

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.

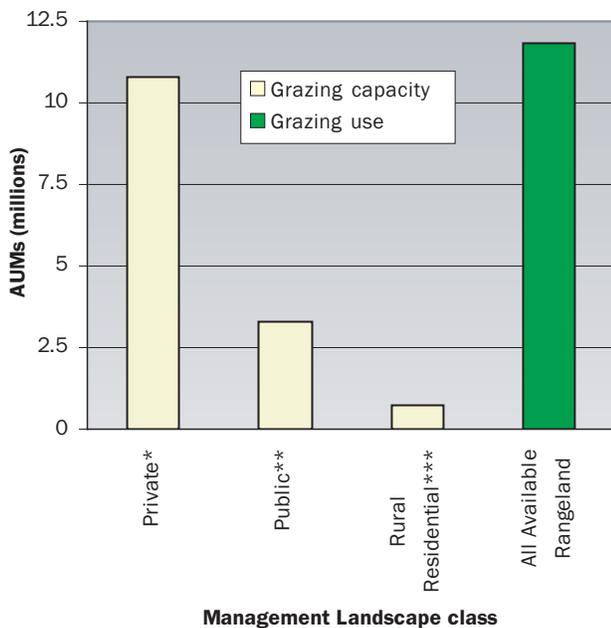
Grazing capacity on available rangelands in places exceeds the amount used for grazing of domestic livestock (Figure 37). However, excess forage for grazing may not be available because of the seasonal nature of

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 Management 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



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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 development 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 profitability.
- **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 threatened 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.

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Land Management and Resource Outputs

On-line Technical Report:
[http://frap.cdf.ca.gov/assessment2003/
Introductory_Materials/population.html](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.

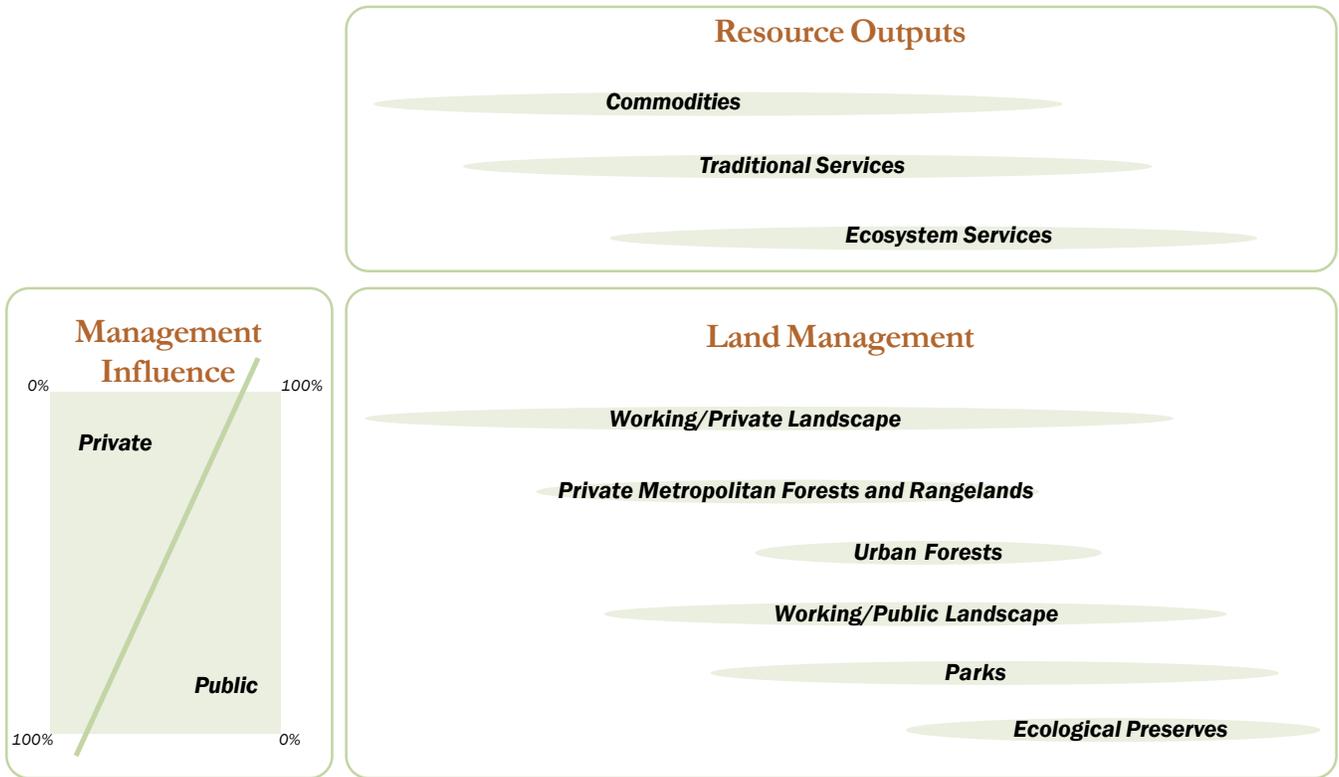
The *Land Management* box in the center of the diagram is designed to illustrate the complex nature of the many different types of parcels in California. The typical range of management influences is suggested by reading from the left box and the typical range of outputs is suggested by reading from 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 management 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 opportunities, 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



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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.

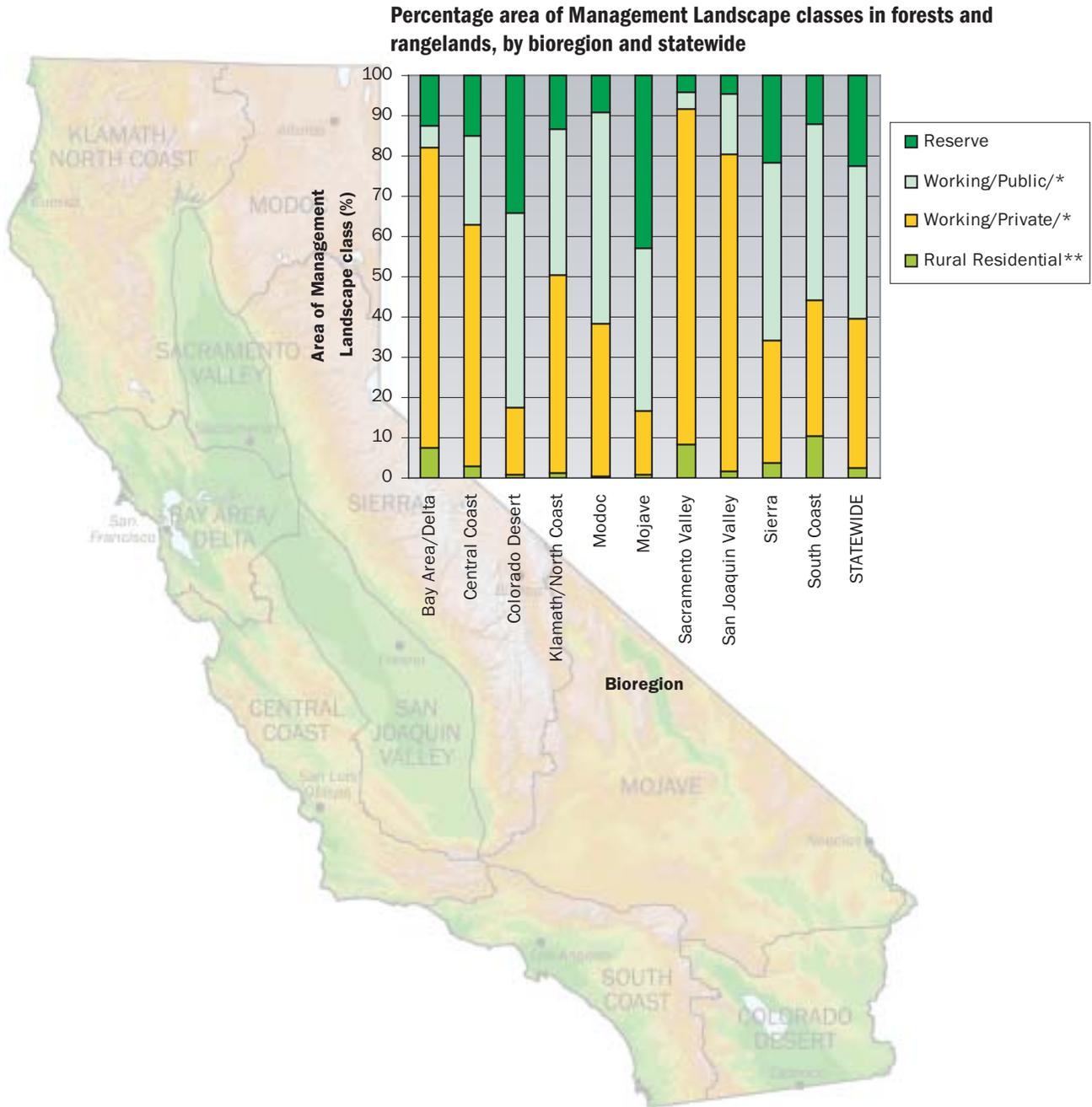
Working/Public/Sparsely Populated: These lands include the portions of U. S. Forest Service, Bureau of Land Management, state forests, and other public lands where commodity production is permitted but is rarely the primary mission. They cover about 38 percent of California’s forests and rangelands. 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

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Metropolitan Forests and Rangelands

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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/Sparsely 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).

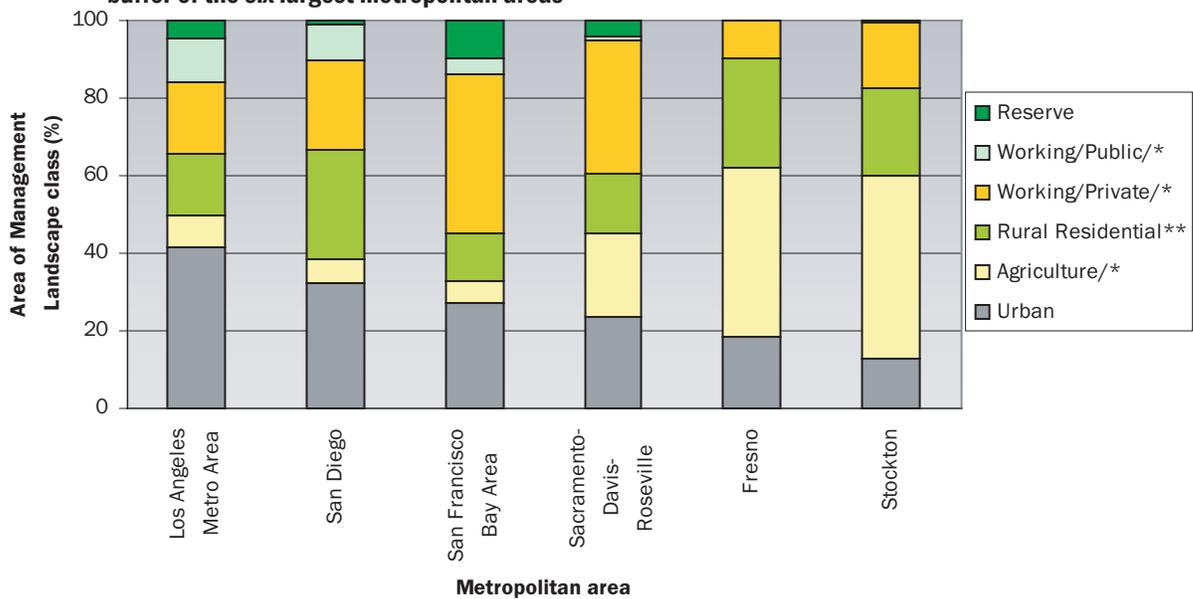
Overall, commodity-based land uses (Working and Agriculture) are a very small component of metropolitan economies but contribute a large share of total open space benefits at a very low public cost compared to the acquisition and management of public sector open space.

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

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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 activities 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.

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

Number of Beef Cattle Farms Excluding Feedlots Over 500 Acres

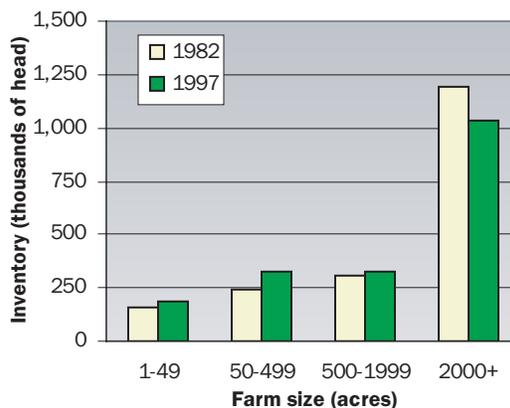
The category *beef cattle farms excluding feedlots* most closely approximates the livestock industry reliant on forests and rangelands. Overall, the number of beef cattle farms excluding feedlots has declined 22 percent between 1982 and 1997. The majority of this decline has occurred in farms less than 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

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

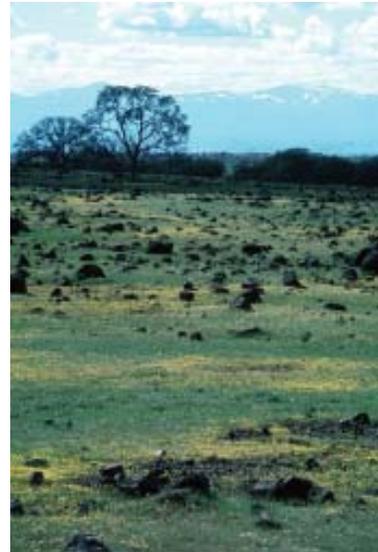
plans that provide for protection of water quality under Rangeland Water Quality Management Plans to ensure environmentally sustainable operations requirements.

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.

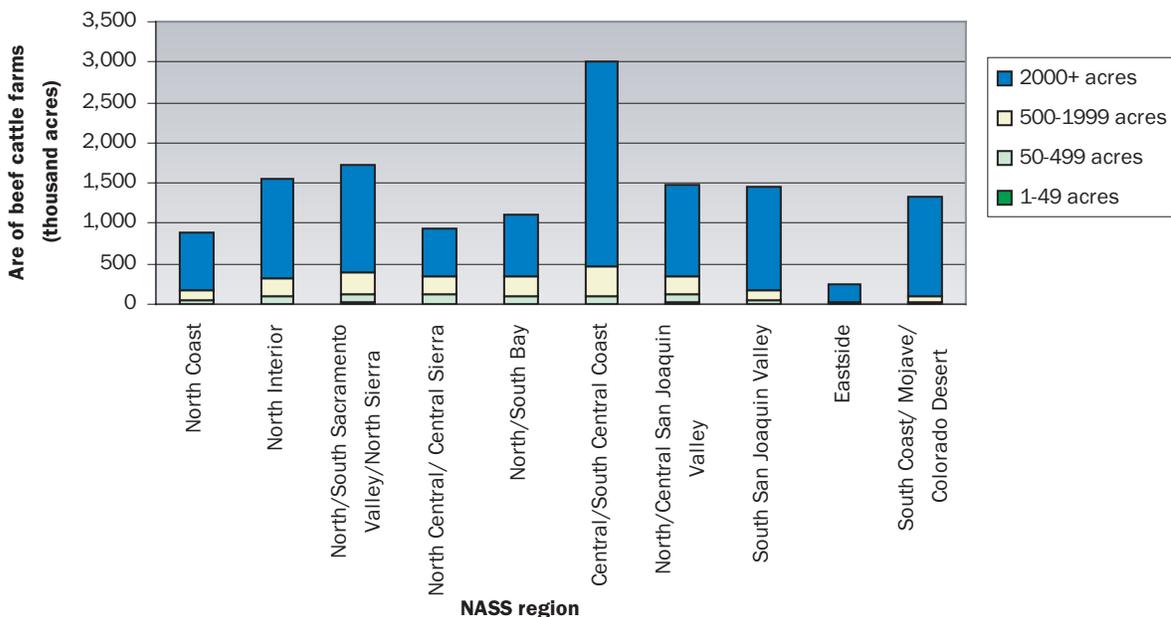
In 1998, the Conservancy also purchased the Simon Newman and Romero Ranches (61,000 acres) east of San Jose with the purpose of creating a perimeter of

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

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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.

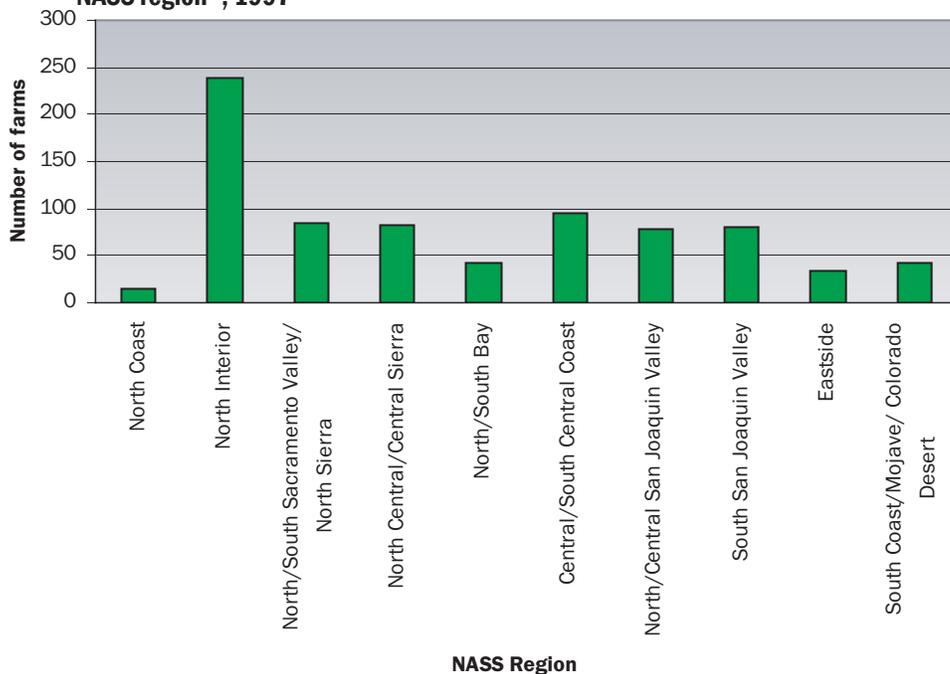
Within the range livestock industry, beef cattle farms of less than 50 acres have relatively more new owners. This is consistent with land development patterns in California where newer owners occupy smaller parcels near urban areas, and parcel size increases with distance from urban areas. These landowners 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 🕒

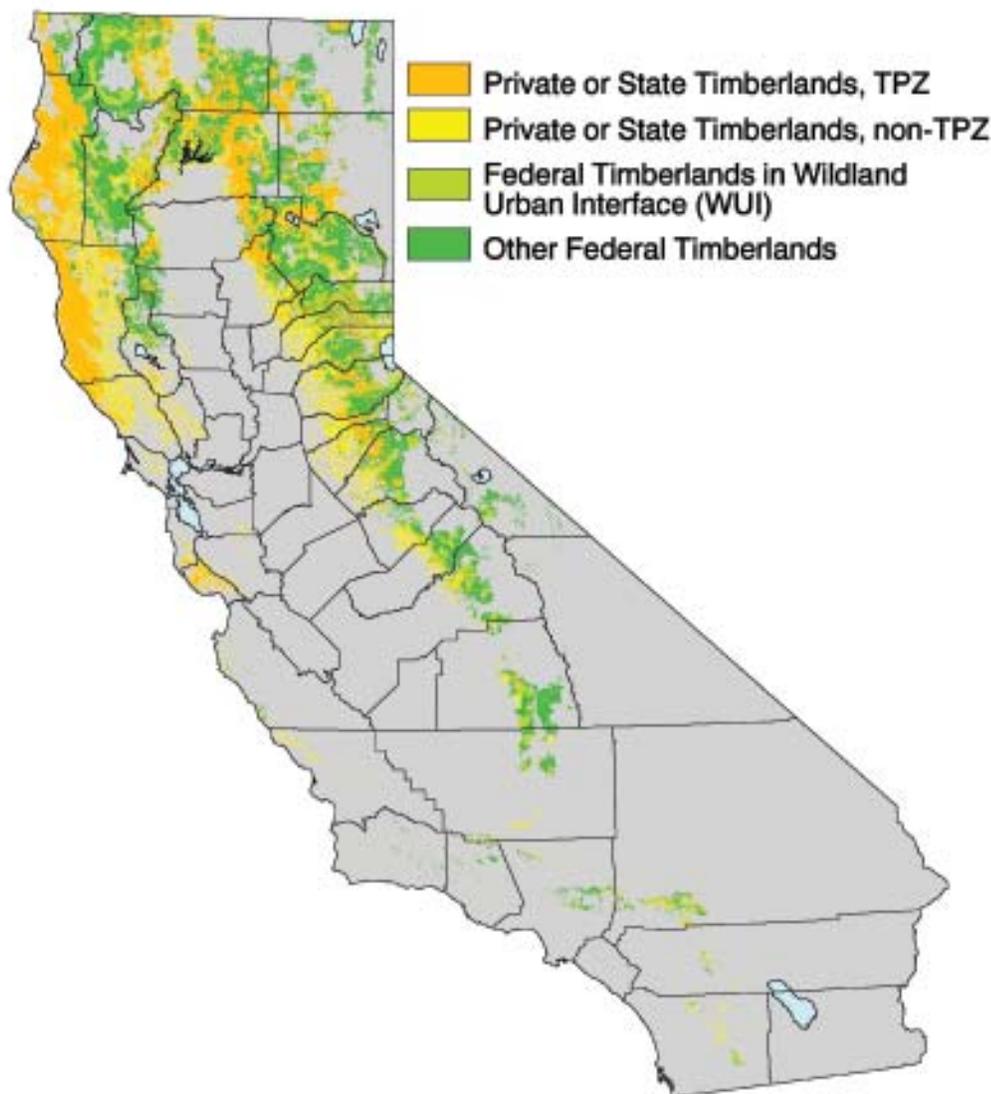
Locations of Timber Management Activities

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

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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

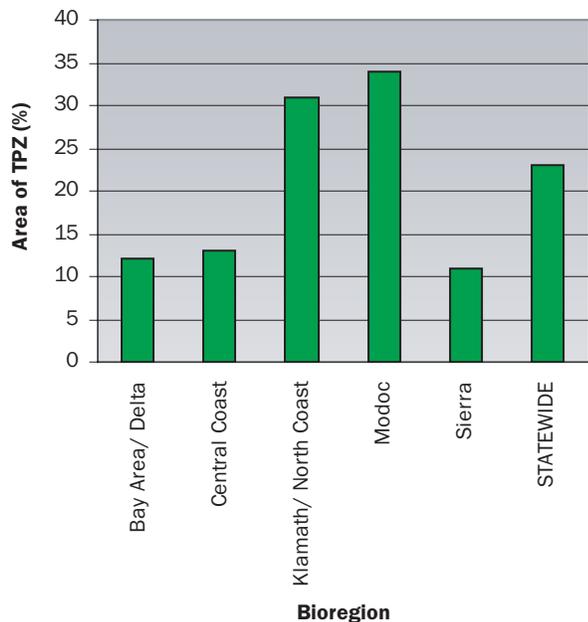
Recent trends in timber harvest levels and types of silvicultural systems used for harvesting provide insight into potential future impacts from timber management. According to the State Board of Equalization (2003), timber harvesting on both public and private lands in California has decreased from 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.

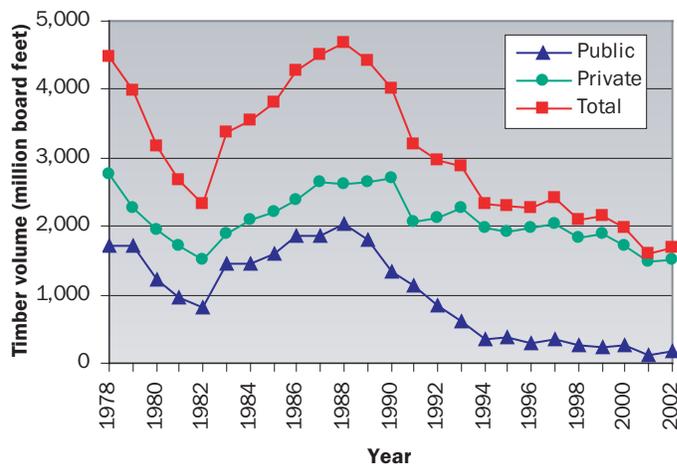
Both trends, overall reduced harvesting and less harvesting of old growth, suggest that land management impacts due to logging will continue to decrease in the future. The logging activities that remain will be focused on lands with younger forests. Even though overall harvesting has declined, California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

Figure 45. Percentage 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

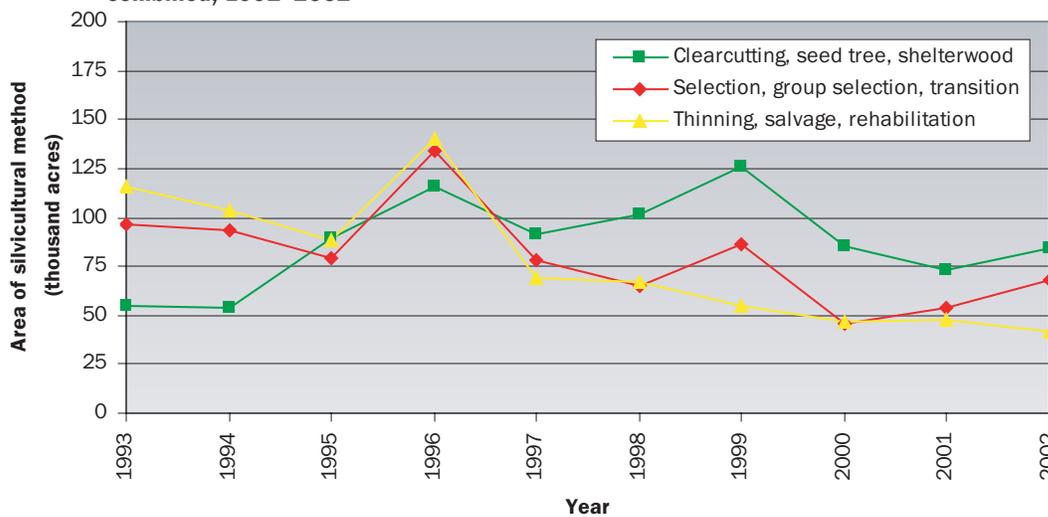


Source: Compiled by FRAP from California State Board of Equalization, 2003

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

3 Forest Health Land Management Activities

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

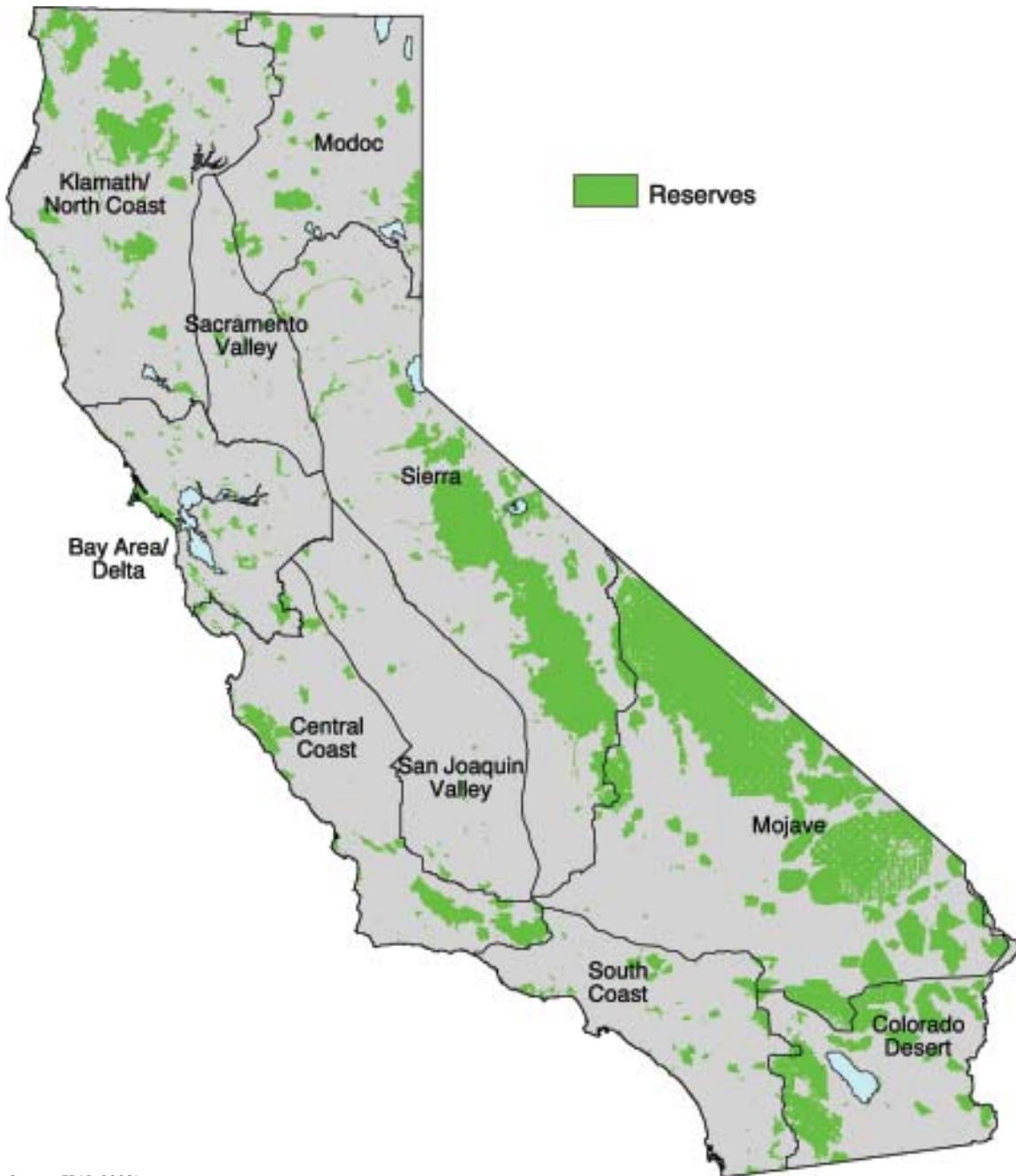
Bioregion	Percentage area in Reserve
Bay Area/Delta	12
Central Coast	15
Colorado Desert	34
Modoc	9
Mojave	43
Klamath/North Coast	13
Sacramento Valley	4
San Joaquin Valley	5
Sierra	22
South Coast	12
Statewide	23

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

3 Forest Health Development

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.

3 Forest Health Development

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

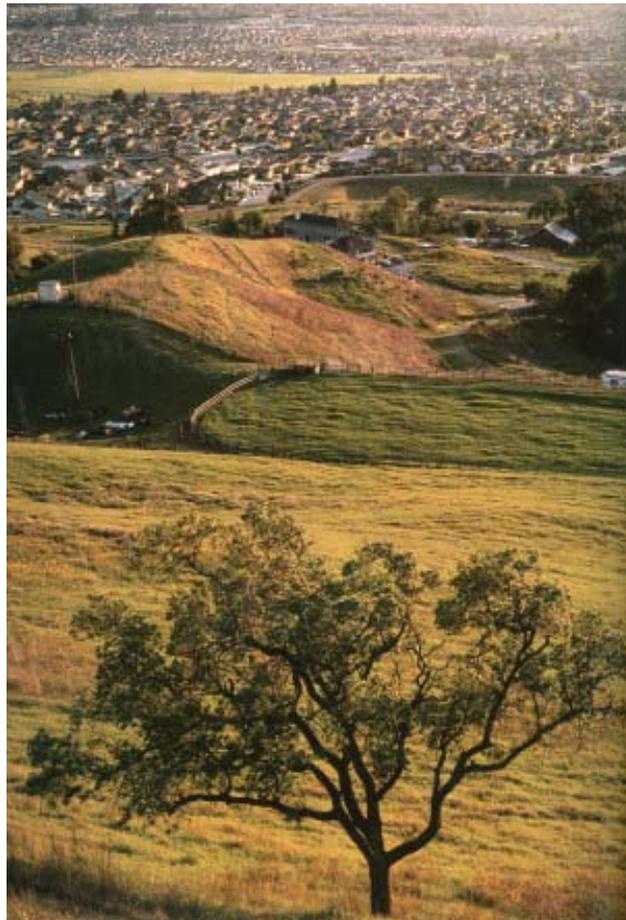
Data Quality: Partial data 🕒

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.

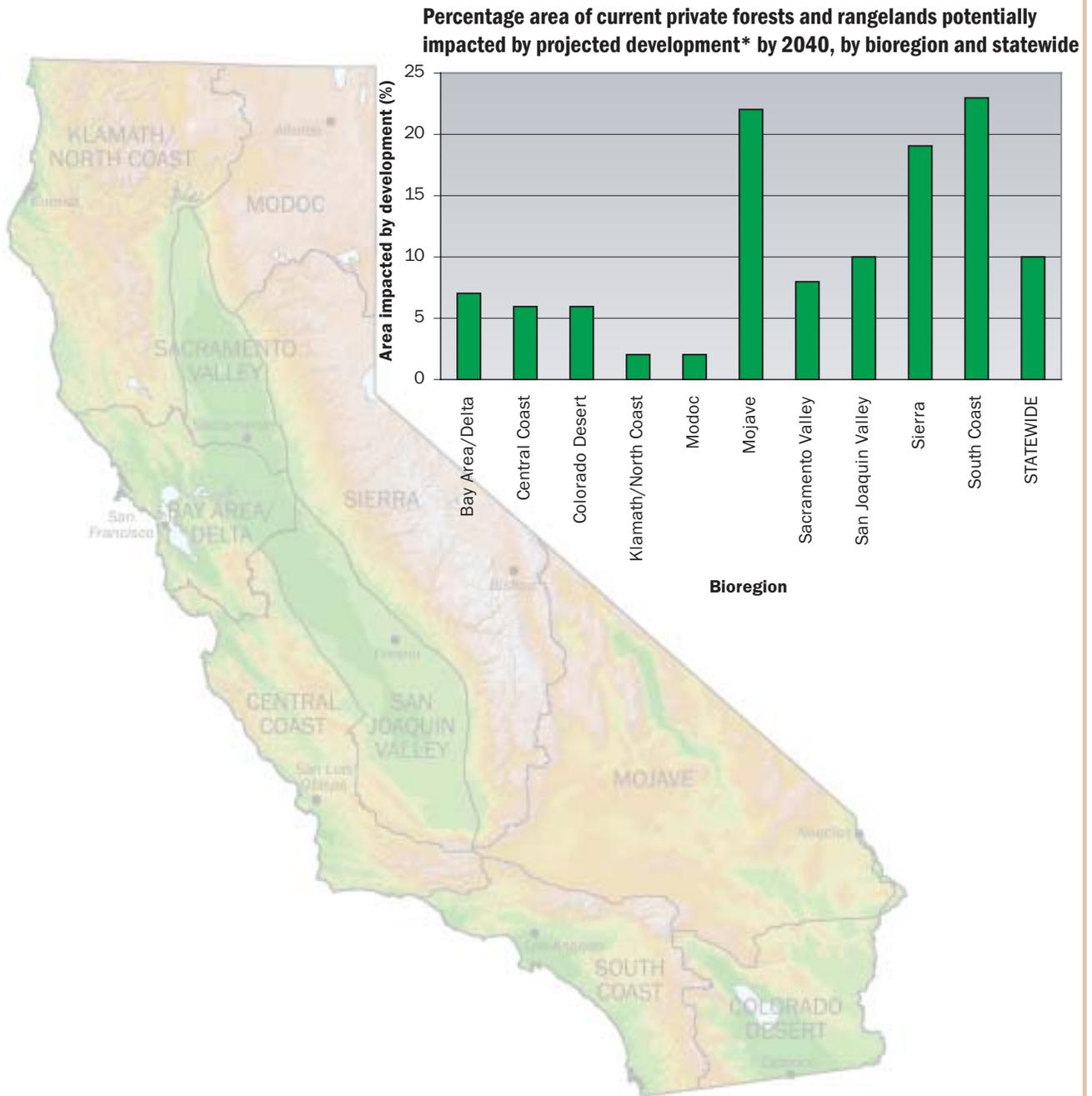
A detailed study conducted by FRAP in El Dorado County reveals that habitat fragmentation and degradation of habitat quality from rural residential development are of greater magnitude than actual habitat loss (Saving and Greenwood, 2002). Whereas projections revealed that only four percent of natural 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.



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

3 Forest Health Development

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

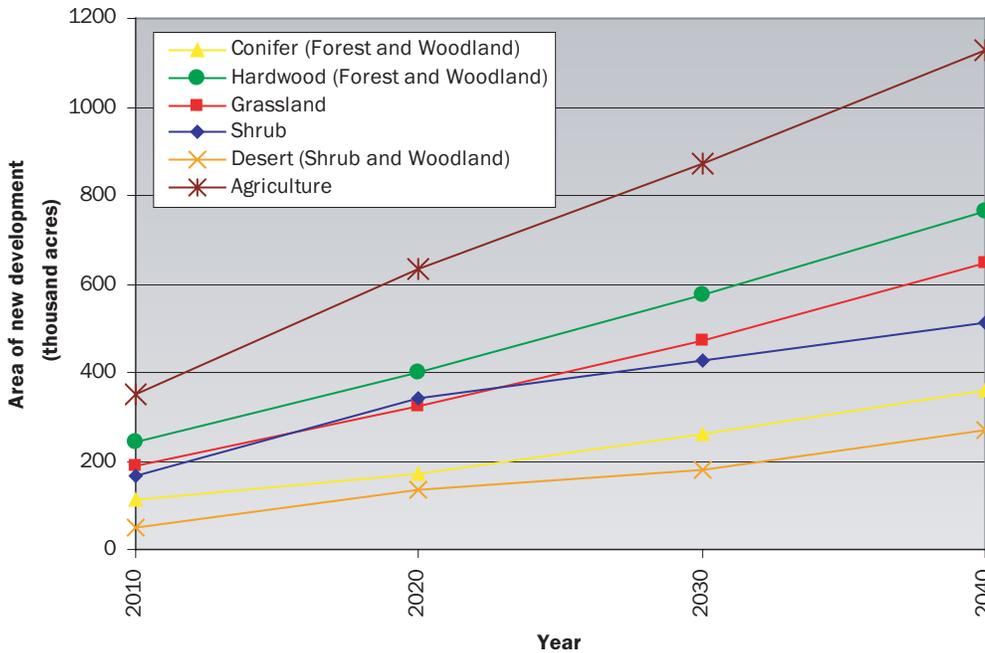
and Wetland) will experience the most development, reaching 2.2 million acres by 2040. This exceeds the projected development of agricultural lands (1.1 million acres) (Figures 50 and 51, Appendix map Historical and Projected Development).

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 2000-2040	Percentage loss 2000-2040
		2000-2010	2010-2020	2020-2030	2030-2040		
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

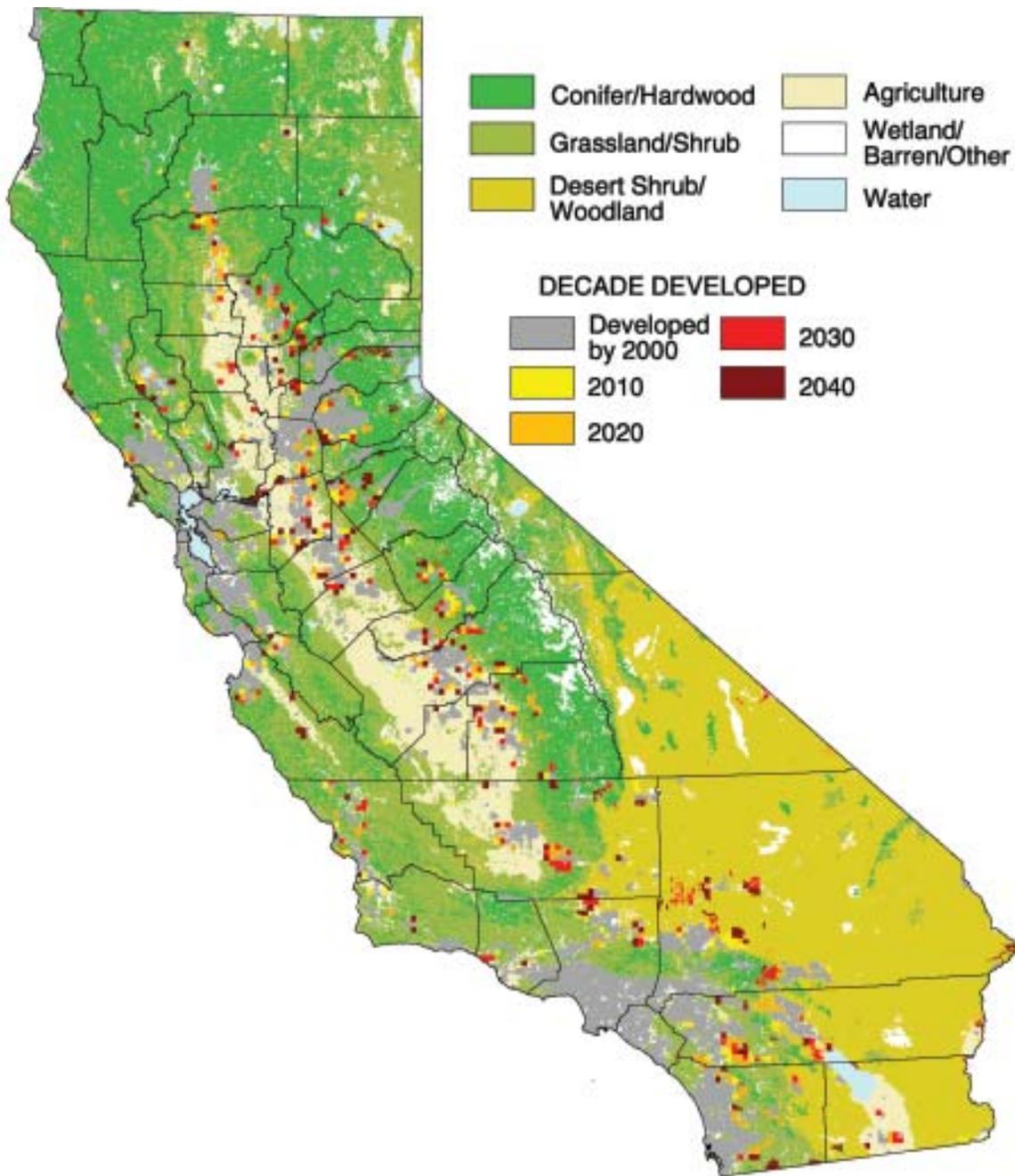
* housing density of one or more units per 20 acres
 ** Only the CWHR type Wet Meadow is considered forests and rangelands. See Appendix, Table A-2.
 Source: FRAP, 2002d; FRAP, 2003b

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.

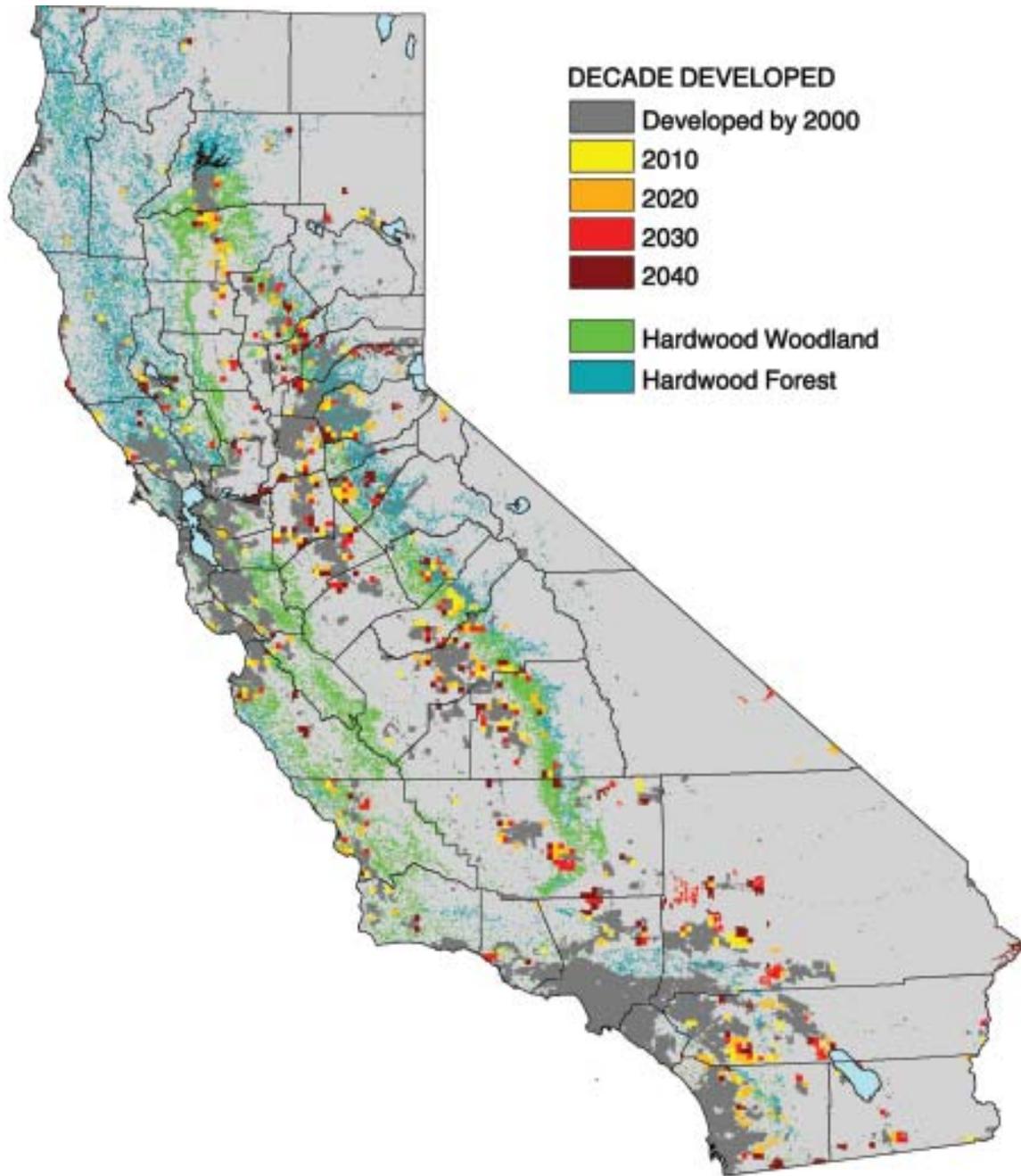
Oak resources can also be protected at the local level through implementation of California Environmental Quality Act (CEQA) guidelines and county general plans. However, local planning processes often do not discuss cumulative impacts across watersheds or larger areas, especially regarding oak woodlands.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

3 Forest Health Wildfire

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.

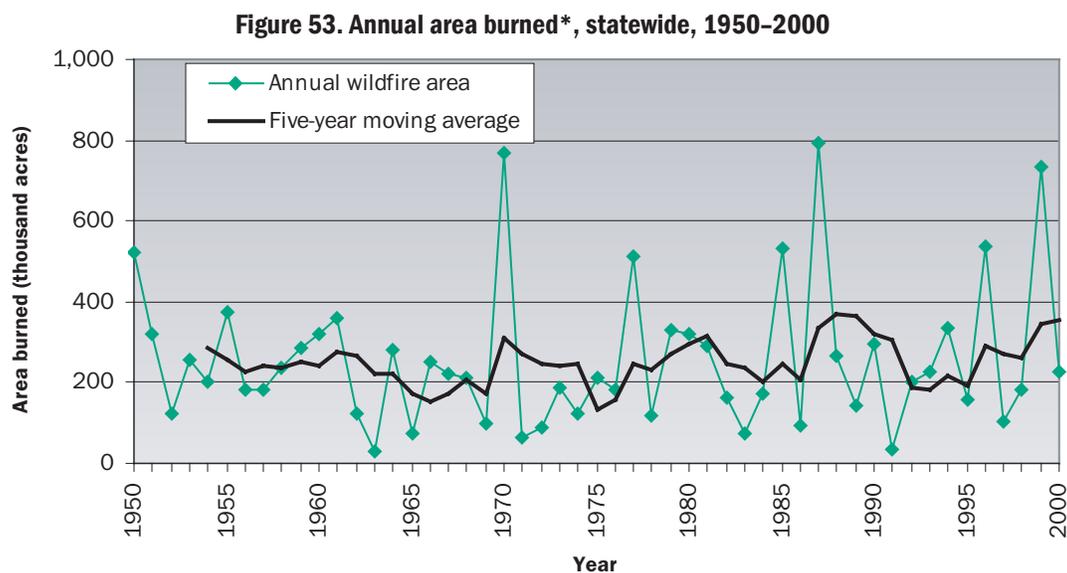
Modern-era acreage of fire covers only a fraction of that during the presettlement era. Over the last two decades, California has averaged 250,000 acres burned annually (Figure 53). This represents only a fraction of the several millions of acres that burned under presettlement regimes. Data from 1950–2000 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**



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

Wildfire

Representative Goal

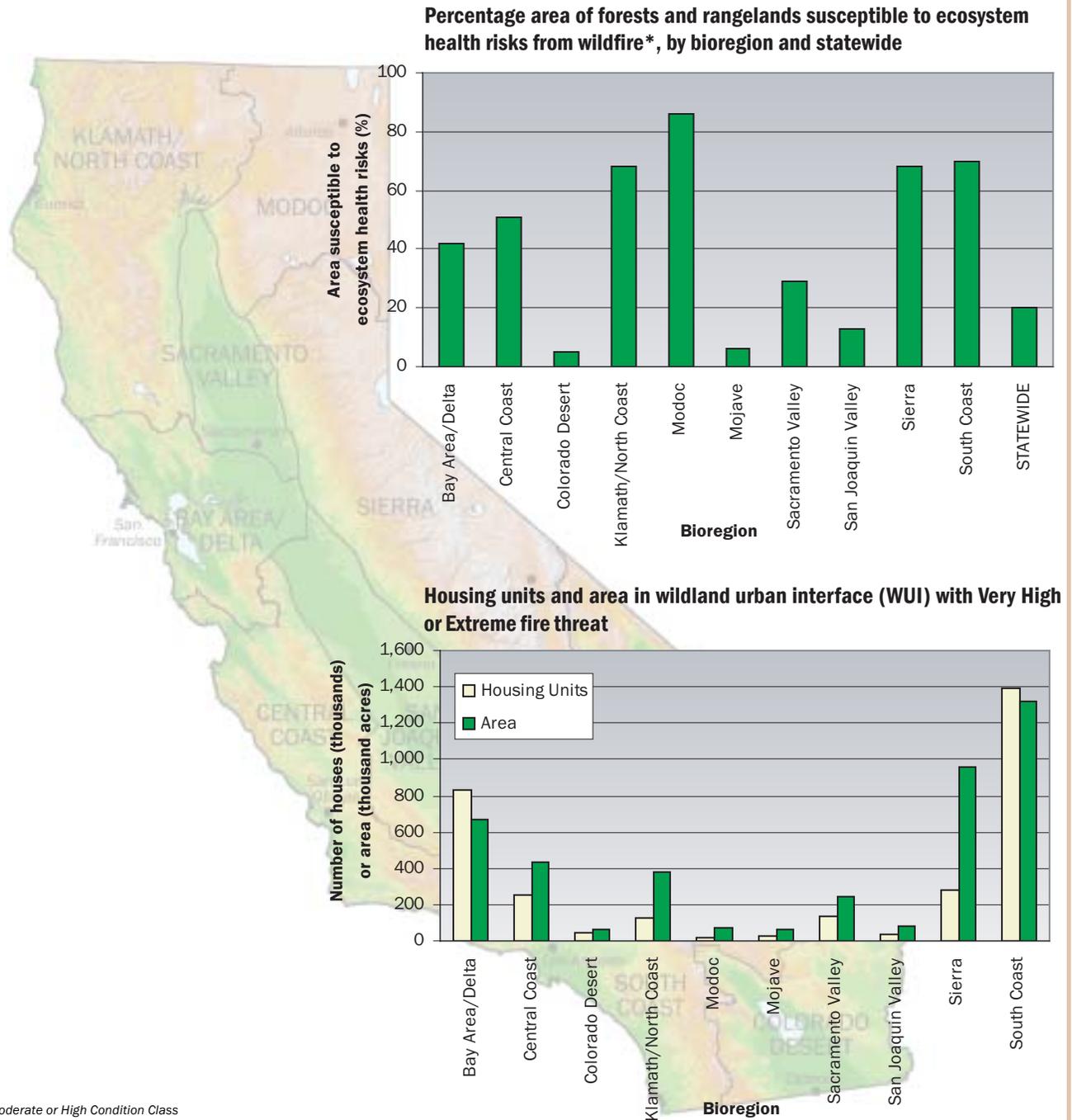
Classify lands ... [for] severity of fire hazard [to] reduce the potential intensity of uncontrolled fires that threaten to destroy resources, life, or property; apply fuels reduction in fire defense improvements; make direct immediate and aggressive continuing attacks on all unwanted fires (*paraphrased 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.

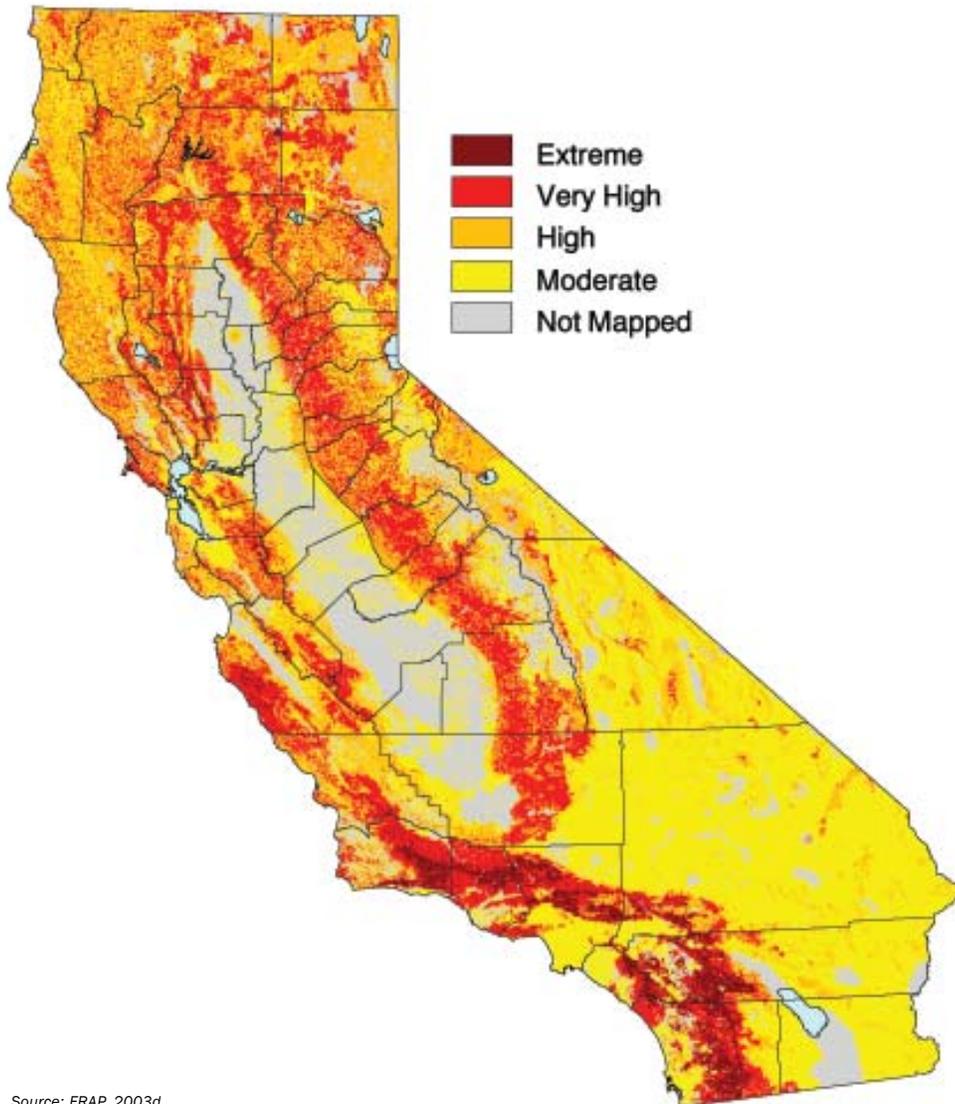
The distribution of fire threat suggests that areas of highest threat are scattered statewide, with large contiguous zones in southern California, the central coast, lower elevations of the Sierra Nevada, and much of the interior of northern California (Figure 55, Appendix map Fire Threat). Fire threat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

tion 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

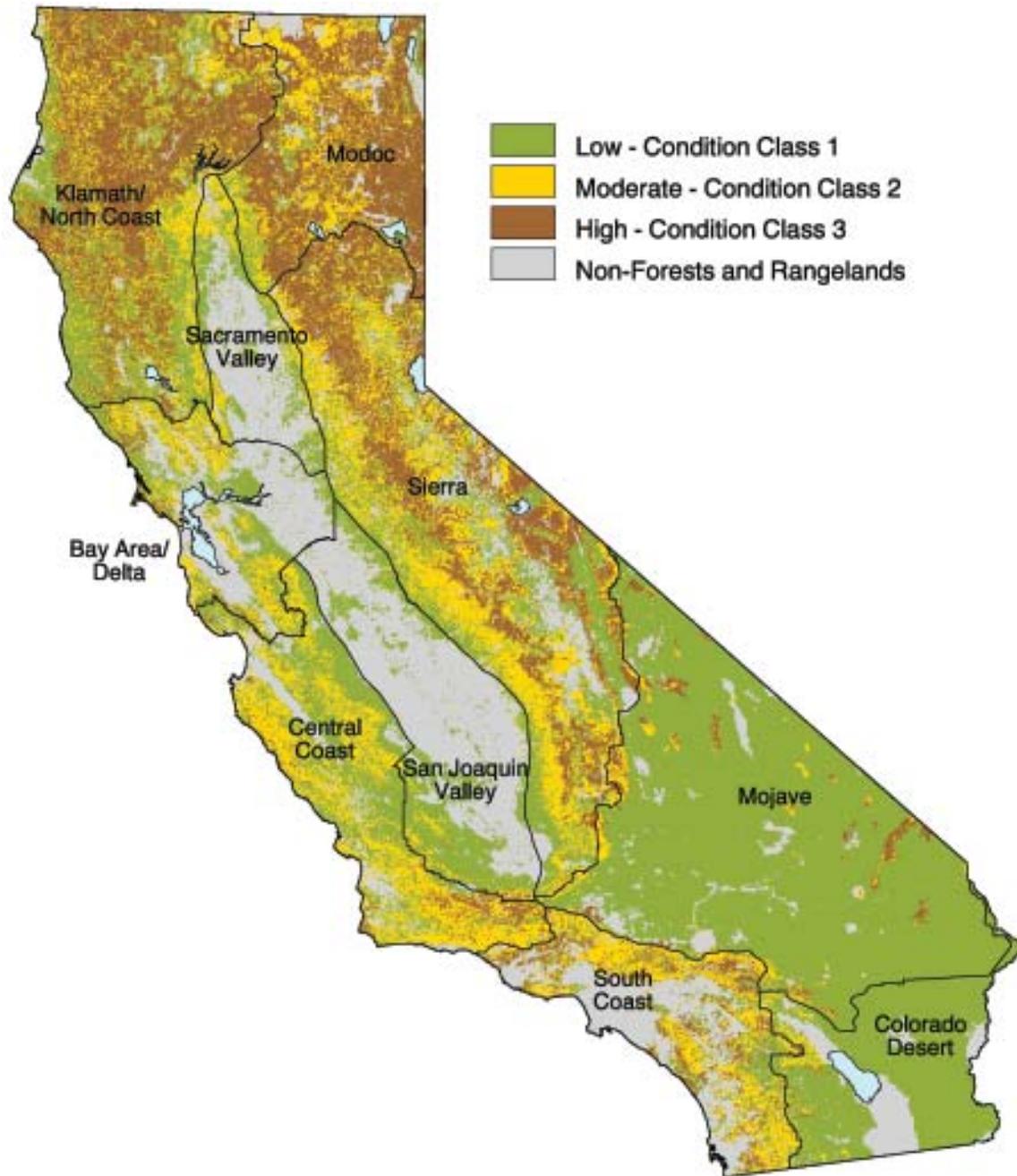
Source: FRAP, 2003c

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

3 Forest Health Wildfire

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

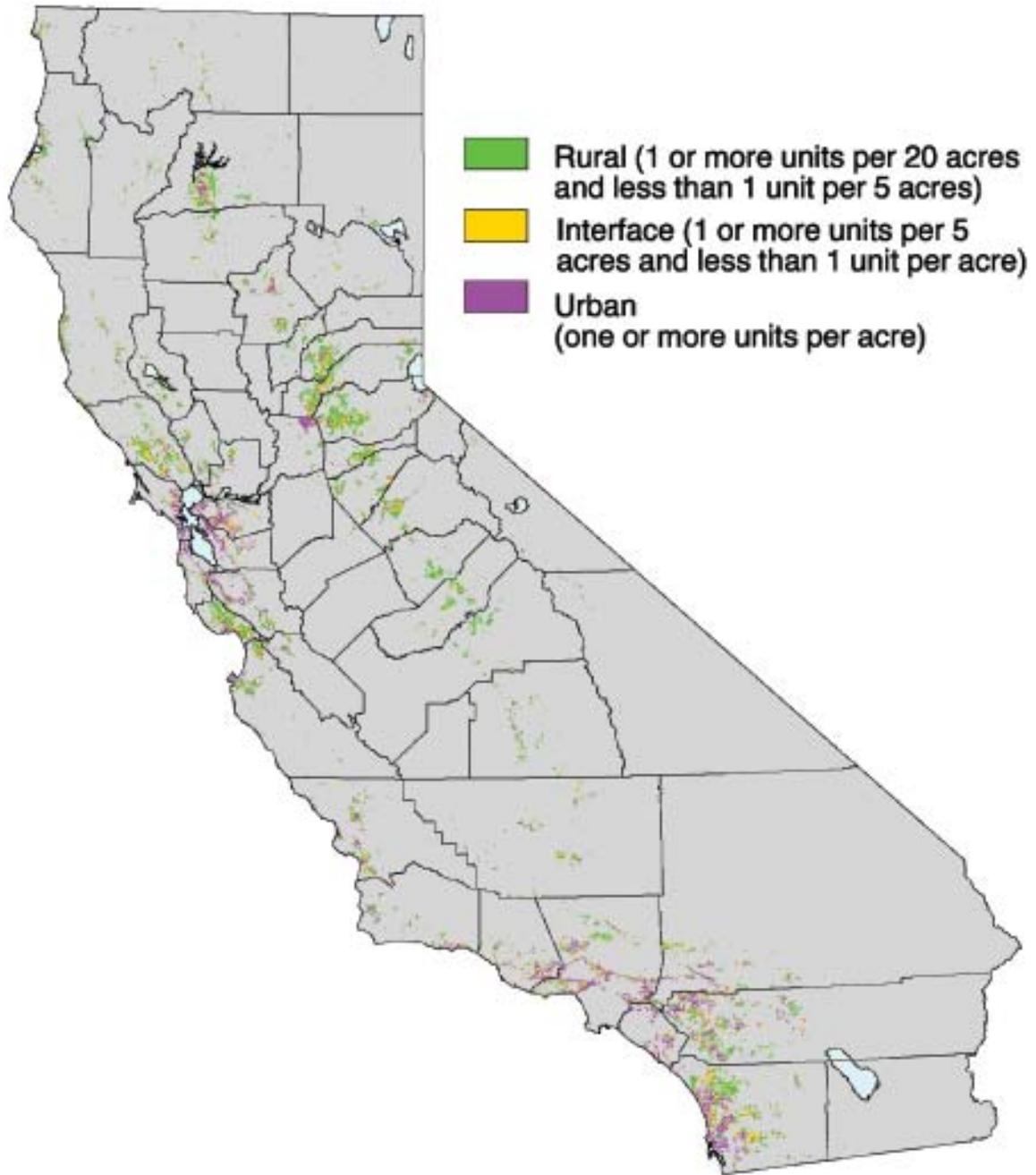
* WUI does not include sparsely populated areas with housing densities less than one unit per 20 acres.
 Source: FRAP, 2003j

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, 2003

3 Forest Health Wildfire

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



3 Forest Health

Pests and Disease

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.

3 Forest Health Pests and Disease

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 📍

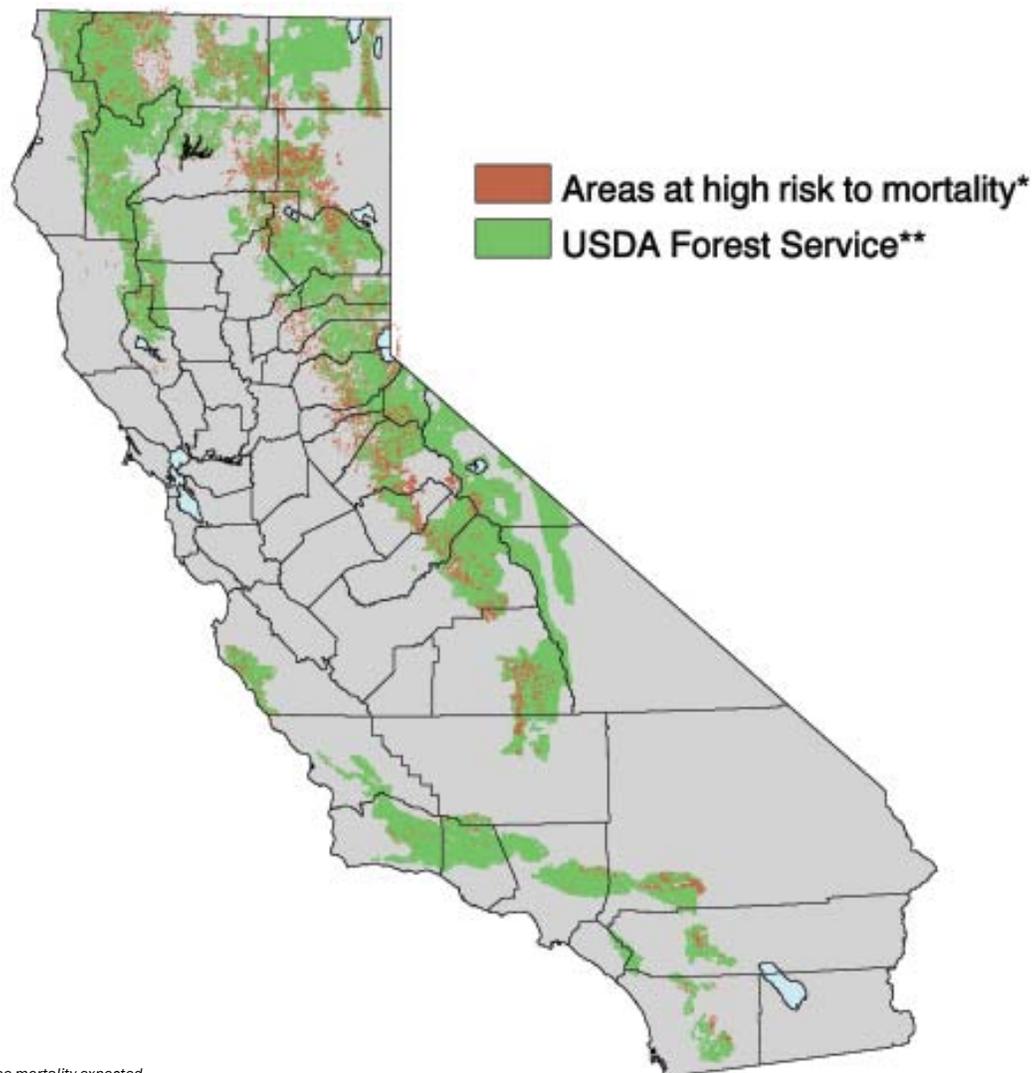
Much of California's forests are at *high risk to mortality* from pest damage (greater than 25 percent tree mortality expected). Given current management regimes and fire suppression tactics, stocking levels on many forests are very high. With increased stocking levels, host materials

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).

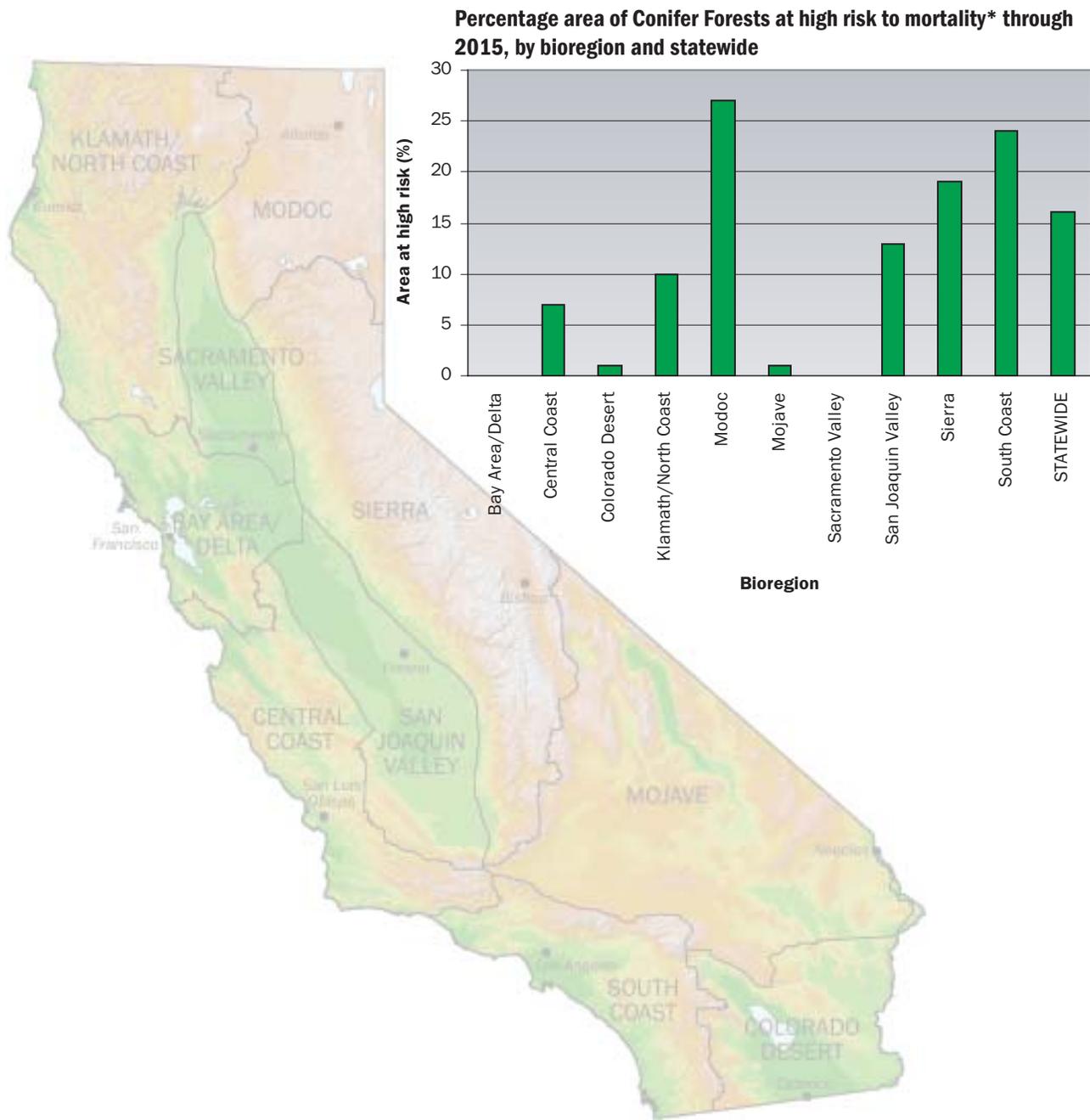
Figure 58. Areas at high risk to mortality* from insects through 2015



* 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

3 Forest Health Pests and Disease

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.

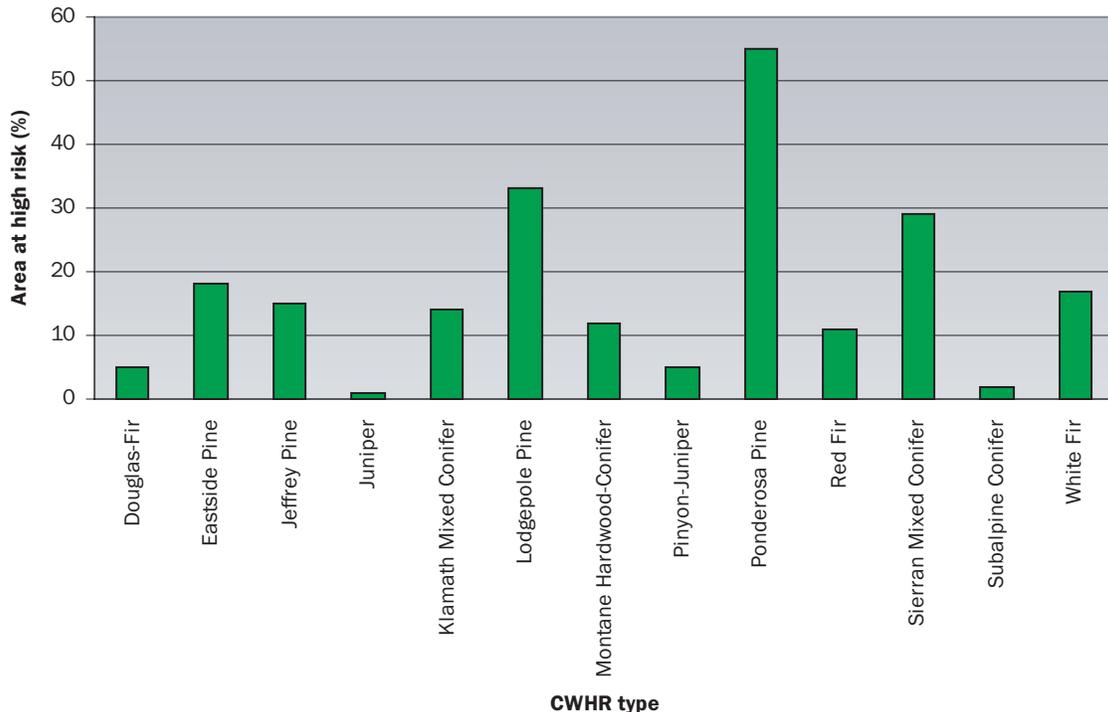
Identification of Emerging Pests and Diseases

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.

Presence or Absence of Range Livestock Diseases

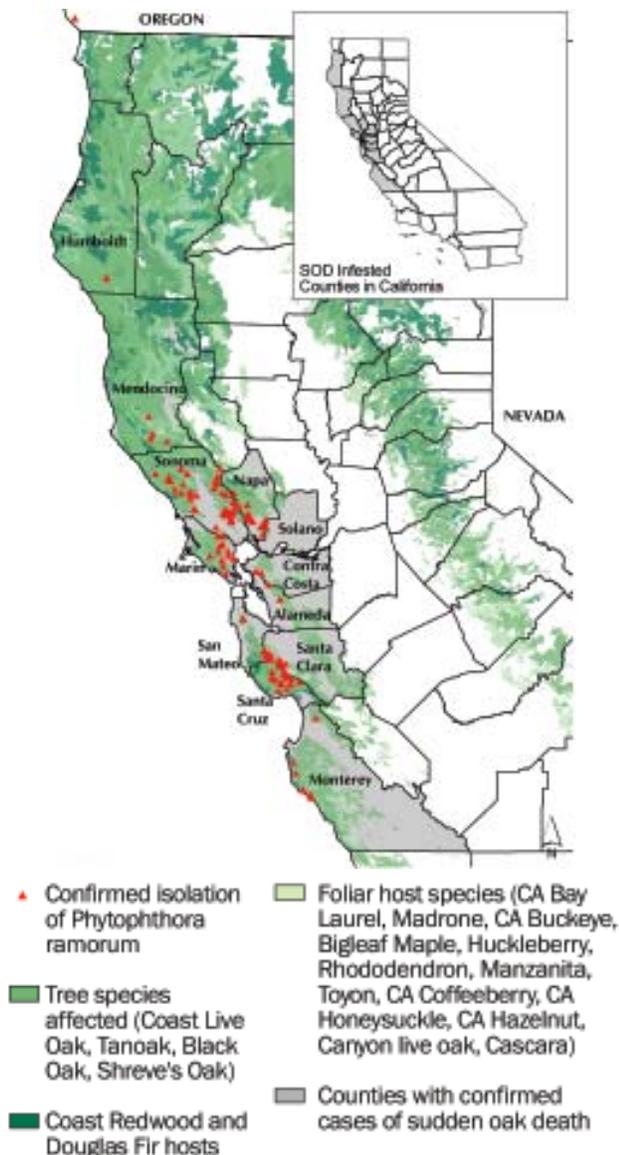
On-line Technical Report:
http://frap.cdf.ca.gov/_assessment/Chapter6_Socioeconomic/rangelivestock.html
Data Quality: Partial data ●

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.

Figure 61. Distribution of sudden oak death*



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

3 Forest Health

Exotic and Invasive Species

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.

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**



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

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.

3 Forest Health

Exotic and Invasive Species

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 health 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 solstitialis*), Scotch broom (*Cytisus scoparius*), and medusa-head (*Taeniatherum caput-medusae*).

An evaluation of the occurrence 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).



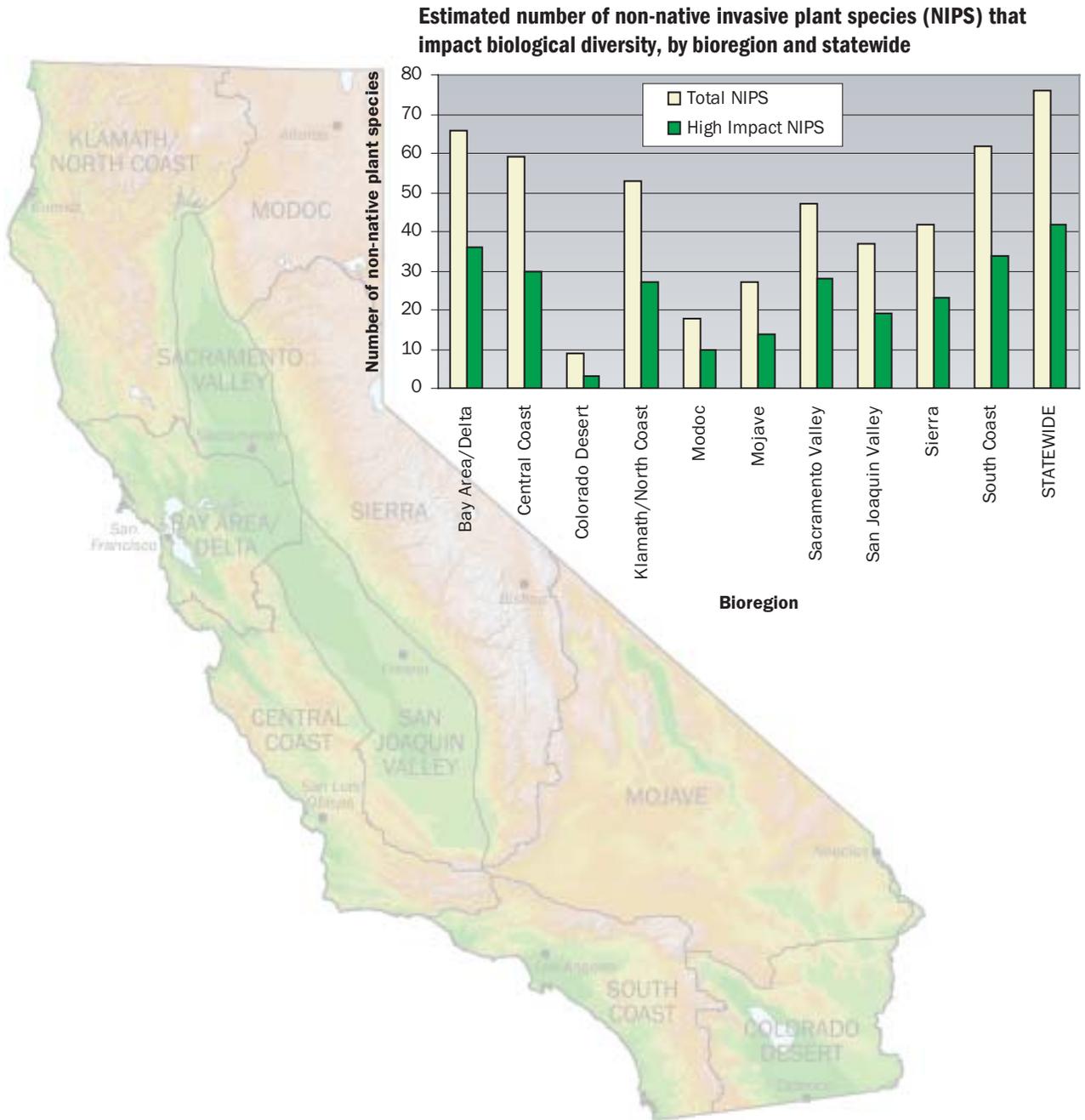
Medusa-head (*Taeniatherum caput-medusae*). Photo courtesy of Craig Thorsen, California Department of Food and Agriculture, Botany Laboratory.



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

3 Forest Health

Exotic and Invasive Species

Proportion of Non-native Animal Species Relative to Total Species

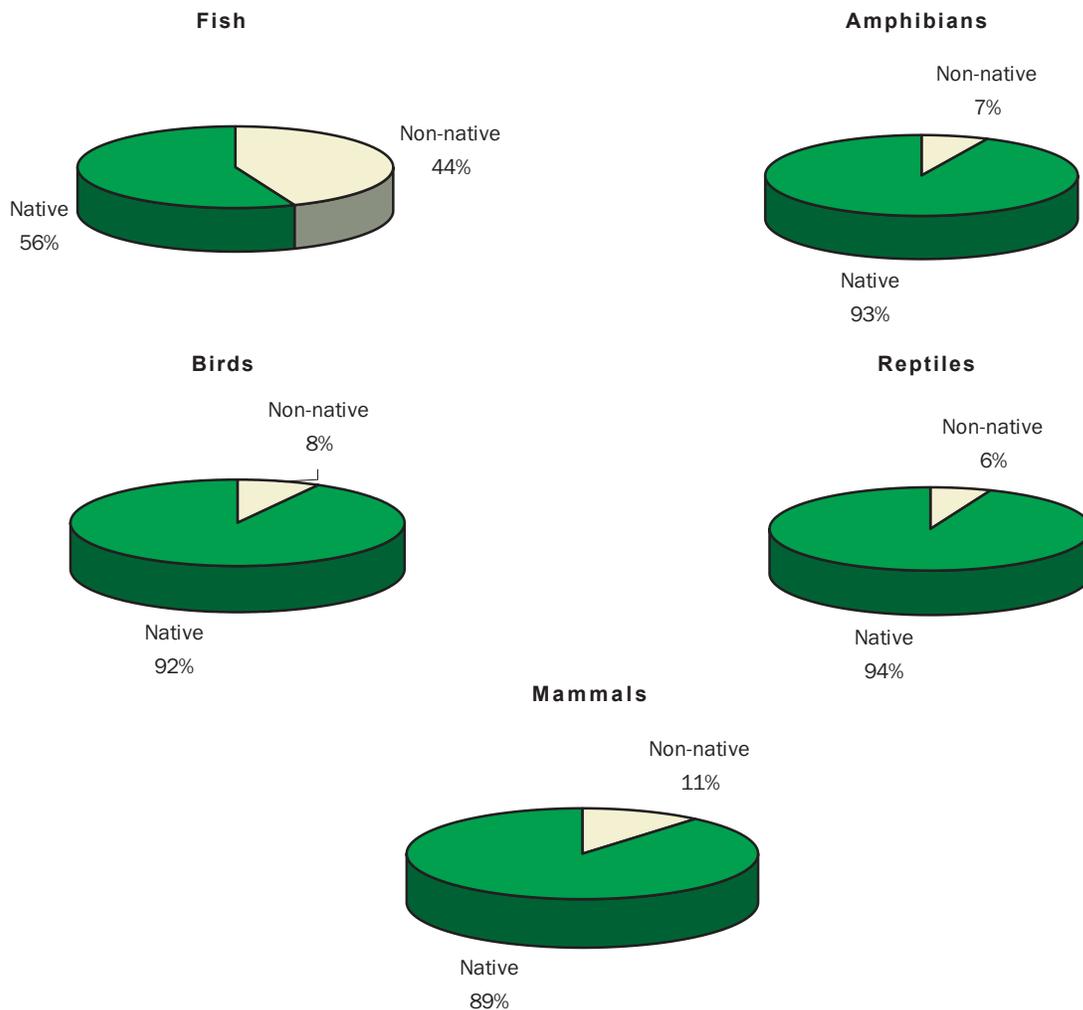
On-line Technical Report:
http://frap.cdf.ca.gov/_assessment/Chapter3_Quality/nonnative.html

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 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 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.

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.



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

3 Forest Health Air Pollution

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.

3 Forest Health Air Pollution

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).

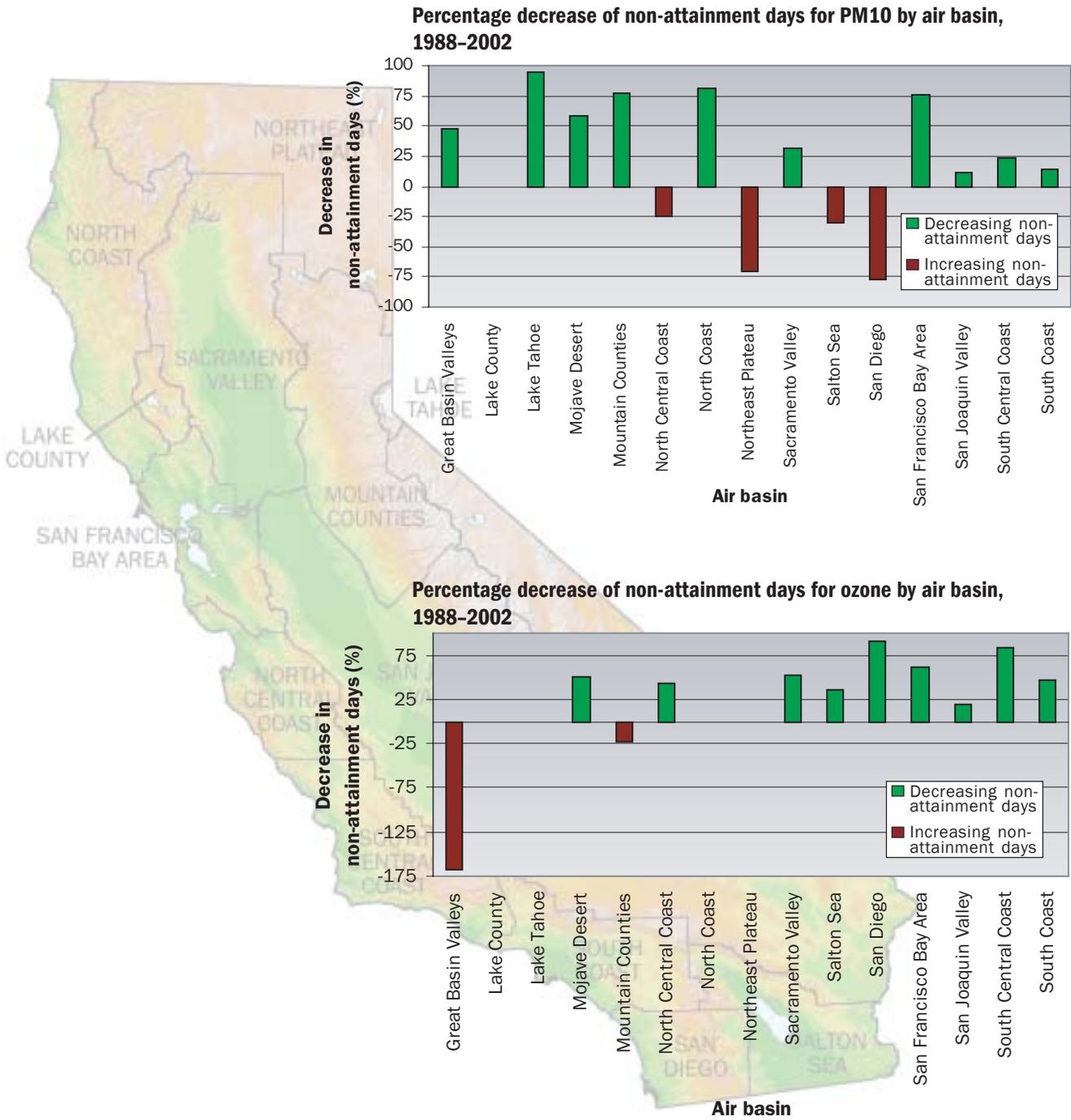
Plant species have varying degrees of sensitivity to ozone exposure. Ponderosa and Jeffrey pines are the most sensitive species and are among the most valuable timber resources in California. Ozone, combined with other stressors such as drought, makes timber resources more vulnerable to disease, fire, 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.



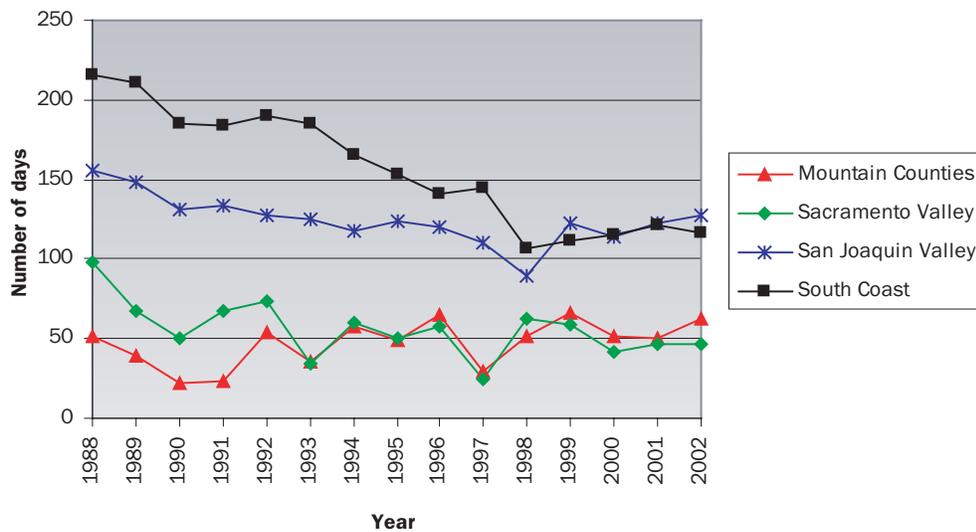
Source: Compiled by FRAP from Alexis et al., 2001
 Map: California Air Resources Board air basins

3 Forest Health Air Pollution

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