown, but detailed information on fire size is known. Hence, fire rotation is a common estimate of fire frequency during periods of recorded fire sizes.

fire threat: An index of expected fire frequency and physical ability to cause impacts. Components include surface fuels, topography, fire history, and weather condition.

FishNet4C: Fishery Network of Central California Coastal Counties.

FMD: See Foot–and–Mouth Disease.

Foot–and–Mouth Disease: Foot–and–Mouth Disease is a highly contagious and economically devastating disease of cattle and swine. It also affects sheep, goats, deer, and other cloven–hooved ruminants.

forage: All browse and herbage that is available and acceptable to grazing animals.

forb: A broad–leafed herb other than a grass, especially one growing in a field, prairie, or meadow.

forest/forests: A biological community of plants and animals that is dominated by trees and other woody plants; Lands with great than 10 percent tree canopy cover; All habitats in the Conifer and Hardwood land cover categories.

forest and rangeland: Specific habitats in the Conifer, Hardwood, Shrub, Grassland, and Desert and some Wetland (Wet Meadow) land cover types excluding Urban, Agriculture, Barren, and Water categories.

forest health: A condition where a forest has the capacity for renewal, for recovery form a wide range of disturbances, and for retention of ecological function, while meeting the current and future needs of people for desired levels of values, uses, products, and services (Dahms and Geils, 1997).

Forest Industry: Lands owned by companies that grow timber for industrial use. Includes companies both with and without wood processing plants; An ownership class in the USDA FS PNW Experiment Station Forest Inventory and Analysis program.

Forest Inventory and Analysis: Forest land and timberland statistics reported by the Pacific Resource Inventory, Monitoring and Evaluation program (PRIME) of PNW. Every decade, PRIME conducts the Forest Inventory and Analysis, which is a national mandate authorized by the Forest and Rangeland Renewable Resource Research Act of 1978. The FIA is a plot–based survey and statistical analysis with representative field based plots of all forest lands outside the National Forest System.

forest structure: the horizontal and vertical distribution of components of a forest stand including height, diameter, crown layers, and stems of trees, shrubs, herbaceous understory, and done woody debris (Helms,1998).

formal list or formally listed: A State and federally regulatory list of animals and plants considered endangered, threatened, or rare pursuant to the Native Plant Protection Act of 1977, California Endangered Species Act of 1984, and/or federal Endangered Species Act of 1973.

FPR: Forest Practice Rule.

fragmentation: The process by which a landscape is broken into smaller islands of forests within a mosaic of other forms of land use ownerships e.g., islands of a older particular age class that remain within areas of younger, aged forest (Helms, 1998).

FRAP: Fire and Resource Assessment Program.

FSC: Fire Safe Council.

FWS: U.S. Fish and Wildlife Service.

GAP: Gap Analysis Program.

Geographic Information System: A computer based system used to store and manipulate geographical (spatial) information.

geothermal: Natural heat from within the earth, captured for production of electric power, space heating, or industrial steam.

GIS: See Geographic Information System.

Grassland: Lands on which the vegetation is dominated by grasses, grasslike plants or forbs; A land cover class with greater than two percent grass cover but less than ten percent tree or shrub cover.

grazing capacity: Maximum stocking rate possible without damage to vegetation or related resources.

grazing permit: Land lease offering written permission to graze a specific number, kind, and class of livestock for a specified defined allotment.

gross state product: Gross output (sales, receipts and other operating income, commodity taxes, and inventory changes) minus intermediate inputs (consumption of goods and services purchased from other U.S. industries or other nations).

GSP: see gross state product.

growing stock volume: Net volume (gross volume less deductions for defect) of live trees greater than 5 inches dbh from stump to a four inch top.

habitat: A unit in the environment natural or otherwise where an animal, plant, or population naturally or normally lives and develops; a specific land cover subclass classified by the California Wildlife Habitat Relationship System.

habitat quality: A subjective term used to describe the condition of a specific habitat and its ability to support a species.

hardwoods: Dicotyledonous trees; trees that are generally deciduous, broad–leafed species such as oak, alder, or maple.

Hardwood Forest: A land cover type with greater than ten percent of the overstory canopy occupied by trees of which 50 percent or more are hardwood trees such as black oak (*Quercus kelloggii*), canyon live oak (*Quercus chryoslepis*), tanoak (*Lithocarpus densiflorous*) and madrone (*Arbutus menziesii*). Hardwood Forests are usually located in the mountainous elevations above the Woodlands and are often associated with Conifer Forest tree species.

Hardwood Woodland: A land cover type with greater than 10 percent tree cover of which greater than 50 percent are hardwood trees. Different form Hardwood Forest, trees are widely spaces, shorter stature and often found in the lower elevations in the transition between grasslands/shrub and conifer forests. Hardwood Wood-

lands are very extensive throughout California and are found in many different lower elevation mountainous areas with both evergreen and deciduous tree species. In the Sierra Nevada range, tree species typically include blue oak (*Quercus douglasii*) and interior live oak (*Quercus wislizenii*). In the northern coastal ranges, tree species include black oak (*Quercus kelloggii*), and canyon live oak (*Quercus chryoslepis*). In the mid to southern coast range species include coast live oak (*Quercus agrifolia*) and California bay (*Umbrellula californica*) and further south, Englemann oak (*Quercus englemannii*). Typical understory is composed of extensive annual grass vegetation.

HCP: Habitat Conservation Plan.

herbaceous: Refers to a plant that has a non–woody stem such as forbs, grasses and ferns.

hydroelectric: A technology that produces electricity from falling water that turns a turbine generator, referred to as hydro. See also small hydro.

impaired: Condition of the quality of an ecosystem or habitat that has been adversely affected for a specific use by contamination or pollution.

invasive species: A species of plant or animal that is able to proliferate and alter native biological communities and ecosystem function.

land cover: Predominant vegetation life forms, natural features, or land uses that occupy a land area.

land trust: A private, non–profit organization formed to protect natural resources such as wildlife habitat, prime farmland, and recreational lands. It accomplishes this through a variety of means, including outright purchase, securing donations, and receiving conservation easements.

Late Succession Forest: A regulatory term defined by the California Forest Practice Rules where stands of dominant and predominant trees meet the criteria of CWHR class 5M, 5D, and 6 with open, moderate or dense canopy classification, often with multiple canopies and are at least 20 acres in size. Characteristics include large decadent trees, snags and large down logs.

late successional: Life stage of vegetations where plant communities are in a stable state reflective of increased age.

litter: The uppermost layer of the forest floor consisting chiefly of fallen leaves and other decaying organic matter.

livestock: Domestic animals, such as cattle or horses, raised for home use or for profit, especially on a farm.

LSF: Late Succession Forest. A regulatory tern for forests with characteristics of CWHR 5, 6 MD, 20 forest stand size minimum, and containing snags and down logs.

LWD: Large woody debris.

Management Landscape: A conceptual framework developed by FRAP which classifies lands based on the primary land use objective, ownership status, and population density.

Management Landscape class: One of eight unique management landscape classifications that describe areas with similar land use objectives, ownership status, or housing unit density. Each class shares similar administrative, regulatory, and legal frameworks.

Management Landscape Map: Depicts the geographic distribution of land use objectives, ownership, and population density.

megawatt: One thousand kilowatts; one megawatt is about the amount of power to meet the peak demand of a large hotel.

metropolitan forest: Forest areas within six miles of urban areas with greater than 10 percent tree canopy.

Montréal Process: A scientifically rigorous set of criteria and indicators used to measure forest management and sustainablility.

MSG: Monitoring Study Group.

national forest: Federal lands that have been designated by Executive Order or statute as national forest or purchase units and other lands under the administration of the U.S. Forest Service (U.S. Department of Agriculture).

native species: A species of plant or animal present prior to European settlement.

NASS: National Agriculture Statistics Service.

native surface road: a dirt surfaced road with noapplied paving or gravel.

NCCP: Natural Community Conservation Planning.

NCWAP: North Coast Watershed Assessment Program.

neotropical migrant: Refers to bird species that nest in temperate regions and migrate to the neotropical faunal region, which includes the West Indies, Mexico, Central America, and that part of South America within the tropics.

NMFS: National Marine Fisheries Service.

non–attainment status: A pollutant is designated non–attainment if there was at least one violation of a state standard for that pollutant in the area.

non–native species: see exotic.

nonpoint: Pollution whose source cannot be ascertained including runoff from storm water and agricultural, range, and forestry operations, as well as dust and air pollution that contaminate waterbodies.

NO_x: A general group of nitrogen compounds often termed oxides of nitrogen.

NPS: National Park Service.

NRCS: U.S. Natural Resources Conservation Service.

nutrient cycling: The exchange or transformation of elements among the living and nonliving components of an ecosystem.

O_3: See ozone.

OHV: Off highway vehicles.

old growth forest: A subjective description of a stand or stands of forest trees that exhibits large tree sizes, relatively old age, and decay characteristics common with over–mature trees; As defined by USDA FS ecologists, specific forest structure characteristics, by forest type and site class, such as size of trees, number of trees per acre, multiple canopies, degree of decay, and size and number of snags and down woody debris.

open–cup nesting: Refers to bird species that construct nests on the ground or in a shrub or tree that is shaped like a cup and accessed from the top.

open forest stand: A forest condition where large, old trees exist within a mosaic of open grasslands.

open space: Land free from intensive residential or commercial uses.

other private: Private lands not owned by forest industry; an ownership class in the USDS FS PNW Experiment Station Forest Inventory and Analysis program.

other public: An ownership class that includes all public lands except National Forests; an ownership class in the USDA FS PNW Experiment Station Forest Inventory and Analysis program.

ozone: An unstable, poisonous allotrope of oxygen that is formed naturally from atmospheric oxygen by electric discharge or exposure to ultraviolet radiation. It is also produced in the lower atmosphere by the photochemical reaction of certain pollutants.

parcelization: The process of land ownership being broken into increasingly smaller tracts.

particulate matter: Airborne particles 10 microns in diameter and smaller.

perennial: A plant which lives or continues over two years, whether it retains its leaves in winter or not.

PM10: Particulate matter 10 microns or greater in diameter.

prescribed fire: A deliberate burn of wildland fuels in either their natural or modified setting and under specific environmental conditions which allow the fire to be confined to a predetermined area and intensity to attain of planned resource management objective (Helm, 1998).

productive capacity: The ability of an ecosystem to produce the raw materials necessary for economic activities. These materials include all renewable resources found both on and below the surface of the ecosystem such as agricultural products, fibers, foodstuffs, timber, water, etc.

potential growth: The theoretical periodic volume growth of trees based on the inherent productivity (site class) of the soil.

Public: Lands owned by local, state, or federal government, or special districts.

Private: Lands not publicly owned, including private conservancy lands.

Rangeland: Any expanse of land not fertilized, cultivated or irrigated that is suitable, and predominately used for, grazing by domestic livestock and wildlife. These include the Conifer Woodland, Hardwood Woodland, Shrub, Grassland, Desert land cover types along with and some habitats within the Wetland and Hardwood Forest land cover classes.

renewable: A power source other than a conventional power source within the meaning of Section 2805 of the Public Utilities Code, provided that a power source utilizing more than 25 percent fossil fuel may not be included.

Reserve: A management landscape class where lands are

permanently protected from conversion of natural land cover and having a mandated management plan in operation to maintain a primarily natural state, but which may receive management practices; lands managed consistent with statutory designation such as wilderness, wild and scenic, national park, and nation monument.

riparian: Relating to or located on the banks of a river or stream.

riparian area: Transition zone between a stream's edge and the dryer uplands.

Rural Residential: A Management Landscape class where with housing densities greater than one unit per 20 acres (greater than 32 units per square mile) and less than one unit per acre.

RVD: Recreational visitor day.

RWQCB: Regional Water Quality Control Board.

salmonids: Salmon species.

seed tree: The cutting method (in silvicultural) where all trees are removed except for a small number of seed bearers left singly or in small groups, maybe 10 per acre. The seed trees are generally harvested after regeneration is established. An evenaged stand results.

SFI: Sustainable Forest Initiative.

shelterwood: A silvicultural method to establish seedling regeneration via a series of partial harvests, followed by the almost complete removal of overstory trees in a removal harvest once adequate numbers of seedlings are in place to permit the seedlings to grow in full sunlight.

Shurb: A land cover class with greater than ten percent shrub cover and less than ten percent tree cover.

Significant (fire threat) risk: Those lands exposed to Very High or Extreme fire threat.

silviculture: Generally, the science and art of cultivating (such as with growing and tending) forest crops, based on the knowledge of silvics. More explicitly, silviculture is the theory and practice of controlling the establishment, composition, constitution, and growth of forests.

size class: an internal into which a measurement of the trees' trunk diameters at breast height (DBH) is divided for classification e.g., two–inch size classes.

small hydro: A facility employing one or more hydroelectric turbine generators, the sum capacity of which does not exceed 30 megawatts.

snags: Standing dead trees with a minimum DBH of 10 inches and a height of 10 feet.

SOD: Sudden Oak Death.

Sparsely Populated: A component of Management Landscape classes describing housing unit densities of less one housing unit per 20 acres.

Special Management Zone: Forest and rangelands where specific regulatory requirements or lands of particular concern under the Forest Practice Rules dictate the intensity and type of land use management permitted.

stand: A group of trees sufficiently uniform in composition, age, and/or condition forming a management entity and distinguishable from adjoining tree groups.

Standard Industrial Classification: A numerical system for categorizing industrial sectors, used in the U.S. until 1997.

stocking level: A measure used to determine how much wood fiber is growing in a standing timber acre.

succession: Process of vegetational development whereby an area becomes successively occupied by different plant communities of higher ecological order.

successional stage: A particular state of ecological development.

sudden oak death: a brown alge species, Phytophthora ramorum, that infects a variety of host species, including several coastal oak species.

sustainability: Meeting the needs of the present without compromising the ability of future generations to meet their own needs.

SWRCB: California State Water Resources Control Board.

T&E: Threatened and Endangered Species.

THP: Timber Harvesting Plan.

threatened species: Any species that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

Timberland Production Zone: A statutory designation for lands assessed for taxes based on growing and harvesting timber as the highest and best use of the land.

timberland: Forest land capable of growing 20 cubic feet or more of industrial wood/acre/year (mean increment at

culmination in fully stocked, natural stands). Timberland is not in a reserved status through removal of the area from timber utilization by statute, ordinance, or administrative order and is not in a withdrawn status pending consideration for reserved.

TMDL: See Total Maximum Daily Load.

Total Maximum Daily Load: A calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards, as well as an estimation of the percentage originating from each pollution source. A TMDL is the sum of the allowable loads of a single pollutant from all contributing point and non-point sources. The calculation must include a margin of safety to ensure that the waterbody can be used for State-designated purposes. The calculation must also account for seasonal variation in water quality.

TPZ: See Timberland Production Zone.

transfer payments: Income payments to persons for which no current services have been performed. They consist of payments to individuals and to non-profit institutions by businesses and federal, state, and local governments.

turbidity: The relative clarity of water, that may be affected by material in suspension in the water.

UC: University of California.

UCCE: University of California Cooperative Extension.

understory: The trees and other woody species growing under a relatively continuous cover of branches and foliage formed by the overstory trees.

unevenaged: Silvicultural system in which individual trees originate at different times and result in a forest with trees of many ages and sizes; stands where less than 70 percent of the tree stocking falls in three adjacent 10 year age classes.

unsuitable: Lands that are not in a reserved status through removal of the area from timber utilization by statute, ordinance, or administrative order, but in practice or as prescribed in management plans or regulatory rules are not primarily managed for timber production.

Urban: A land cover class and Management Landscape class having housing densities greater than one unit per acre or classified as commercial/industrial/transportation. Human impact on natural ecological processes is significant.

USFS: U.S. Forest Service.

value-added: Of or relating to the estimated value that is added to a product or material at each stage of its manufacture or distribution.

Variable retention: A silvicultural approach to harvesting based on retention of structural elements or biological legacies from the harvested stand for integration into a new stand to achieve various ecological objectives (Helms, 1998).

viewshed: The total area visible from a point (or series of points along a linear transportation facility). Viewshed is typically evaluated both from the roadway and conversely of the roadway as viewed from the adjacent area.

watershed: The land area drained by a particular stream course.

Wetland: An aquatic (water dominated) land cover type having greater than two percent vegetation cover and having less than 10 percent of the over story canopy occupied by trees or shrubs.

wildfire: Any fire occurring on undeveloped land; the term specifies a fire occurring on a wildland area that does not meet management objectives and thus requires a suppresion response. Wildland fire protection agencies use this term generally to indicate a vegetation fire. Wildfire often replaces such terms as forest fire, brush fire, range fire, and grass fire.

wildland: A region with minimal development as evidenced by few structures; transportation networks may traverse region. Region typically contains natural vegetation and may be used for recreational or agricultural purposes.

wildland urban interface: The geographical meeting point of two disparate systems, wildland and structures. At this interface, structures and vegetation are close enough that a wildland fire could spread to structures or fire could spread from structures to ignite vegetation.

woody debris: Fallen dead wood or large branches; an important source of nutrients and habitat. Woody debris is also a source of fuel for fire.

woody plant: A plant having hard lignified tissues or woody parts especially stems.

Working: Lands held or managed for some degree of commodity output, usually range or forested lands. Human impact is measurable and definite yet there remains considerable habitat value for native species.

WUI: See wildland urban interface.

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Table A-1. County land cover area (thousands of acres)

County	Conifer Forest	Conifer Woodland	Hardwood Forest	Hardwood Woodland	Shrub	Grassland	Desert Woodland	Desert Shrub	Wetland	Agriculture	Barren/ Other	Urban	Water	Grand Total
Alameda	4		18	64	35	154			4	14	(L)	174	8	477
Alpine	238	17	4		116	11			2	5	74	1	4	474
Amador	121		71	50	25	78			1	11	11	10	8	387
Butte	310		102	122	34	139			18	269	5	48	27	1,073
Calaveras	261		102	57	73	143			(L)	1	3	5	17	663
Colusa	35		30	93	97	110			19	340	1	9	7	740
Contra Costa	2		2	37	36	155			7	65	(L)	156	13	475
Del Norte	439		110	(L)	65	4			1	11	6	9	5	649
El Dorado	634		151	48	96	76			8	8	31	39	55	1,146
Fresno	810	2	105	316	176	529		2	20	1,390	319	140	42	3,852
Glenn	89		46	77	111	216			11	277	5	9	9	849
Humboldt	1,343		518	33	56	221			9	41	28	32	10	2,293
Imperial		8			4	10	4	1,981		597	19	50	195	2,868
Inyo	64	350	15		542	(L)	47	5,022	8	2	478	7	12	6,547
Kern	154	172	63	339	394	1,345	13	1,434	9	1,080	15	183	18	5,218
Kings	(L)			10	12	209		5	3	615	(L)	34	2	890
Lake	200		117	76	294	51			1	42	2	20	49	852
Lassen	849	199	16		1,540	36		31	70	128	17	10	113	3,010
Los Angeles	92	56	71	41	807	90	4	399	(L)	91	14	850	14	2,529
Madera	348	1	87	137	54	263		(L)	5	365	81	27	10	1,378
Marin	36		41	29	37	124			6	8	3	48	5	336
Mariposa	320	1	137	133	143	165			3	(L)	20	4	7	935
Mendocino	1,055		639	28	162	277			(L)	54	9	17	6	2,248
Merced	1		2	69	8	497		1	45	575		37	25	1,261
Modoc	612	400	8		1,037	27		73	41	232	69	4	187	2,689
Mono	258	231	23		897	42		226	12	51	201	5	57	2,003
Monterey	59		42	518	528	638			3	249	7	68	8	2,120
Napa	20		111	64	121	63			3	67	1	31	25	505
Nevada	347	(L)	91	36	50	31			4	5	25	24	12	623
Orange	1		2	14	134	34		(L)	1	21	2	297	4	511
Placer	445	(L)	94	66	68	102			5	45	18	57	61	960
Plumas	1,279	(L)	40		185	41			10	61	11	7	40	1,673
Riverside	54	71	20	26	747	184	29	2,645	4	390	82	361	59	4,672
Sacramento	(L)		3	21	1	203			7	212	1	170	11	628
San Benito	4	1	2	249	124	446		(L)		53	1	10	1	889
San Bernardino	183	263	47	6	490	102	37	11,004	1	98	190	401	45	12,867
San Diego	54	45	29	112	1,155	162	1	554	8	147	7	417	19	2,712
San Francisco				(L)	(L)	(L)			(L)		(L)	29	(L)	30
San Joaquin	(L)		2	27	4	170			6	607	1	82	13	912
San Luis Obispo	18	6	29	425	426	991		34	(L)	121	6	54	15	2,125
San Mateo	66		(L)	9	87	23			2	7	1	91	4	291
Santa Barbara	26	38	40	208	796	282		(L)	1	127	16	94	6	1,634
Santa Clara	51		5	192	174	152			2	50	(L)	201	6	833
Santa Cruz	138		1	10	56	14				30	(L)	36	1	285
Shasta	1,186	12	337	286	336	110			10	69	27	44	47	2,462
Sierra	408	(L)	21	(L)	124	8			4	33	10	1	6	615
Siskiyou	2,427	174	279	1	618	188		(L)	40	202	65	20	50	4,064
Solano	(L)		5	24	15	177		(L)	47	184	1	64	21	539
Sonoma	190		278	12	49	227			7	155	3	85	9	1,015
Stanislaus	1		5	100	65	320			3	400	(L)	67	9	970
Sutter			(L)	15	(L)	39			11	306	(L)	12	7	389
Tehama	447		83	430	256	499			10	131	10	18	10	1,895
Trinity	1,536	(L)	251	7	173	44			1	1	17	3	21	2,053
Tulare	840	166	158	352	179	340		(L)	19	794	185	56	11	3,098
Tuolumne	781	7	162	29	162	103			15	(L)	157	8	33	1,458
Ventura	72	144	30	53	538	65		1	1	121	24	124	6	1,179
Yolo	1		1	82	48	108			10	363	2	31	8	654
Yuba	95		46	55	3	82			4	99	2	17	10	412
California	19,004	2,363	4,691	5,188	14,565	10,919	134	23,414	540	11,421	2,283	4,909	1,486	100,915

(L) less than 500 acres
Sources: Teal Data Center Ownership (Govtown 1999) FRAP Multi source landcover data v. 02_1 (Fveg 02_1g, 2002)

Table A-2. California Wildlife Habitat Relationships forest and rangeland habitat types by owner (thousand acres)

Habitats	Private	USFS	BLM	NPS	Other Public	Total
Conifer Forest						
Closed-Cone Pine-Cypress	56	50	25	12	11	155
Douglas Fir	1,323	1,726	163	21	102	3,335
Eastside Pine	443	929	40	(L)	8	1,420
Jeffrey Pine	38	409	8	109	6	570
Klamath Mixed Conifer	340	1,011	16	9	6	1,381
Lodgepole Pine	35	310	(L)	245	1	591
Montane Hardwood-Conifer	723	801	41	11	49	1,626
Ponderosa Pine	424	369	38	62	13	906
Red Fir	117	998	(L)	296	2	1,414
Redwood	1,079	5	1	45	167	1,297
Sierran Mixed Conifer	1,598	2,912	48	131	44	4,734
Subalpine Conifer	17	495	6	121	4	642
White Fir	153	628	2	38	4	826
Unclassified Conifer	85	1	6	6	10	107
Total	6,432	10,644	394	1,108	426	19,004
Conifer Woodland						
Juniper	339	317	234	66	59	1,015
Pinyon-Juniper	119	734	249	154	92	1,348
Total	458	1,051	482	220	151	2,363
Hardwood Woodland						
Blue Oak-Foothill Pine	754	39	121	17	49	979
Blue Oak Woodland	2,457	129	104	9	120	2,819
Coastal Oak Woodland	832	138	12	8	104	1,095
Eucalyptus	9	(L)	(L)	(L)	1	11
Valley Foothill Riparian	114	4	2	1	27	147
Valley Oak Woodland	126	1	2	(L)	9	137
Total	4,292	310	239	36	309	5,188
Hardwood Forest						
Aspen	3	32	1	2	1	40
Montane Hardwood	2,797	1,215	174	89	165	4,439
Montane Riparian	100	40	1	43	27	211
Total	2,901	1,287	176	134	193	4,691
Shrub						
Alpine Dwarf Shrub	1	201	(L)	18	(L)	219
Bitterbrush	81	162	25	26	5	299
Chamise-Redshank Chaparral	671	399	187	12	114	1,383
Coastal Scrub	1,175	218	74	28	235	1,730
Low Sagebrush	19	151	48	1	11	230
Mixed Chaparral	1,813	2,152	457	16	301	4,739
Montane Chaparral	369	1,032	23	43	14	1,481
Sagebrush	880	1,347	1,407	168	174	3,976
Unclassfied Shrub	426	12	40	8	24	509
Total	5,433	5,673	2,261	319	878	14,565
Grassland						
Annual Grassland	9,592	233	496	38	494	10,852
Perennial Grassland	30	(L)	(L)	4	32	67
Total	9,621	233	496	43	526	10,919
Desert Shrub						
Alkali Desert Scrub	630	70	1,184	470	648	3,003
Desert Riparian	15		18	3	11	47
Desert Scrub	3,348	126	8,326	4,136	3,099	19,036
Desert Succulent Shrub	115		216	17	156	503
Desert Wash	164	(L)	471	33	204	872
Total	4,272	197	10,216	4,659	4,117	23,461
Desert Woodland						
Joshua Tree	27	3	34	18	2	84
Palm Oasis	(L)		3		(L)	3
Total	27	3	37	18	2	87
Wetland						
Wet Meadow	145	69	11	20	23	268
Total	33,582	19,468	14,312	6,558	6,626	80,545

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The Management Landscape

Wildlife Habitats

Historical and Projected Development

Fire Threat

Castle Crags Wilderness Area, Humboldt County