

# 2 Productive Capacity

## Productive Capacity Status and Trends

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

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

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

## Productive Capacity Indicators

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



*Skyline yarding used in timber harvesting*

## Productive Capacity

# Representative Goal

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

## Findings

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 On public lands, areas capable of timber production have been administratively withdrawn for a variety of purposes and have been redirected to uses other than those primarily devoted to timber production.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

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### Actual and Potential Growth of Trees on Timberland

**On-line Technical Report:**  
[http://frap.cdf.ca.gov/assessment2003/Chapter2\\_Area/timberland.html](http://frap.cdf.ca.gov/assessment2003/Chapter2_Area/timberland.html)

**Data Quality: All required data** ●

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

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

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

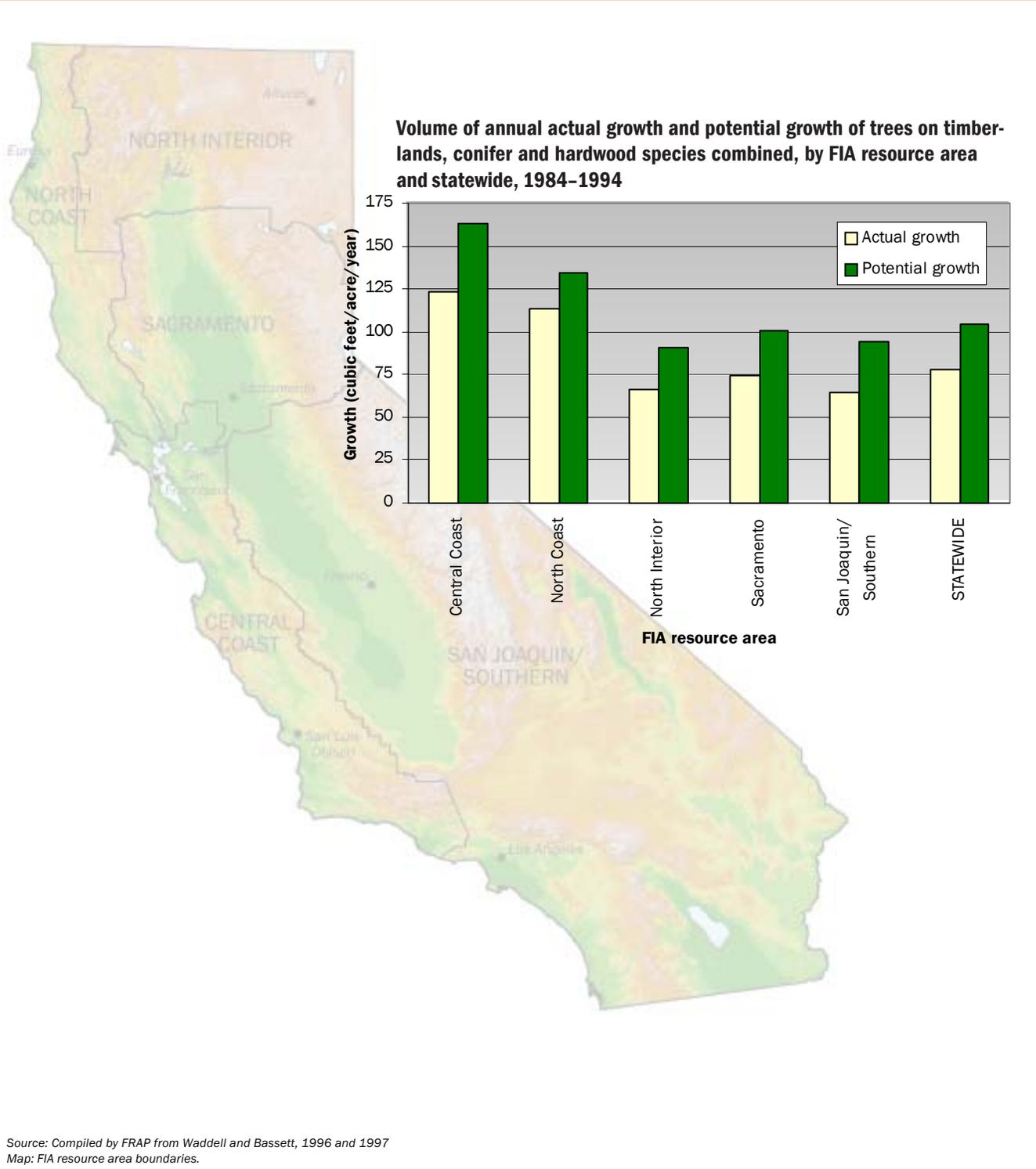
- most regions are not fully utilizing the timber growing capability of their lands, although this may be appropriate based upon economic, ecological, and biological diversity concerns such as streamside protection buffers or special wildlife habitat requirements;
- productive lands occupied by hardwoods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



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

**Figure 24. Regional Productive Capacity Indicators**

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



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## Forest Land Available for Timber Production

**On-line Technical Report:**  
[http://frap.cdf.ca.gov/assessment2003/Chapter2\\_Area/forestlandbase.html](http://frap.cdf.ca.gov/assessment2003/Chapter2_Area/forestlandbase.html)

**Data Quality: All required data** ●

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

Although 16 million acres are productive and statutorily available for timber production, much of the land is not “suitable” due to public agency management plan designations or regulation constraints on private lands. In the case of the 9.2 million acres of timberland in public ownership, substantial portions have been in effect ad-

ministratively withdrawn and have been redirected to uses other than those primarily devoted to timber production. In most resource areas, very limited amounts of public timberland are available for harvests under existing or proposed national forest management plans. No areas in Southern California national forests are primarily devoted to timber production.

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

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

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



Figure 25. Forest land\* and FIA resource areas



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

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



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

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

Timberland is permanently removed from production when it is converted to other uses such as development or intensive agriculture. Timberland can also be removed from production through transfers to another

administrative status such as reserves in either public or non-profit ownership. The primary goal of these land shifts from timber production is the enhancement of ecosystem services and related open space and recreational uses.

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

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

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

\* Values may not sum to totals due to rounding.

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



### Characteristics of Timberland Growing Stock

**On-line Technical Report:**  
[http://frap.cdf.ca.gov/assessment2003/Chapter2\\_Area/timberland.html](http://frap.cdf.ca.gov/assessment2003/Chapter2_Area/timberland.html)  
**Data Quality: All required data** ●

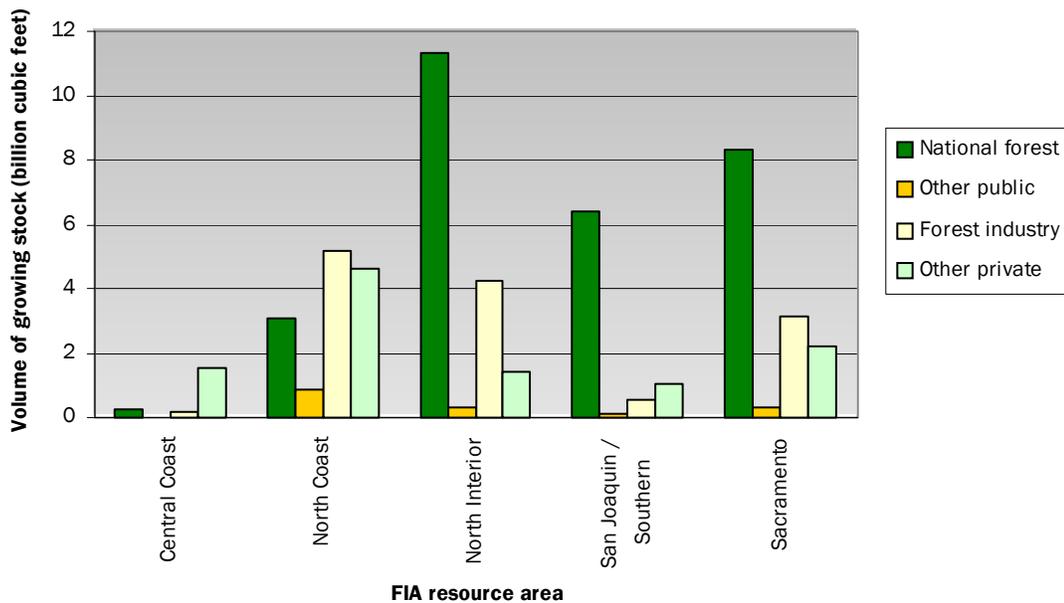
Estimates of growing stock volume (measured by trees greater than five-inches in diameter at breast height (DBH)), and how it changes are central to assessments of sustainable timber production. Decreases in volume due to losses from wildfires or changes in age structures due to timber management affect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

In 1994, California timberlands contained an estimated 55 billion cubic feet of wood. Fifty-three percent (29 billion cubic feet) of the total net volume of grow-

ing stock was on national forest land, 24 percent (13.3 billion cubic feet) on forest industry, 20 percent (10.8 billion cubic feet) on other private, and the remaining three percent (1.6 billion cubic feet) on other public lands (Figure 27). The North Interior, Sacramento, and North Coast areas have the highest growing stock volumes.

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

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



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

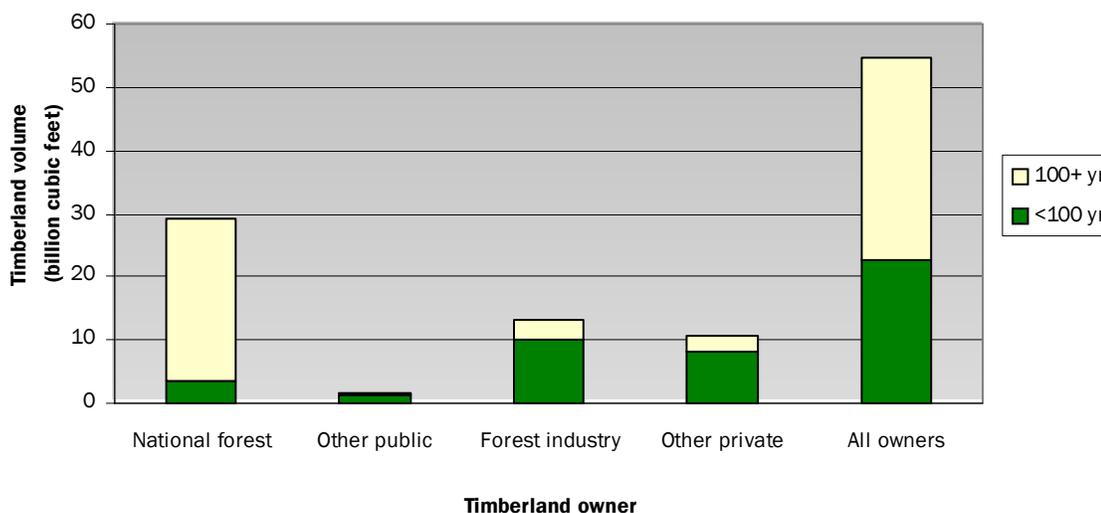
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The distribution of age classes or successional stages of timberlands provides information about the future availability of trees of different sizes that can be used for different purposes. As of 1994, California had a wide age class distribution of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

Viewing the pattern of timberland age distribution by ten-year age class groups reveals that the two largest

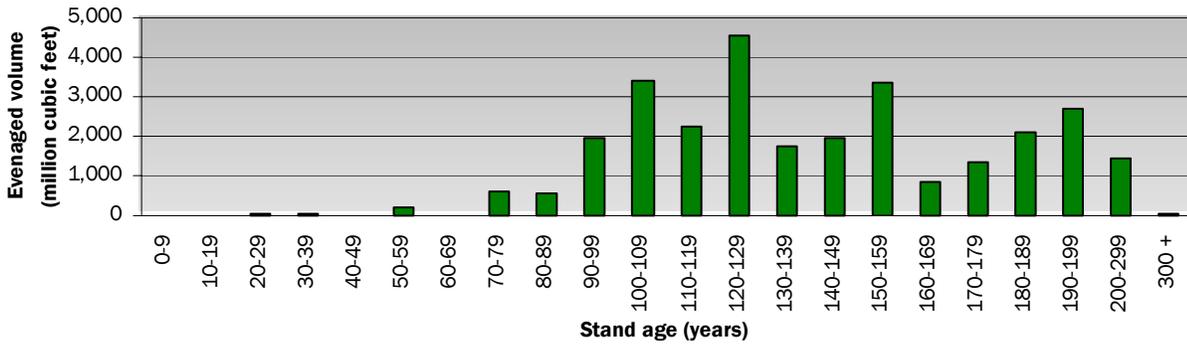
ownership classes show different age class structures for evenaged forests (stands where more than 70 percent of the volume is in trees within a 30-year age band) (Figures 29 and 30). For example, national forests consist of greater proportions of growing stock in older age classes than do forestry industry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

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



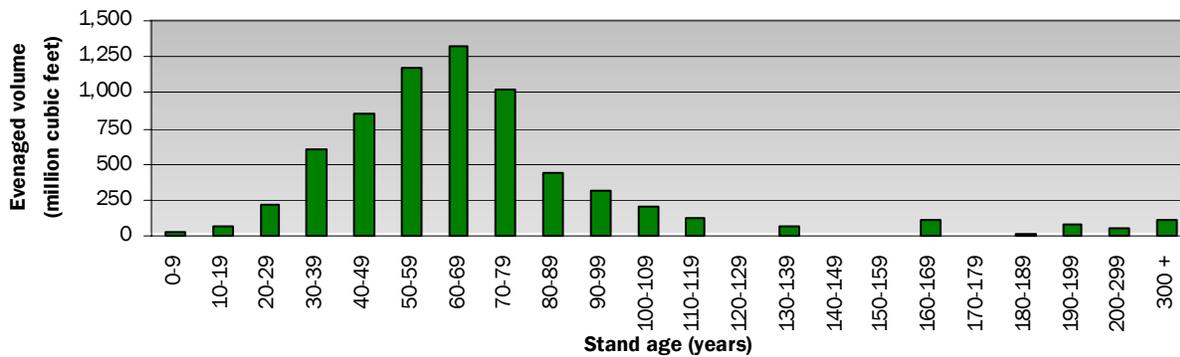
Source: Compiled by FRAP from Waddell and Bassett, 1996 and 1997

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



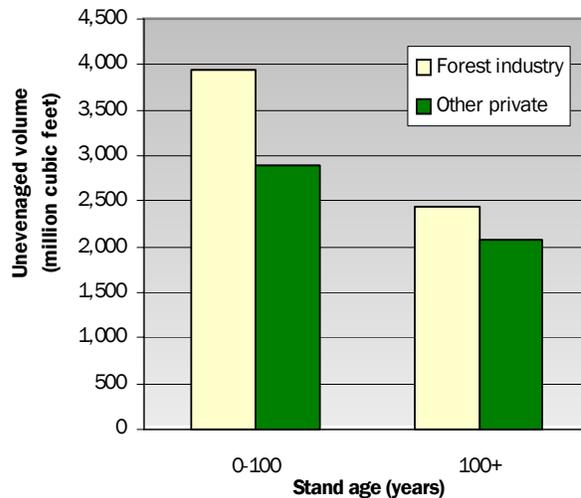
Source: Compiled by FRAP from Waddell and Bassett, 1996 and 1997

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



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

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



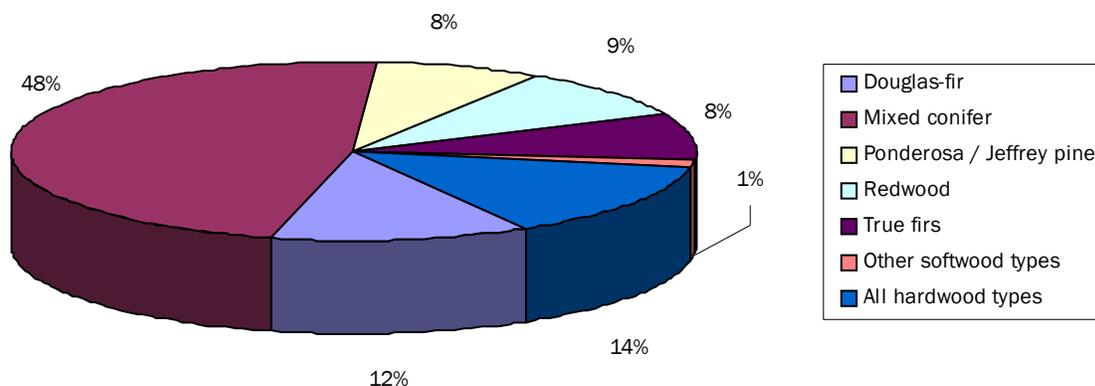
Source: Compiled by FRAP from Waddell and Bassett, 1996 and 1997

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Forest composition is another descriptor of forests and refers to tree species grouped into forest types. Softwood forest types (stands dominated by coniferous tree species, usually evergreen with needle-like leaves) dominate California's timberlands across all ownerships. Approximately 86 percent of the net volume of growing stock on California timberlands is composed of soft-

wood forest types while hardwood types comprise 14 percent. The forest types on timberlands have been grouped into seven general categories (Figure 32), and a detailed listing of timberland growing stock volume by forest type and ownership is included in Table 19. The mixed conifer forest type is the most dominant, comprising nearly half of all timberland volume.

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



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

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

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

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

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

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

## Timber Harvest Versus Growth between 1984 and 1994

**On-line Technical Report:**  
[http://frap.cdf.ca.gov/assessment2003/Chapter2\\_Area/timberland.html](http://frap.cdf.ca.gov/assessment2003/Chapter2_Area/timberland.html)

**Data Quality: All required data** ●

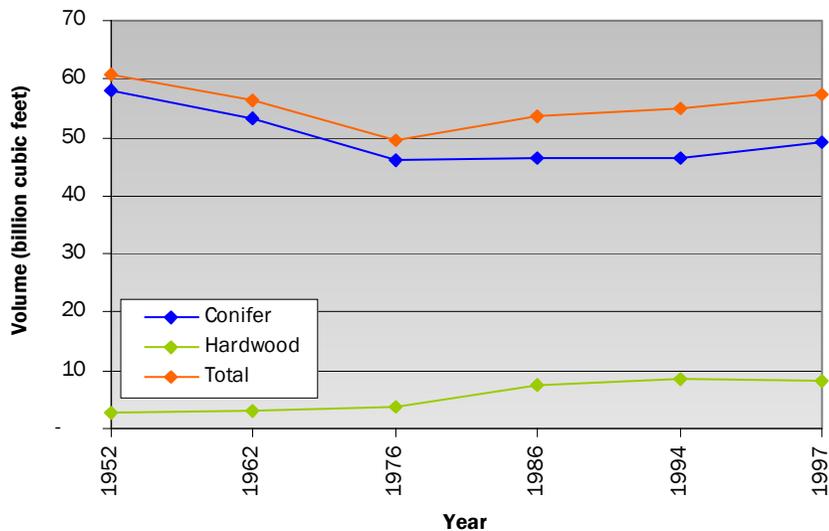
A standard measure of sustainable timber production is the comparison of harvest to growth over time. In terms of growth, the standing volume of California's timberland inventory continues to increase and is approaching pre-1950 levels (Figure 33, next page). As large volumes of old growth timber were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

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

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

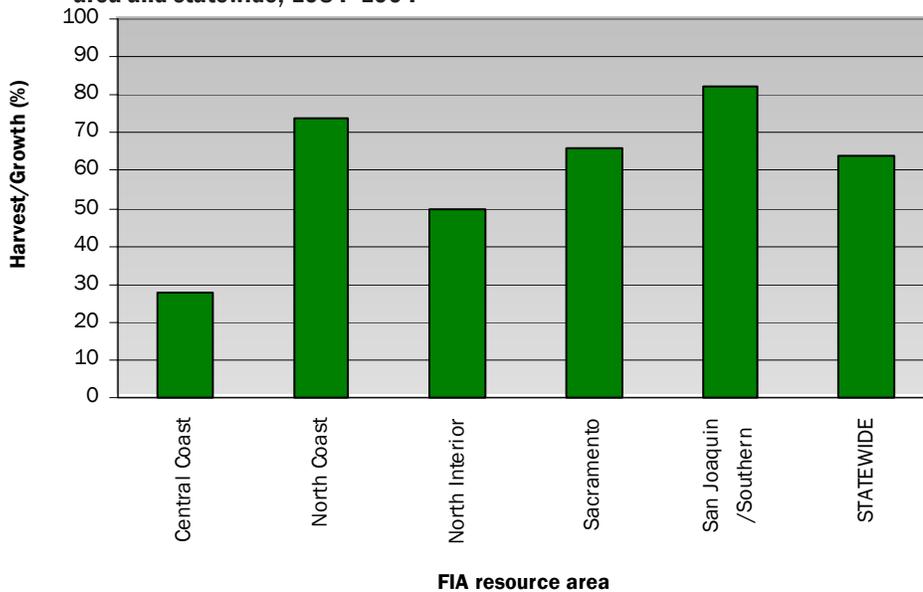
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**Figure 33. Net volume of conifer and hardwood growing stock on timberland, statewide, 1952-1997**



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

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



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

## Rangeland Available for Grazing

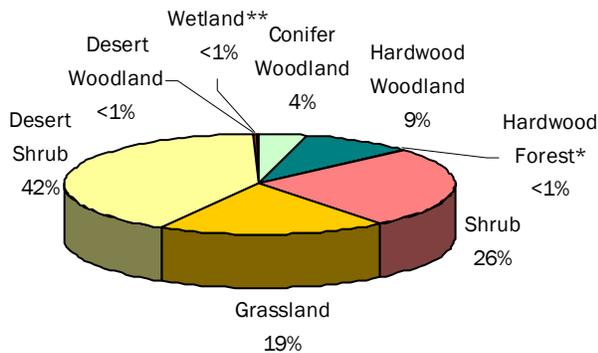
**On-line Technical Report:**  
[http://frap.cdf.ca.gov/assessment2003/Chapter2\\_Area/rangelandarea.html](http://frap.cdf.ca.gov/assessment2003/Chapter2_Area/rangelandarea.html)

**Data Quality: Partial data** 

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

Identifying the specific land covers most important to grazing provides a broad estimate of rangelands (Figure

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



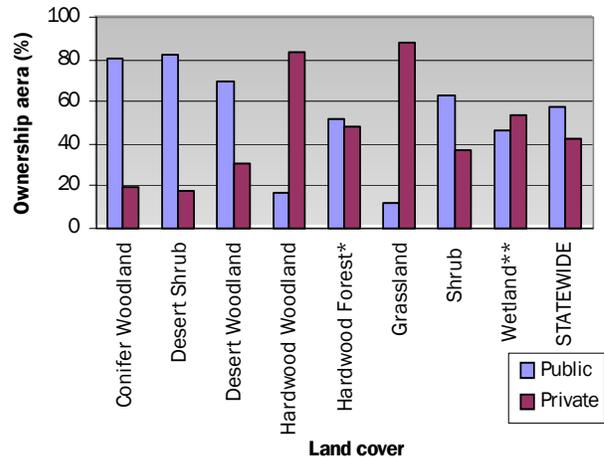
\* Montane Hardwood Conifer CWHR type is not considered primary rangelands.  
 \*\* Only the Wet Meadow CWHR habitat type is considered primary rangelands. See Appendix.  
 Source: FRAP, 2002d

35). The total area of primary rangelands is approximately 57 million acres, or nearly 57 percent of the State (Table 20).

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

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

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



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

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

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

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

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

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

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

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

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

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

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

**Table 22. Various rangeland area estimates by ownership, 1997**

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

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