



# Forest Management in the 21st Century

## Changing Numbers, Changing Context

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ABSTRACT

Results from the fifth Resources Planning Act (RPA) Timber Assessment suggest that we face a future nearly the reverse of that anticipated in the Forest Service's first post-World War II assessment completed five decades ago, with a growing abundance of softwoods but a regionally restricted supply of hardwoods. Both the bulk of the softwood harvest expansion and the set of limitations in hardwood supply are in the US South. Assessment results also provide insights on trends in some measures of sustainable forest management, timber supply complexities in western forest health issues on public lands, the impacts of forest fragmentation, and the preeminence of private lands in national timber supply.

**Keywords:** economics; industry; sustainable forestry

This article outlines some of the key findings from the current Resources Planning Act (RPA) Timber Assessment and suggests how they might relate to future timber management and forest policy. These findings include

- An economic abundance of softwood timber will be accompanied by relatively stable prices, and a contraction in supplies of hardwoods will be accompanied by rising prices.
- The largest part of future harvest increases is concentrated in the US South.
- There are positive changes in some national and regional measures of sustainable forest management.
- There will be market complications in dealing with forest health issues in the West.
- Fragmentation of the forest land base will continue.
- Preeminence of private lands in timber supply will occur.

### Many Softwoods, Limited Hardwoods

Earlier timber assessments have presented arguments for forest management in the context of increasing soft-

wood resource scarcity and an “over-abundance” of hardwoods (e.g., USDA-FS 1958, 1973). Policy issues were reduced to a consideration of measures that would (1) close the expected gap between increases in softwood demand and slower increases in supplies and (2) find new markets for an expanding hardwood resource. In the current RPA Timber Assessment, this outlook has been partially reversed (*table 1, p. 40*). We see a relative economic abundance of softwood timber in the future but a mixed regional outlook for hardwood supplies. Specifically, we face a future in which softwood timber harvests and inventories continue to rise (as they have in most regions for the past 50 years), but real timber prices show modest growth. Hardwood harvest will also increase, while inventories will rise in the North but fall in the South. Hardwood stumpage prices will rise at varying rates in all regions.

In terms of underlying changes in softwood stumpage markets, demands for both sawtimber and pulpwood expand markedly in the projection, but supplies, albeit from varying sources,

keep pace and limit price growth. The rapid price growth experienced in the 1990s has come to an end. At the same time, prices are not expected to fall back to levels observed in earlier decades. Softwood stumpage prices have taken another, essentially permanent, step upward as they have in many similar periods in the past.

In fact, this is not the first assessment to suggest these results. *Figure 1* (p. 41) illustrates softwood sawtimber stumpage price forecasts from the last five RPA Timber Assessments for the South. Since 1989, these projections have envisioned roughly stable prices after 2010. In earlier projections completed in 1979 and 1983, sawtimber prices rose steadily. Pulpwood prices have been projected only in the most recent assessments and generally have shown little growth above historical levels.

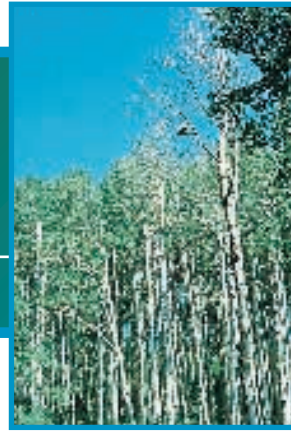
For sawtimber the differences between the rising price trend projections in 1979–83 and more recent studies result primarily from changes in the methods used to project the private forest inventory. Earlier projection models represented the inventory on a diameter-class basis and assumed that the diameter growth rates observed in the historical inventory data would remain the same in the future. In retrospect, the resulting aggregate growth projections, particularly for forest industry lands, were extremely conservative, leading to lower inventory projections and stable or contracting sawtimber supply over the projection. Because demand forecasts did not differ greatly from those of later assessments, the result was a rising price trend.



With more area devoted to timber production than all other regions combined, the South is the largest timber-producing region in the United States. Nearly 80 percent of projected increases in softwood harvests will come from the South. *Above: Red spruce (*Picea rubens*).*



By 2050, hardwood removals in the Northeast will be 33 percent higher than average levels of the 1990s, while North-Central harvest will be roughly 6 percent higher. In the North as a whole, harvests will rise less rapidly than growth and nonindustrial inventories will expand by more than 50 percent. *Above: Yellow-poplar (*Liriodendron tulipifera*).*



The forests of the Interior West face unique forest health and fire hazard issues arising from decades of fire suppression. It is unlikely that there will be sufficient markets or productive capacity to process the material removed in fuel-reduction operations, a scenario with profound implications for forest management in the region. *Above: Quaking aspen (*Populus tremuloides*).*



In the Pacific Northwest, the recent declining trend of industrial harvest will soon end, as large areas of young growth reach the age of minimum merchantability. By 2050 projected industrial inventories will be roughly 18 percent higher than 1997 levels, and NIPF inventories will rise by 22 percent. *Above: Western hemlock (*Tsuga heterophylla*).*

But the effects of higher growth and more abundant supplies were foreseen even in the 1979 assessment (labeled “1979 with intensive management” in *fig. 1*), in a scenario with higher diameter growth rates reflecting “active investment” in forest management (see Adams et al. 1982 for details). The results, in both the Pacific Northwest and South, were roughly stable to declining prices 10 years into the projection. Over the period to 2030, at least, this projection is much closer to the current assessment base than the static investment and growth scenario of the 1979 base.

The mixed outlook for hardwoods has also been foreseen in assessment projections since 1989. Harvest rises rapidly and exceeds growth on southern hardwood lands by 2010, pushing inventory steadily downward and prices up. Harvest also expands in the North but remains below growth, with price increases much slower than in the South. Changes in inventory projection methodology, in the case of hardwoods, have allowed a better representation of declining growth rates in the

face of limited investments in hardwood silviculture and a shrinking hardwood land base.

### Softwood Timber and the US South

In the context of privately owned timberland, the South is the largest timber-producing region both in terms of area and volume. With 37 million acres of industrial timberland, the South has more than twice the area devoted to timber production as does its nearest rival, the North, and more than all other (western plus northern) regions combined. The South supports a broad non-industrial base (also larger than all other regions combined), with a significant area managed for timber under miscellaneous corporate ownership and a large number of acres leased to industry.

*Table 1* suggests that the majority (79 percent) of the projected increases in softwood harvests will come from the South, owing to a combination of growth in available inventories and market forces. As discussed in earlier articles in this series, investment by private landowners increases available

softwood inventories by pushing up the rate of growth and the volume per unit of area harvested. The South continues to account for roughly two-thirds of all roundwood removals. Expanding forest inventories and modest increases in stumpage prices ultimately lead to increased wood processing capacity. This industry evolves along with a highly productive resource base that depends on high levels of investment designed to produce sawtimber and wood fiber on relatively short rotations of 20 to 30 years.

These projections have some notable implications. First, the current (1997) harvest intensity, as measured by the percent of timberland area annually disturbed for harvest, is almost twice as high in the South as the Pacific Coast and three times as high as the North and Intermountain regions. As projected harvest expands in the South, the percent of area disturbed for harvest increases. While the area treated for partial harvest is projected to be relatively stable, averaging 1.3 million acres per year, the area treated with clearcutting

**Table 1. Softwood and hardwood timber harvest and growing stock inventory in the United States by region, 1952–97 with projections to 2050.**

| Item                           | 1952    | 1962    | 1970    | 1976    | 1986    | 1991    | 1997    | Projections |         |         |         |         |
|--------------------------------|---------|---------|---------|---------|---------|---------|---------|-------------|---------|---------|---------|---------|
|                                |         |         |         |         |         |         |         | 2010        | 2020    | 2030    | 2040    | 2050    |
| ..... Million cubic feet ..... |         |         |         |         |         |         |         |             |         |         |         |         |
| <b>North*</b>                  |         |         |         |         |         |         |         |             |         |         |         |         |
| <i>Softwoods</i>               |         |         |         |         |         |         |         |             |         |         |         |         |
| Removals                       | 622     | 528     | 583     | 692     | 725     | 723     | 674     | 644         | 612     | 609     | 616     | 621     |
| Harvest                        | 596     | 501     | 549     | 636     | 908     | 940     | 825     | 817         | 786     | 790     | 806     | 818     |
| Net annual growth              | 972     | 1,212   | 1,336   | 1,558   | 1,288   | 1,214   | 1,175   | 1,199       | 1,158   | 1,108   | 1,058   | 1,017   |
| Inventory                      | 27,053  | 33,661  | 38,817  | 43,850  | 47,618  | 50,977  | 49,376  | 56,742      | 61,201  | 65,206  | 68,480  | 71,532  |
| <i>Hardwoods</i>               |         |         |         |         |         |         |         |             |         |         |         |         |
| Removals                       | 1,279   | 1,391   | 1,722   | 1,801   | 1,982   | 2,029   | 2,088   | 2,135       | 2,306   | 2,364   | 2,449   | 2,544   |
| Harvest                        | 1,381   | 1,329   | 1,465   | 1,502   | 3,190   | 3,684   | 2,713   | 3,070       | 3,341   | 3,639   | 3,869   | 4,113   |
| Net annual growth              | 2,743   | 3,213   | 3,593   | 3,790   | 4,223   | 4,148   | 4,169   | 4,126       | 4,060   | 3,955   | 3,830   | 3,697   |
| Inventory                      | 76,695  | 94,627  | 106,867 | 119,158 | 142,420 | 156,142 | 164,905 | 195,597     | 212,565 | 226,549 | 238,029 | 247,573 |
| <b>South</b>                   |         |         |         |         |         |         |         |             |         |         |         |         |
| <i>Softwoods</i>               |         |         |         |         |         |         |         |             |         |         |         |         |
| Removals                       | 3,122   | 2,823   | 3,674   | 4,437   | 5,740   | 5,840   | 6,481   | 5,921       | 6,972   | 7,966   | 8,537   | 9,206   |
| Harvest                        | 3,036   | 2,707   | 3,527   | 4,251   | 5,317   | 5,282   | 6,157   | 5,703       | 6,743   | 7,722   | 8,299   | 8,954   |
| Net annual growth              | 3,641   | 4,699   | 5,644   | 6,314   | 5,500   | 5,100   | 5,892   | 7,519       | 8,195   | 8,670   | 8,925   | 8,777   |
| Inventory                      | 60,462  | 75,087  | 89,156  | 101,208 | 105,613 | 102,927 | 104,847 | 116,087     | 132,588 | 143,950 | 150,192 | 149,326 |
| <i>Hardwoods</i>               |         |         |         |         |         |         |         |             |         |         |         |         |
| Removals                       | 2,731   | 2,832   | 2,344   | 2,241   | 2,958   | 3,086   | 3,630   | 4,247       | 4,581   | 4,848   | 4,954   | 4,921   |
| Harvest                        | 1,933   | 1,662   | 1,840   | 1,707   | 2,931   | 2,914   | 3,366   | 4,588       | 4,700   | 4,700   | 4,684   | 4,650   |
| Net annual growth              | 3,040   | 3,394   | 4,282   | 5,009   | 4,488   | 4,731   | 4,877   | 4,781       | 4,527   | 4,434   | 4,474   | 4,465   |
| Inventory                      | 88,008  | 98,985  | 109,271 | 122,165 | 139,027 | 147,667 | 151,783 | 156,772     | 158,025 | 154,954 | 150,197 | 145,366 |
| <b>Rocky Mountains</b>         |         |         |         |         |         |         |         |             |         |         |         |         |
| <i>Softwoods</i>               |         |         |         |         |         |         |         |             |         |         |         |         |
| Removals                       | 534     | 738     | 889     | 842     | 839     | 841     | 517     | 638         | 657     | 678     | 700     | 696     |
| Harvest                        | 497     | 684     | 812     | 773     | 876     | 996     | 612     | 781         | 825     | 864     | 902     | 912     |
| Net annual growth              | 1,101   | 1,256   | 1,446   | 1,594   | 1,956   | 1,985   | 2,026   | 2,251       | 2,094   | 1,921   | 1,796   | 1,696   |
| Inventory                      | 87,545  | 93,222  | 94,275  | 95,111  | 100,298 | 101,487 | 114,682 | 133,311     | 148,578 | 162,265 | 174,359 | 185,255 |
| <i>Hardwoods</i>               |         |         |         |         |         |         |         |             |         |         |         |         |
| Removals                       | 34      | 24      | 24      | 21      | 17      | 40      | 27      | 44          | 48      | 52      | 55      | 56      |
| Harvest                        | 10      | 13      | 12      | 4       | 30      | 14      | 44      | 92          | 98      | 103     | 110     | 113     |
| Net annual growth              | 87      | 97      | 117     | 136     | 168     | 167     | 434     | 190         | 158     | 162     | 163     | 153     |
| Inventory                      | 5,074   | 5,595   | 6,034   | 6,138   | 7,681   | 8,863   | 9,360   | 6,004       | 6,317   | 6,537   | 6,702   | 6,815   |
| <b>Pacific Coast</b>           |         |         |         |         |         |         |         |             |         |         |         |         |
| <i>Softwoods</i>               |         |         |         |         |         |         |         |             |         |         |         |         |
| Removals                       | 3,484   | 3,514   | 4,039   | 4,024   | 4,057   | 3,460   | 2,451   | 2,431       | 2,537   | 2,502   | 2,681   | 2,847   |
| Harvest                        | 3,393   | 3,429   | 3,805   | 3,850   | 4,189   | 3,765   | 2,507   | 2,548       | 2,667   | 2,633   | 2,811   | 2,991   |
| Net annual growth              | 2,021   | 2,444   | 2,904   | 3,034   | 3,777   | 3,673   | 4,460   | 4,779       | 4,791   | 4,863   | 4,955   | 4,894   |
| Inventory                      | 256,729 | 247,785 | 237,754 | 226,787 | 199,382 | 194,502 | 214,937 | 242,846     | 265,975 | 289,549 | 314,360 | 335,975 |
| <i>Hardwoods</i>               |         |         |         |         |         |         |         |             |         |         |         |         |
| Removals                       | 43      | 77      | 115     | 125     | 115     | 142     | 118     | 340         | 314     | 290     | 271     | 257     |
| Harvest                        | 37      | 62      | 87      | 102     | 145     | 264     | 172     | 525         | 491     | 460     | 436     | 425     |
| Net annual growth              | 304     | 389     | 485     | 486     | 681     | 604     | 597     | 643         | 645     | 638     | 638     | 643     |
| Inventory                      | 14,093  | 16,413  | 19,197  | 18,437  | 23,220  | 22,776  | 26,080  | 32,717      | 36,626  | 40,756  | 44,914  | 49,242  |
| <b>Totals</b>                  |         |         |         |         |         |         |         |             |         |         |         |         |
| <i>Softwoods</i>               |         |         |         |         |         |         |         |             |         |         |         |         |
| Removals                       | 7,762   | 7,603   | 9,185   | 9,995   | 11,362  | 10,864  | 10,123  | 9,633       | 10,778  | 11,756  | 12,534  | 13,371  |
| Harvest                        | 7,522   | 7,321   | 8,695   | 9,510   | 11,289  | 10,983  | 10,101  | 9,848       | 11,021  | 12,009  | 12,818  | 13,674  |
| Net annual growth              | 7,734   | 9,611   | 11,338  | 12,501  | 12,521  | 11,973  | 13,553  | 15,748      | 16,237  | 16,562  | 16,733  | 16,385  |
| Inventory                      | 431,789 | 449,755 | 460,002 | 466,956 | 452,911 | 449,893 | 483,842 | 548,985     | 608,342 | 660,970 | 707,392 | 742,088 |
| <i>Hardwoods</i>               |         |         |         |         |         |         |         |             |         |         |         |         |
| Removals                       | 4,087   | 4,330   | 4,208   | 4,191   | 5,083   | 5,299   | 5,866   | 6,796       | 7,283   | 7,590   | 7,768   | 7,818   |
| Harvest                        | 3,361   | 3,066   | 3,405   | 3,316   | 6,323   | 6,875   | 6,299   | 8,346       | 8,707   | 8,985   | 9,188   | 9,393   |
| Net annual growth              | 6,175   | 7,095   | 8,478   | 9,423   | 9,561   | 9,650   | 10,086  | 9,740       | 9,389   | 9,190   | 9,106   | 8,959   |
| Inventory                      | 183,870 | 215,620 | 241,369 | 265,898 | 312,348 | 335,448 | 352,128 | 391,090     | 413,534 | 428,796 | 439,842 | 448,996 |

\*Includes Great Plains states.

NOTES: Harvest data for 1952, 1962, 1970, 1976, 1986, and 1991 are estimates of the trend level of harvests and differ somewhat from the estimates of actual consumption shown in some tables. For the projection years, the data show the volume that would be harvested given the assumptions of the study. Inventory data for 1952 and 1962 are as of December 31. Inventory data for 1970 and the projection years are as of January 1. Inventory data shown under 1976, 1987, 1991, and 1997 are as of January 1 of the following year.

SOURCE: Haynes (in press).

risers from 1.3 to 1.9 million acres per year. Second, growing stock removals as a percentage of growing stock inventories rises in the South, while in other regions that ratio remains fairly constant. Third, at the same time, the projections do not imply that the majority of southern forest acres will be shifted into pine plantations. At present, plantations comprise 14 percent of the southern private timberland base and provide 16 percent of southern private harvest (all species). By 2050, in the base projection, plantations occupy 23 percent of the timberland base and provide 46 percent of the harvest. Thus, a large increment in harvest is derived from a much smaller increment in the land base, reducing harvest pressure on the remaining nonplantation stands.

Within the southern projection there are cycles in growth and harvest that derive in part from unequal concentrations of land area in certain age groups in the southern private inventory. One such cycle will commence in the 2000–10 period, as large areas of young pine stands reach the ages of most rapid volume accumulation and inventory rises rapidly. These cycles derive from past harvest and investment decisions, and their future extent and persistence are influenced by similar decisions today.

### Sustainability

The United States is committed to following the Montreal Process in assessing the sustainability of forest management. The Montreal Process provides a broad basis for discussing forest management organized around 67 indicators of resource, economic, and social conditions grouped into seven broad criteria. The current assessment results provide a number of both direct and proxy measures for some of these indicators. These data, grouped by criterion at the national level, are shown in *table 2* (p. 42). Criterion 1 relates to conservation of biological diversity, criterion 2 to the maintenance of the productive capacity of the forest ecosystem, and criterion 6 to maintenance and enhancement of long-term socioeconomic benefits to meet the needs of society. Direct measures are extent of area by forest type (percent of timberland in

softwood types), area of timberland, total growing stock, ratio of removals to net growth, and consumption of wood products. Indirect or proxy measures are average diameter of private timber stands (for extent of area by age class or successional stage), annual area harvested (as a measure of fragmentation of the land base), and harvest volume (as a proxy for wood product production). The data were developed by aggregating regional data and are shown as indices computed by dividing each value by the 1952 value for that series. The exceptions are the ratio of removals to growth and the softwood proportion of total inventory.

With the current assessment data the issue of sustainability can be considered within a two-dimensional framework, viewing measures of sustainability both at a point in time as well as their variation over time. Data in *table 2* show that there has been an adverse movement in many of the criteria 1 and 2 indicators over the historical period but that this decline has slowed in the recent past. During this same period, the measure from criterion 6 has increased, suggesting a tradeoff took place between ecological conditions and economic growth. Slower declines in the criteria 1 and 2 measures in recent years may indicate that improving forest management and increased productivity of forestlands have helped reduce the extent of the tradeoff in some cases. For example, increases in average stocking levels have helped to reduce the area harvested for a given volume removed

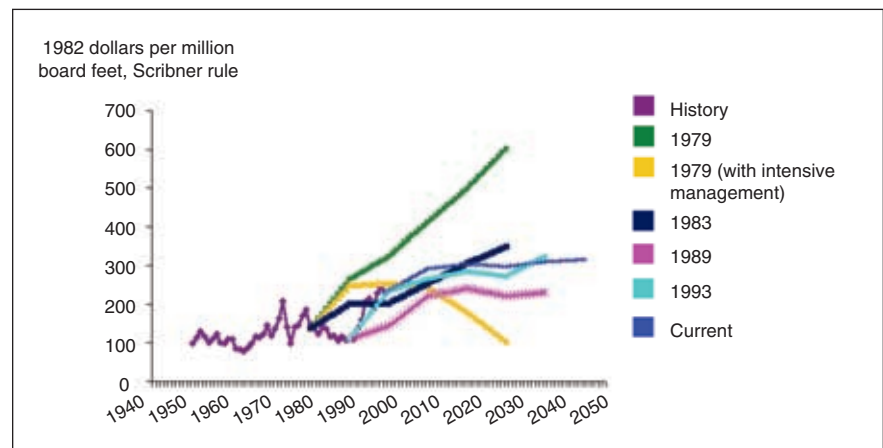
(hence reducing the fragmentation measure), and there has been a slowing in the shift from softwoods to hardwoods.

For the future, the projection indicates approaching stability in many of the indicators. Harvest area (fragmentation) falls slowly with waves of new stands reaching maturity, primarily in the South. Harvest rises, growth remains above harvest, and inventory expands.

These results suggest that, at the national level, the future sustainability debate might be framed more in terms of balancing both economic development and environmental gains rather than the traditional “economy or environment” confrontation. At the same time, these national indices hide significant regional and owner-level tradeoffs: For example, most of the increase in softwood inventories comes in the West, but nearly all of the increases in softwood harvest come in the South; southern hardwood harvest exceeds growth after 2010, while northern hardwood inventories grow markedly above current levels. Clearly, conclusions about sustainability can vary at different geographic scales.

### Western Forest Health and Small Logs

The forests of the Interior West face unique forest health and fire hazard issues that have been compounded by federal, state, and local efforts to suppress or limit forest fires since the early 1900s and have led to a set of conditions that significantly depart from the historical or “natural” conditions (Hann et al. 1997). Public attention



**Figure 1. Softwood sawtimber stumpage prices in the South, with projections from five RPA Timber Assessments.**

now focuses on the potential for treatments such as thinning to remove excessive accumulation of smaller-diameter timber to reduce the risks of wildfire. (In this context small-diameter timber are stands whose average diameter is roughly 8 inches dbh in an area where sawtimber is conventionally thought of as starting at 11 inches dbh.)

The current assessment results suggest that it is unlikely that there will be sufficient markets or productive capacity to process the material removed in these thinning operations. Currently, sawmills in the Interior West use roughly 830 million cubic feet of logs with an average diameter of nearly 11 inches with the emphasis on larger green logs. The pulp and paper industry uses about 1 billion cubic feet of mill residues and cull logs. Given the prospective small size of the timber expected to be removed in restoration strategies, forest products based on the use of pulpwood have the greatest potential for profitably using the largest volumes of timber. There are also many smaller enterprises that use some small-diameter timber, such as small-log sawmills, log cabin manufacturers, and wooden pole and post producers, along with various other types of smaller-scale, wood-based enterprises. But the volume used by these enterprises is relatively small.

Pulpwood consumption in the Interior West has fallen since the mid-

1980s, as processing capacity has adjusted to higher-cost federal timber associated with declining public harvests. There have been notable declines in regional production capacity for products such as wood pulp and oriented strand board (OSB) despite the fact that such technologies expanded elsewhere in the United States. Investments in these types of capacity require large capital outlays, and exposure to uncertain pulpwood supply is undoubtedly a risk factor that inhibits new mill investments. This lack of investment will likely have profound implications for forest management opportunities in the region, especially the opportunity to commercially thin large volumes of small-diameter timber to restore ecosystem health.

Little consideration has been given to the magnitude of the market impact and market challenge presented by thinning large volumes of timber on public lands. There is no guarantee that there will be a future match between volumes of small logs, which can be produced by thinning operations on public lands, and the regional timber market's capacity to economically absorb those volumes.

### Forest Fragmentation

The current assessment estimates that approximately 17 million acres of US forestland will be converted to

urban and developed uses over the next 50 years, if historical trends continue. These land-use conversions will contribute to an increasingly fragmented forest landscape, with more forested areas being surrounded by, or adjacent to, houses, streets, parking lots, and shopping malls. In addition, timber harvesting and other human activities within the forest will continue to disturb and alter past geographic patterns of vegetation. Forest fragmentation can also result from disturbances that are initiated by natural processes such as fire, wind, and flooding. Often, human and natural agents interact to either enhance or lessen the resulting fragmentation effects. A significant difference between human-caused and naturally caused fragmentation is that human actions are often more frequent, less random, and more permanent than natural disturbances.

Forest fragmentation resulting from changing land-use and land-cover patterns is of growing concern because of its potential impacts on wildlife habitat, timber supply, and related issues. Although some wildlife species need the edge habitat present in fragmented forested areas, "too much edge" has many unfavorable consequences for wildlife, including increased populations of invasive and non-native species that thrive in edge areas, changes in local biotic and abiotic environments,

**Table 2. Selected sustainability indicators for the United States.**

| Year | Criterion 1:<br>Biodiversity conservation |                                      |                               | Criterion 2:<br>Productive capacity of<br>forest ecosystem |   |                                  | Criterion 6:<br>Socioeconomic<br>benefits |
|------|---|--------------------------------------|-------------------------------|--|---|----------------------------------|---|
|      | Extent of<br>softwood<br>area             | Extent of<br>older stands<br>(index) | Fragmen-<br>tation<br>(index) | Area of<br>timberland<br>(index)                           | Total growing<br>stock inventory<br>(index) | Ratio of<br>growth to<br>harvest | Total<br>harvest<br>(index)               |
| 1952 | 70%                                       |                                      | 100                           | 100  | 100   | 128%                             | 100                                       |
| 1962 | 68  |                                      | 89                            | 99   | 108   | 161                              | 95  |
| 1970 | 66  |                                      | 97                            | 97   | 114   | 164                              | 111                                       |
| 1976 | 64  | 100                                  | 96                            | 95   | 119   | 171                              | 118                                       |
| 1986 | 59  | 76                                   | 124                           | 96   | 124   | 125                              | 162                                       |
| 1991 | 57  | 74                                   | 124                           | 99   | 128   | 121                              | 164                                       |
| 2000 | 58  | 67                                   | 110                           | 99   | 136   | 144                              | 151                                       |
| 2010 | 58  | 66                                   | 108                           | 98   | 153   | 140                              | 167                                       |
| 2020 | 60  | 65                                   | 107                           | 97   | 166   | 130                              | 181                                       |
| 2030 | 61  | 65                                   | 106                           | 97   | 177   | 123                              | 193                                       |
| 2040 | 62  | 65                                   | 105                           | 96   | 186   | 117                              | 202                                       |
| 2050 | 62  | 65                                   | 105                           | 96   | 193   | 110                              | 212                                       |

NOTE: Indexes equal 100 in base years unless otherwise noted.

and associated losses in biodiversity. Timber supply may decline as fragmentation grows in the face of increasingly diverse and labile landowner objectives and rising costs of management with declining parcel size.

In policy deliberations, fragmentation should be considered within the broader context of regional and local land development and infrastructural decisions. Policies to promote dispersed development, such as zoning regulations and development of road and transportation systems, can lead to fragmentation as an unintended by-product. Research also is needed to develop a better understanding of fragmentation, its extent, location, and rate of change. This will involve the development of a long-term database with comprehensive geographic coverage in key forested areas.

### Private Lands and Timber Supply

Over the past decade, policy decisions at state and federal levels have acted to sharply limit the role of public forestlands in the supply of timber. Assuming a continuation of these policies, the current assessment projection envisions public lands of all types providing only some 8 percent of total growing stock removals (all species) by 2050, compared to nearly 20 percent on average over the 1977–90 period. Thus, the future of the US timber supply rests largely with the 350 million acres of privately owned timberland. As a conse-

quence, there is a considerable need to better understand the determinants of timber supply behavior on these lands.

This is certainly not a new issue in US forestry, but it has taken on a new urgency. Research over the past 40 years has given us some insights into harvest behavior and policy responses of both industrial and nonindustrial private forestland (NIPF) owner groups. But as the structure of the US forest industry evolves in a changing economy and the composition of NIPF owners continues to shift, these issues must be frequently readdressed. At the most basic level, we must learn more about private owners' land-use decisions, why they choose to keep land in forestry or convert it to agricultural or other uses, or to afforest land previously in nonforest uses. To understand the long-term outlook, we also must have some knowledge of the motivations for and extent of private investments in forest management, and when and how landowners choose to conduct reforestation and other silvicultural activities. Finally, we need better insights into the decisions to harvest currently mature stands and how these decisions vary with type of owner, market conditions, and characteristics of the stand. As this research accumulates, we will gain a better understanding of how owners may respond to incentives, regulations, and other public policy tools.

Our approaches to timber assessments have evolved greatly during the past 25 years, stimulated both by

methodological improvements and the expanding scope and complexity of forest policy issues. These same forces will shape future assessments. In the end, assessments are needed to act as a foundation for helping resource managers anticipate problems that can be alleviated by actions of present generations. As Solomon noted 2,600 years ago, one generation comes and another goes, but the land remains forever.

### Literature Cited

- ADAMS, D.M., R.W. HAYNES, G.F. DUTROW, R.L. BARBER, and J.M. VASIEVICH. 1982. Private investment in forest management and the long-term supply of timber. *American Journal of Agricultural Economics* 64(2):232–41.
- HANN, W.J., J.L. JONES, M.G. KARL, et al. 1997. Landscape dynamics of the basin. In *An assessment of ecosystem components in the Interior Columbia Basin and portions of the Klamath and Great Basins: Volume 2*, tech. eds. T.M. Quigley and S.J. Arbelbide, 337–1055. General Technical Report PNW-GTR-405. Portland, OR: USDA Forest Service, Pacific Northwest Research Station.
- HAYNES, R.W. In press. *An analysis of the timber situation in the United States: 1952–2050*. General Technical Report. Portland, OR: USDA Forest Service, Pacific Northwest Research Station.
- USDA FOREST SERVICE (USDA-FS). 1958. *Timber resources for America's future*. Forest Resources Report 14. Washington, DC: US Government Printing Office.
- . 1973. *The outlook for timber in the United States*. Forest Resources Report 20. Washington, DC: US Government Printing Office.

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